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A CLINICAL TEXT-BOOK

OF

SURGICAL DIAGNOSIS AND TREATMENT

FOR

PRACTITIONERS AND STUDENTS OF SURGERY AND MEDICINE.

BY

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WITH 328 ILLUSTRATIONS.

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JAN 18 1950

TO

JOSEPH BELL, Esq., F.R.C.S.,

FROM WHOSE LIPS I RECEIVED MY FIRST LESSONS IN SURGERY,

THIS WORK IS GRATEFULLY DEDICATED BY

THE AUTHOR.

PREFACE.

THE rapid advances made in the art of surgery have caused the literature of the science to grow apace. Systems of surgery in many volumes, and text-books of large dimensions, are now deemed necessary to cover the field. The practical part of the surgeon's work is, however, almost limited to two questions which he must answer every time his professional advice or help is sought. The first question is, "What is the disease or injury?" The second question is, "What is the proper treatment?"

While I would not for a moment underestimate the importance of a profound study of the principles of surgery, of surgical pathology, or of bacteriology, the present work will be confined to a solution of the two questions just mentioned with the view of putting into the hands of students and practitioners a single volume containing the most practical part of practical surgery.

The young practitioner is often embarrassed by not knowing how to make a systematic examination in a case of injury, and he may be placed at a disadvantage by the criticism of excited bystanders. The man who goes about the examination of his patient in a systematic manner, leaving nothing undone and guarding against all contingencies, will not only command the approval of the patient and his friends, but will protect himself against dangerous errors. In the following pages care is taken to make the examination of each disease or injury systematic and comprehensive, and, when possible, directions are laid down as to the methods of examination.

The surgery of the eye, the ear, and the skin is now so generally left to the care of specialists in these respective fields that I have thought it best to refer the reader to works exclusively devoted to these studies.

While the field of medical diagnosis has been well covered by such excellent works as those of DaCosta, Musser, Vierordt, and others, surgical diagnosis up to the present time is not dealt with in any work that claims to represent the most recent surgical knowledge; at the same time the profession may almost be said to have stampeded to surgery. This very popularity of surgery, especially among young practitioners, is not free from a serious danger—viz. that in being

absorbed with the thought of the operation that may be required the mind of the surgeon dwells too lightly upon the diagnosis of the disease. I send this work upon its mission with the hope that the reader may be led into the habit of making every examination systematic and exhaustive, that he may find help in the diagnosis of difficult cases, and that his labors may be thereby lessened and his responsibilities lightened.

I take this opportunity of expressing my deep obligations to Drs. Hoegh, Bartlett, Hall, Ferro, and others for valuable suggestions; to Dr. Florence M. Baier, Dr. Findley, Dr. Mowat, and Dr. C. B. Roberts for long-continued and patient labor in collecting and arranging materials; and to the many friends who have contributed illustrations.

J. W. MACDONALD.

MINNEAPOLIS, November, 1897.

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SURGICAL DIAGNOSIS AND TREATMENT.

CHAPTER I.

GENERAL EXAMINATION OF PATIENTS.

Introduction.—Year by year the scope of surgery is expanding, and as new territory is added to his domain the surgeon must widen his field of investigation. Until a few years ago he worked within a narrow sphere, and devoted about as little time to the study of diseased conditions in the abdominal, thoracic, and cranial cavities as the modern oculist gives to general medicine. All this is changed. To-day there is no organ of the body beyond the legitimate field of surgery, no cavity whose innermost recesses cannot be explored.

It is possible in many surgical diseases and injuries to take in the situation at a glance and instantly to decide upon a plan of treatment; as, for example, in fractures, dislocations, diseases of joints, and in certain tumors; but in the broader field of modern surgery every known method of diagnosis must be employed. A systematic and complete examination of his cases is therefore as necessary to the surgeon as to the physician.

While the surgeon's case-taking need not, as a rule, be lengthy, it should be systematic and comprehensive. The discovery of one disease or injury should not end the investigation. Every organ and system should pass under review, so that there shall be no possibility of any important point being overlooked.

To the student or the young practitioner the formation of a habit of recording his cases in this manner will prove invaluable. By it he trains his powers of observation, collects material from which he can draw conclusions, and, most important of all, avoids errors into which many of his seniors have fallen.

It cannot be denied that the wider application of operative procedures increases these dangers. To operate upon a pyosalpinx, and afterward to find that the patient is not benefited owing to the existence of long-standing tuberculosis in the lung, may be a triumph in technique, but it is a blunder in diagnosis. It is sadly disappointing, when a patient submits to clamp and cautery for the relief of hemorrhoids, to find, a few weeks later, that his days are drawing to a close by reason of a carcinomatous liver, which existed but was not thought of at the time of the operation. None but those who have suffered thereby can realize what it is to have treated a fracture of the humerus and to be confronted months afterward with a dislocation at the elbow that was overlooked at the first examination.

In the diagnosis of any surgical disease or injury a decision must be arrived at by two lines of evidence—that derived from the patient or the friends of the patient, and that obtained by the surgeon's own objective examination.

Information Obtained from the Patient or his Friends.—No matter how clear a case may appear or how urgent the demand for our assistance, we should not neglect this part of our examination. If called to a case of fracture, do not immediately begin to manipulate the injured limb. While removing your overcoat or gloves it is easy to inquire how the accident happened or in what position the patient was standing or lying when he was injured. A few questions of this character will elicit information which may influence your examination and prove helpful in the diagnosis. For example, a fall upon the outstretched hands is apt to produce Colles's fracture, or upon the shoulder fracture of the clavicle, or upon the knee—with a strong effort on the part of the patient to save himself—fracture of the patella. A history of an injury caused by jumping from a rapidly-moving railway or street car and landing upon the feet excites our suspicion that a fracture of the fibula has been sustained.

In every case the following points should be noted under the heading of history: Name; address; occupation; age; sex; family history; heredity; habits, etc.; previous residences; former diseases or injuries and results; previous operations.

1. *Age* has an important bearing upon our examination. Sarcoma attacks persons of all ages, but particularly young people. Carcinoma is exceedingly rare before thirty years of age, and common after forty. Tuberculosis of bones and joints is most common in childhood. Inflammation of joints in children is, in nearly all cases, an osteitis, while in adults it not uncommonly begins as a synovitis. Goiter rarely occurs before the ninth year.

2. *Heredity.*—Our ideas on the question of heredity have undergone considerable change. Formerly it was supposed that a tubercular child must, almost of necessity, be the offspring of tubercular parents. While Baumgarten asserts that it arises more frequently by inheritance than in any other way, the general opinion at present is that, although the bacillus may undoubtedly be transmitted from parent to offspring, the more frequent result of heredity is only a predisposition to the disease. In other words, the child of tubercular parents rarely, if ever, inherits the disease; he is more likely to acquire it when exposed to the bacillus tuberculosis.

Syphilis is a disease in which heredity plays a most important part. The poison can be transmitted through the ova and spermatozoa, so that the characteristic lesions make their appearance before or shortly after birth. It must also be borne in mind that the disease can be thus transmitted long after the power is lost of communicating it by direct contact.

Cancer is not now believed to be so markedly hereditary as was formerly supposed, although its tendency to run in families cannot be denied. It would appear that races and nationality have an influence upon heredity. The whites of the Southern States are more than twice as liable to cancer as the negroes of the same region. The tendency

to tuberculosis, on the other hand, is greater in the negro than in the white. Jews are less liable than other whites to cancer and consumption, but they are specially liable to diabetes and to certain degenerations of the spinal cord in their declining years.

In examining for the evidence of heredity the patient should be questioned concerning the health of his parents, brothers, sisters, aunts, and uncles. It occasionally happens that an hereditary disease skips over a generation (atavism); hence we must inquire into the history of the grandparents on both sides.

3. *Sex.*—Apart from diseases peculiar to each sex, there are certain surgical diseases and injuries which, although common to both, show marked preference for the one or the other. Cancer is more common in females, owing to the frequency with which it attacks the mamma and the uterus. Sarcoma is more frequent in males, from the fact that they are more exposed to blows and other traumatic causes which so often precede sarcomata. The same rule applies to fractures. Goiter is much more frequent in women.

4. The manner of living, habits, occupation, ability to endure fatigue, residence, and, in the case of women, whether married or single, also the number of children, if any,—all of these are important points in evidence upon which we must return a verdict.

In the matter of living, the diet, habitation, hygienic surroundings, and the clothing must be taken into account. The appetites, the use of alcohol and tobacco, venereal excesses, and other abuses play an important part.

Previous residences must be noted. Natives of Iceland are liable to echinococcus; residents of tropical countries are liable to abscess of the liver. Certain districts are conducive to goiter, and others to calculus of the bladder. Sterility in either sex and miscarriages in females create a suspicion of syphilis, while the puerperal period in itself may be a source of grave disease, as, for instance, extra-uterine pregnancy, in the treatment of which some of the brightest victories of modern surgery have been won.

Many cases of sarcoma can be traced back to a fracture or other traumatism. Brain-abscess or blood-clot or epilepsy may manifest its presence weeks or months after the receipt of a blow which caused fracture of the skull.

History of the Present Disease or Injury.—The patient or his friends should be required to give the particulars, as far as they can, of the present disease or injury, the manner in which the first departure from health was felt, and the circumstances under which an accident occurred, the direction and force of a missile, and the position of the body of the injured person at the time of the accident. In cases which are at all likely to come into court these points, although apparently insignificant, should receive close attention, as they may attain great prominence during the trial.

Examination of the Patient.—Having noted down the information which can be obtained from the patient or his friends, the surgeon next devotes himself to a systematic examination of the case. This is done under two heads: 1. General; 2. Special.

General Examination.—Under this heading will be comprised

(1) *the general appearance of the patient*—whether emaciated or well-nourished, well-developed or deformed; the condition of his mind—whether calm, excited, depressed, delirious, etc.

(2) *The Position of the Patient.*—Much valuable testimony may be obtained by noting the position which the patient assumes while lying in bed. A person in good health or only slightly ill will naturally lie upon his back or in an easy posture on one or other side. In a state of great weakness or when consciousness is impaired the patient is inclined to slide down toward the foot of the bed. Dyspnea induces a person to maintain a sitting posture, while inflammation of the lungs or pleura causes him to lie in the posture which gives most steadiness, usually upon the affected side. In peritonitis the sufferer lies on his back with the limbs drawn up, and cannot even bear the weight of the bed-clothes. In cerebral meningitis the head is drawn backward, burrowing, as it were, into the pillow. In localized inflammation of the brain the head is persistently held to one side. When the cerebellum or crura cerebelli are the seat of disease, it is not uncommon to see the whole body drawn sharply to one side, and immediately returning to this position if disturbed.

(3) *Surface-markings and Changes of Contour.*—Under this head will be noted any scars, deformities, changes in the shape of limbs, etc. It will embrace tumors, deformities from old or recent fractures, dislocations, etc.

(4) *The Condition of the Skin.*—(*a*) Color: Redness may be due to hyperemia, by which is meant an increase of the quantity of blood in the vessels of the part, or to an escape of blood from the vessels (extravasation.) It is a very simple matter to decide which of these conditions is producing the redness. Light pressure will empty the vessels in hyperemia and cause a momentary paleness; upon extravasations or purpura pressure has no effect.

Besides paleness or redness, certain modifications of color are deserving of notice. One-sided redness of the face indicates localized vasomotor paralysis and is suggestive of hemicrania. A characteristic sallow hue with shiny appearance is given to the skin in sudden and severe hemorrhage. Prof. Syme was in the habit of drawing our attention to the peculiar appearance of the faces of those who suffered repeated loss of blood from hemorrhoids. Cyanosis, or blue-red skin, is due to an accumulation of carbonic acid and a deficiency of oxygen in the capillaries. It arises in connection with disturbed respiration and circulation through the lungs. It may also occur in the greater circulation, and be either general or local according to the extent of obstruction. Cyanosis is seen in the following conditions: spasm of the glottis; tumors of the larynx; acute and chronic inflammation of the larynx or trachea; foreign bodies in the air-passages; goiter or other tumors which press upon the larynx or trachea; mediastinal tumors; bronchitis; aneurysm of the aorta; and in any condition which prevents complete expansion of the lungs, such as pleuritic or pericardial effusion, thoracic tumors, and peritonitis when it produces paralysis of the diaphragm, etc.

The yellow or jaundiced or icteric skin is of interest to us in the surgery of the liver and gall-bladder. It is not, as a rule, an indication

of abscess of the liver; in fact, its existence may be said to be an argument against the diagnosis of abscess.

Obstruction in the hepatic duct or the common bile-duct produces jaundice, while obstruction in the cystic duct does not. One of the most common causes is the presence of gall-stones. It may also be produced by any tumors which press upon the duodenal orifice of the ductus communis choledochus, and especially cancer of the head of the pancreas. A practical point worth remembering is that jaundiced patients bleed more freely during operations than do others.

Scars are especially worthy of notice, but in no location are they so important as on the scalp. A scalp wound dressed in the drug-store style, with no regard for asepsis, may heal, to all appearance, in a satisfactory manner, but at the same time germs may find their way through the skull along the vessel-channels and lead to cerebral abscess later on.

(5) *Temperature.*—High temperature is present in fever, inflammatory disease, and some nervous conditions. It is important as indicating the absorption of septic material from a wound or pus-cavity, and is a reliable indication for a removal or change of dressings. After operations of any magnitude there is during the first forty-eight hours a rise of temperature known as fermentation or aseptic fever, which may reach 102° F., without exciting any uneasiness.

Subnormal temperatures occur temporarily in severe hemorrhages, in chronic diseases of the heart and lungs, and in most chronic wasting diseases. A sudden fall of temperature, accompanied by weakness of the heart and general prostration, is spoken of as collapse. Continued low temperature is rare, but it may be found in abscess, in inflammation of the brain, and in some wasting diseases. In acute alcoholism the temperature has been observed as low as 75° F.

Local Changes in Temperature.—A local increase in temperature is indicative of inflammation or paralysis of the vasomotor nerves of the part. A lowered temperature is indicative of disturbance of the circulation. It is commonly found in venous thrombosis. In paralysis of a nerve the local temperature is usually first increased and afterward diminished.

The knowledge gained by the general examination will point to one or more of the special organs or systems of the body as the seat of the disease. The examination will be continued by making a minute and careful study of the special system or organ to which the symptoms so far point. Having exhausted that part, the other systems and organs are systematically examined. Our special study, therefore, will comprise—

1. The Vascular System;
2. The Osseous System;
3. The Joints;
4. The Digestive System;
5. The Genito-urinary System;
6. The Nervous System;
7. The Respiratory System;
8. Morbid Growths;
9. The Female Generative Organs.

CHAPTER II.

EXAMINATION OF THE VASCULAR SYSTEM.

I. THE HEART AND PERICARDIUM.

HAVING removed the patient's clothing so as to expose the chest, the student will find it useful to begin by counting the ribs. The novice may have a little difficulty in distinguishing the first rib. It is covered in its outer half by the clavicle, but near the sternum it lies below the clavicle. Follow the front of the sternum from its notch downward. About 1½ inches from the suprasternal notch the fingers will feel a ridge on the bone. This is the junction of the manubrium with the gladiolus, and is exactly opposite to the insertion of the second rib. Having definitely settled the location of either the first or second rib, it is an easy matter to count downward. (Mark with your pencil the third costal cartilage on the right side and the sixth costal cartilage on the left side: these points represent the upper and lower limits of the heart in the healthy chest.)

Now mark a point half an inch to the right of the sternum, and another point half an inch to the right of the left nipple, and you have the horizontal limits of the heart. The right auricle lies behind the cartilage of the third rib on the right side, and the left auricle behind the third costal cartilage on the left side. Posteriorly the heart-dulness is found between the fourth and eighth dorsal spines. The left auricle is covered by the pulmonary artery. The right ventricle is partly behind the sternum and partly to the left of it. Behind the right lies the left ventricle, except a small portion at its apex.

The pericardium is the fibro-serous sac which contains the heart and the portions of the great vessels which enter into or issue from its base. It is attached above to the deep cervical fascia, and below (which is its widest part) it is in connection with the diaphragm.

Two conditions of the heart which call for surgical interference are—overdistention of the ventricles and effusion into the pericardium.

Overdistention of the Ventricles.—This occurs in acute pulmonary congestion. When the lung-tissue in a violent onset of acute inflammation becomes engorged with blood and the air-cells are filled with exudation, the blood is forced with difficulty through the pulmonary circulation, the right ventricle becomes overdistended, and, unless relief is obtained, the condition becomes critical. The symptoms indicating overdistention are—great dyspnea, dulness on percussion over a considerable area of one or both lungs, vocal fremitus, and distress over the region of the heart.

In the treatment of this dangerous condition the heart may be relieved of a portion of its blood and the distention lessened by tapping its cavity. The most convenient method of doing this is to aspirate the right auricle. Find the third interspace, and at a point close to the right of the sternum insert the needle. The reasons for selecting the right auricle are—first, the wall is thinner than that of the ventricles; second, it has a greater antero-posterior diameter; third, it is least liable to change its position in relation to surrounding parts.

Operation.—Sterilize the skin and instruments. Use a large-sized aspirating needle attached to the tube of an aspirator, for the force of the circulation is not sufficient to drive the blood through the needle. The needle should be pushed directly backward until it enters the cavity, and the operation should be performed as quickly as possible. It is attended with great danger. I question whether it possesses any advantages over the old method of bloodletting, which is attended with very happy results in just such cases.

Effusion into the Pericardium.—Under normal conditions the fluid which lubricates the inner surface of the pericardium is in the form of vapor, thus allowing the heart to beat with the least possible friction or impediment to its movements. In pericardial effusion these favorable conditions are lost, and the laboring heart is compelled to do its work in a pool of watery fluid.

In nearly every instance effusion into the pericardium is a sequel of rheumatic fever. The symptoms are dyspnea, great distress in the precordia: as a patient once expressed herself to me, "The heart feels as if it were bursting." The area of dulness is much increased, and may extend as high as the clavicle. The dull area is generally pyriform or quadrilateral in shape, with the base below and extending to both sides of the apex of the heart. The movements of the left chest are impaired, the veins of the neck are enlarged, and a peculiar wavy motion is felt when the hand is placed over the heart. The apex-beat is felt higher up than in the normal condition, and to the left. By the stethoscope we find muffling of the heart-sounds and the absence of vocal resonance and fremitus. If we examine the case before the pericardial walls become separated from one another by the fluid, we may find a pericardial friction-sound. This sound is not propagated beyond the pericardium, and is wanting in the regularity of rhythm which characterizes the endocardial murmur.

Many cases of effusion are slight and have a tendency to end in absorption. In exceptional cases, however, the fluid increases and threatens life. Then we should unhesitatingly resort to the operation of paracentesis of the pericardium.

In the left fifth interspace mark with a pencil a spot 2 inches to the left of the left border of the sternum. This, as a rule, is the best point at which to aspirate the pericardium. The reasons for selecting this position are—(1) it gets at the fluid in the lowest part of the pericardial cavity, thus securing perfect drainage; and (2) this point is well to the outside of the internal mammary artery.

Operation.—Use a good-sized needle and aspirator. Push the needle directly backward until the cavity is reached; withdraw the trocar quickly, leaving the cannula in position, so as to avoid puncturing the heart-muscle. Draw off the fluid slowly and watch the effect.

In the case of a lady upon whom I thus operated the opening was made in the sixth interspace, because the enormous amount of fluid which was present distended the sac much below the usual limits. The heart touched the cannula at every pulsation. The patient fainted several times during the operation. Thirty-two ounces of serum were withdrawn, and a good recovery was the result.

When the fluid is found to be purulent the proper treatment is to

make an incision and employ drainage. Therefore, while the cannula is still in position and pus is found to escape, use the cannula for a guide, dissecting carefully through the tissues until the finger can enter the pericardial cavity. If sufficient room cannot be obtained or if the drainage-tube cannot be kept open, it will be necessary to remove a portion of a rib. The pericardium bears washing out and disinfecting well, and is tolerant of mechanical and chemical irritations.

Injuries of the Heart.—Rupture of the heart is, fortunately, rare. It has been known to occur as a result of a thrombus or an embolus causing complete obstruction in one of the branches of the coronary arteries. A sudden rupture of an aneurysm or an abscess into one of the cardiac cavities has produced rupture. It has also been noted as a cause of death in tetanus. The onset of the symptom is so sudden and so fatal as to leave little for us to study in the way of diagnosis.

Wounds of the Heart.—The circumstances under which we would expect to find wounds of the heart are—violent compression of the thorax, fracture of the sternum and costal cartilages, with fragments driven inward, or wounds from the outside, such as stabs or gunshot injuries. The organ has also been wounded by fishbones or other foreign bodies penetrating it from the esophagus.

A wound of the heart does not necessarily occasion death. Strange as it may at first appear, a stab wound penetrating this organ may be followed by little or no hemorrhage. This is due to the peculiar arrangement of the fibers of the cardiac muscles. In examining the heart for wounds we must be guided by the following symptoms: Pain is felt, and it is usually severe, but may be absent owing to collapse. In most cases there is syncope. If there be escape of blood into the pericardium, we will find the area of cardiac dulness enlarged, owing to the presence of the fluid. At the same time, the heart-sounds will be less distinct, and in certain cases splashing may be heard. A sign of pericardial hemorrhage is dyspnea.

Treatment.—The patient should be kept at perfect rest, with the head lowered to avert anemia of the brain, and opium may be given to relieve pain and shock. Unless the hemorrhage from the external wound be copious and of itself threatening life, it is best not to check it, lest the flow take place into the pericardium and cause death by its presence there.

II. EXAMINATION OF THE VEINS.

The morbid conditions of veins which are interesting from a surgical point of view are—*Wounds*, *Thrombosis*, *Phlebitis*, *Varix* or *Varicose Veins*, and *Nevus*. The examination is made by inspection, and sometimes by palpation and auscultation.

Wounds of Veins.—When a small vein is wounded it collapses and hemorrhage from it is slight. A wound of a large vein is attended with great danger, owing to the rapidity with which the blood escapes from it. Besides this danger, most serious consequences can arise from septic infection. The symptoms of venous hemorrhage are—a steady flow of dark-colored blood, being in marked contrast to the light-red

color and spirting of the blood from an artery; pressure on the distal side of the vein causes arrest of hemorrhage, while pressure on the proximal side increases it.

Treatment.—In small veins perfect rest of the part, elevation of the limb, and pressure on the distal side are all that are necessary. When large veins are wounded the divided ends should be found and secured with aseptic catgut ligatures. A longitudinal slit in a large vein can sometimes be closed by picking it up with forceps and securing the bleeding point with a ligature, without obstructing the lumen of the vessel. If the longitudinal slit in the vein-wall is too long to be grasped by forceps and ligated, it is possible to close it by a fine continuous silk or catgut suture. It is not necessary that a clot should form at the point of ligation.

Thrombosis.—In its normal state a vein is a soft, unresisting tube. The superficial vessels are readily seen and felt, while the deeper are beyond observation. When thrombosis takes place all this is changed. The veins become transformed into hard, knotted cords, and some of the deep as well as the superficial can readily be felt beneath the examining fingers. Thrombosis is due to some alteration in the wall of the vessel, to changes in the blood, or to both causes combined. We look for it in parts where the circulation is most feeble, as, for instance, in varicose veins or behind valves. In exhausting diseases, such as typhoid fever or advanced phthisis, clots often form very insidiously, without any apparent change in the vessel-walls. Foreign bodies introduced into the lumen of a vessel produce clots in a short time, and this circumstance is made use of in the treatment of aneurysm. The tendency of venous thrombi is to extend toward the heart, spreading from vein to vein. The danger comes when the clot reaches a vessel in which the current is too rapid. A portion of the thrombus is liable to break off, and, being swept into the current of the circulation, sooner or later becomes impacted in a vessel and constitutes an embolus.

Phlebitis, or inflammation of veins, has the knotty, cord-like character just described, but in addition there is acute inflammation of the surrounding cellular tissue (Fig. 1). The affected part is very tender to the touch, and at times the skin is reddened. There is usually considerable pain and stiffness, particularly on movement, and the discomfort is increased by allowing the limb to hang down. The limb is stiff, heavy, and unwieldy. When the deep veins of the leg are inflamed, there is usually edema about the ankle due to interference with the return circulation.

The *treatment* includes rest, elevation of the limb, cold, acetate-of-lead lotion, mild cathartics, light diet, and the proper treatment for the diathetic disease which may be the cause, such as gout, syphilis, or rheumatism. If there is a tendency to the formation of abscess, use warm antiseptic baths, and as soon as practicable get rid of the pus by incision.

Varix, or **varicose veins,** are easily diagnosticated. They are usually found in the lower extremity; and the vein most commonly involved is the internal saphenous. The vessels are dilated, thickened, tortuous, and rise above the level of the skin. Sometimes the varicose condition begins where the veins take their origin from the

capillary system. When such is the case the part shows a fine capillary injection with an arborescent appearance.

We at other times find the limb presenting a marble-like character, hard and swollen, but not pitting on pressure. This is apt to take on an eczema of the skin, which later forms ulcers—the so-called varicose ulcers. The danger attending varicose veins, and more particularly

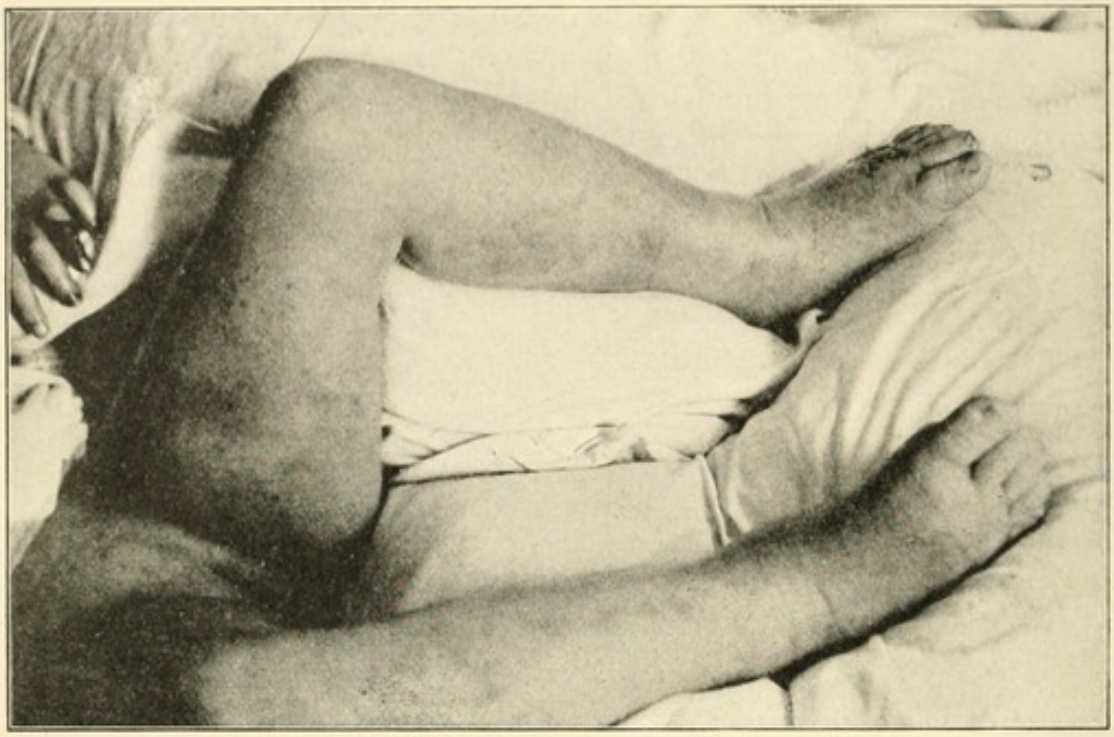


FIG. 1.—Phlebitis of the lower extremities in a child.

where ulceration is superadded, is the liability to bursting of the veins and inevitable hemorrhage. A varicose vein cannot readily be mistaken for anything else. It is possible, however, that a varix of the internal saphenous may be mistaken for femoral hernia. The point is easily settled. When the patient lies down the varicose tumor disappears; so does a femoral hernia. Ask the patient to cough or assume the upright position; both swellings reappear. But press upon the swelling while the patient is in the recumbent position, then, still keeping up the pressure, ask him to stand up; if the swelling is a varix, it will reappear; if a hernia, it will not.

Varicose veins are produced by two conditions acting simultaneously: first, increased local blood-pressure and obstruction of the return circulation, and second, a specific pathological condition not yet satisfactorily explained. The commonest causes are tumors in the pelvis, pregnancy, diseases of the heart and lungs, and occupations which require the person to stand long upon his feet. Obstruction or defective development of the vena cava is capable of producing varicose veins of enormous extent, as was shown in a case reported by Dr. Derville.

Treatment.—Palliative.—Remove the cause by attention to the bowels and by treatment of the disease which has produced obstruction in the veins. Much benefit can be obtained by wearing an elastic bandage or stocking. Bandages of zinc glue are cheap and very

serviceable. They are applied as follows: A gauze roller bandage is first applied to the leg, and over this a layer of the glue, at a temperature sufficient to keep it fluid, is applied with a brush. After a few minutes another layer of bandage, followed by a second coating of glue, completes the dressing. The limb is kept at rest for an hour to allow the bandage to dry. After dissolving the zinc glue the vessel containing it should be left floating in hot water to prevent cooling.

Radical measures include the following: Exposure and ligation of the vein, subcutaneous section with compression, multiple subcutaneous ligatures, injections of pure carbolic acid into the tissues about the veins, the use of acupressure needles and twisted sutures, and excision of more or less of the diseased vein.

Nevus, telangiectasis, or **mother's mark,** is a disease affecting both veins and capillaries. Nevi are easily recognized. Their most common seat is on the face, and sometimes on the trunk. In size they vary from a pin's head to an area the size of the hand or even larger. When the nevus is composed of capillaries, the growth is raised slightly above the skin and is of a scarlet or purple color. If veins enter into its formation, it is either in the skin or beneath it. It pulsates and is larger than the capillary nevus, and of a blue color. To this form the name of *cavernous* angioma is sometimes applied. If one of these growths be cut into or punctured, alarming hemorrhage is liable to follow.

Treatment.—Many operations have been resorted to for the removal of nevus. Ligation and excision are the best. Ligation is best employed by passing a pin under the growth, and then placing a ligature below the pin to constrict the whole mass. Larger nevi require double ligatures, which can best be applied by passing a second ligature under and at right angles to the pin, and tying the nevus in two halves. Excision is very satisfactory when loose skin can be obtained to allow the edges of the wound to come accurately together without puckering or stretching. Injection of coagulating fluids and electrolysis have also been employed, and good results have followed in many cases. It must, however, be borne in mind that this treatment has occasionally led to sudden death from embolism.

III. EXAMINATION OF THE ARTERIES.

Our inquiries under this head will comprise *wounds of arteries, rupture of arteries, atheroma, inflammation of arteries,* and *aneurysm.*

In a wound of any extent the question of hemorrhage is a prominent one. It will be necessary to decide what arteries, if any, are divided, and promptly check the flow of blood from them. Blood flowing from a divided artery is bright red and comes in jerks. From a vein it is purple and has a continuous flow or wells up out of the wound. From capillaries bright red blood oozes out more or less freely, and there is no spirting.

There are conditions in which the spirting of an artery cannot be seen, as when the divided vessel lies at the bottom of a deep wound and the blood wells up rapidly. The flow is then continuous, but its persistence and profuseness are sufficient evidence that a large vessel

is involved. The position of the wound will indicate the arterial trunk or branch from which the blood flows. The treatment will depend upon the size and position of the vessel, and also upon the amount of blood which is escaping. In many cases the natural arrest of hemorrhage is sufficient (the contraction of the coats of the vessel within the sheath and the coagulation of the blood in the divided ends of the artery), in others we must assist nature.

The readiest temporary method of arresting hemorrhage is by pressure at the bleeding point or upon the artery above it. *Never be afraid of a bleeding point when you can place your finger upon it* (not a dirty but an aseptic finger). If you make pressure at the proper spot, very little force is required, and this force can be easily maintained until permanent control of the bleeding has been secured. Pressure upon the artery above the wound is applied by the fingers, by a tourniquet, or by an Esmarch bandage. The brachial can be controlled by pressure upon it in the middle of the arm, where it lies in the angle on the inner side of the biceps. The subclavian can be controlled by the thumb pressing the vessel against the first rib. The femoral at Poupart's ligament lies midway between the symphysis pubis and the anterior superior spinous process. It can be compressed most readily by the thumbs of the operator, who stands in such a position that his arms are almost straight. This position is not fatiguing, and can be maintained for half an hour or so without difficulty. The femoral can also be compressed on the inner aspect of the thigh at its entrance to Hunter's canal. The aorta is compressed with difficulty, except in children and emaciated people. It can, in them, be felt just above and a little to the left of the umbilicus. The radial and ulnar can be compressed just above the wrist, and the tibial for a short distance above the ankle.

Tourniquets are necessary when continued compression is required. The most simple is Esmarch's, which consists of a $\frac{3}{4}$-inch rubber tube about 18 inches in length, with a hook at each end. It is simply wound around the limb above the wound tight enough to compress the artery. The dangers of Esmarch's bandage are paralysis of nerves (by too long compression) and anemia. Sloughing has been produced, particularly when the tourniquet has been applied for primary hemorrhage before amputation. It should be kept on as short a time as possible. An emergency tourniquet can be made from a handkerchief tied around the limb and twisted tightly.

Having got the bleeding under control, the next question is how to arrest it permanently. The stoppage of the circulation by pressure or the tourniquet has given the blood at the bleeding point time to coagulate, and if, when the pressure is slowly removed, no blood escapes, the wound may be dressed, leaving the clot in position. When the divided artery can be seen, it should be tied at both ends with catgut or silk ligature. If the wound is not large enough to expose the vessel, it must be extended and the bleeding points found and tied.

Heat is a valuable means of arresting hemorrhage from a number of small vessels or oozing from a large surface. It is best applied by using water as hot as can be borne by the hand.

Cold is also a good hemostatic. It is employed by exposing the

wound to the air or by ice or ice-water. Its action is upon the muscular coats of the vessels, and is only of value when the bleeding vessels are small.

Packing with iodoform gauze is required in many cases, but except where it is desirable to have the wound heal by the open method, as in operations for the removal of diseased bone, it is seldom employed.

Acute Arteritis.—This is a rare disease, and some writers state that it is doubtful if it has ever been diagnosed during life. The cases in which tenderness and redness were observed along the course of an artery having recovered, there was no opportunity to verify the diagnosis by post-mortem. In a case of symmetrical gangrene which came under my care I was able to trace the radial arteries and the caro-

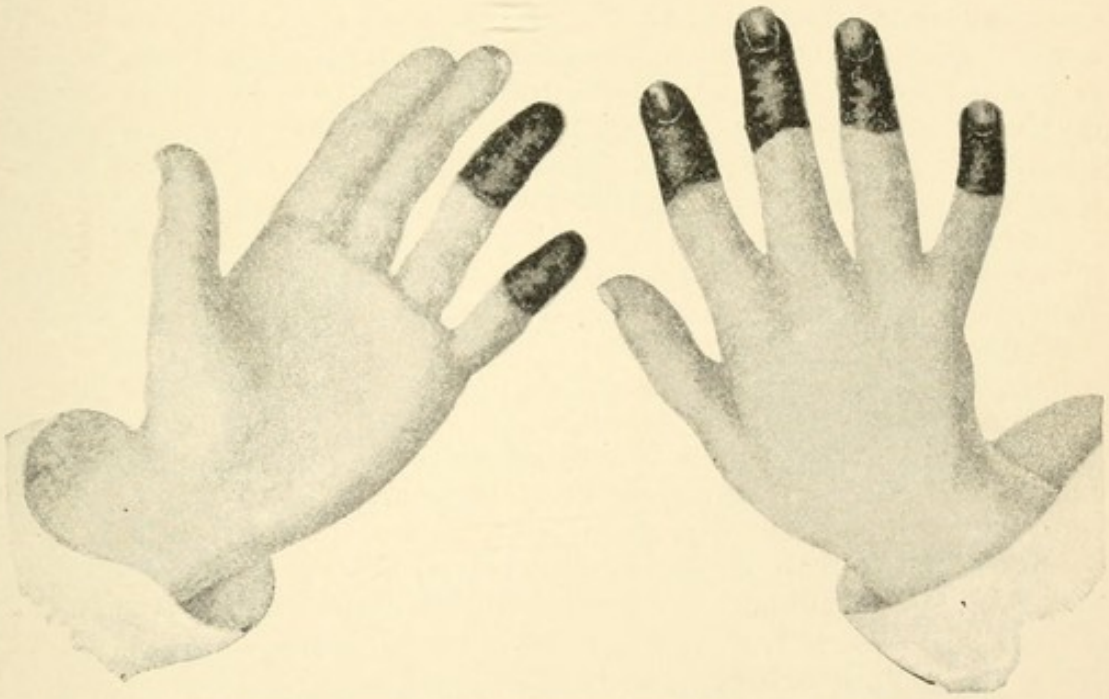


FIG. 2.—Symmetrical gangrene without Raynaud's phenomena (Jonathan Hutchinson).

tids by the tenderness and hard, cord-like feeling, such as is found in phlebitis, and confidently pronounced the condition acute arteritis. The patient, a little girl, died from occlusion of the middle cerebral artery. The post-mortem clearly showed arteritis and an extension of the inflammation from the carotid to the arteries of the brain, which caused her death.

The symptoms which are indicative of acute arteritis are—tenderness along the course of the vessel, a hard, cord-like feeling under the fingers when the vessel is pressed upon, and at times obliteration of the artery, followed perhaps by gangrene of the parts to which the artery is distributed.

Chronic Arteritis.—This is very important to us from a diagnostic point of view. Chronic arteritis, or atheroma of the older authors, is the condition which lays the foundation for aneurysm. It is chronic inflammation of the internal coat, with fatty degeneration and a tendency to the formation of calcareous deposits. We should look carefully for atheromatous arteries in old people, in those who have

suffered from rheumatism, Bright's disease, gout, or syphilis, and in hard drinkers. We must bear in mind that atheroma affects the large, while syphilis attacks the smaller, arteries. The disease begins in the inner coat, which becomes opaque and cloudy. The circulation in it is disturbed, and in parts cut off, so that ulceration soon follows. The middle coat does not become involved until late, and the outer coat is affected last of all. It is only when atheroma has produced its evil effects upon the artery that we can diagnosticate its existence during life. These effects are *calcification* and *aneurysm.*

Following the change in the inner coat is an inflammation in the middle coat, and a deposit of calcareous matter, carbonate of lime, and phosphates. This gives the vessel a firm, hard feeling which has been compared to a pipestem. Such a condition affects the circulation, the vessel losing its elasticity, the flow of blood is impeded, the roughened internal surface increases friction, and, as a consequence, thrombosis and embolism are liable to occur. If the supply of blood is cut off in a marked degree, we have senile gangrene as a result. The arteries are also liable to become elongated and tortuous, as is often seen in the temporals of aged people.

What we have to look for then is a hard, pipestem-like condition in the arteries. The vessels may also be tortuous and elongated. The subjects are old people, men much more frequently than women.

IV. ANEURYSM.

An aneurysm is a tumor containing either fluid or coagulated blood and communicating with the cavity of an artery.

Aneurysms are classified as follows:

According to their causation they are spoken of as *traumatic* and *idiopathic.* A traumatic aneurysm is one in which the coats of a

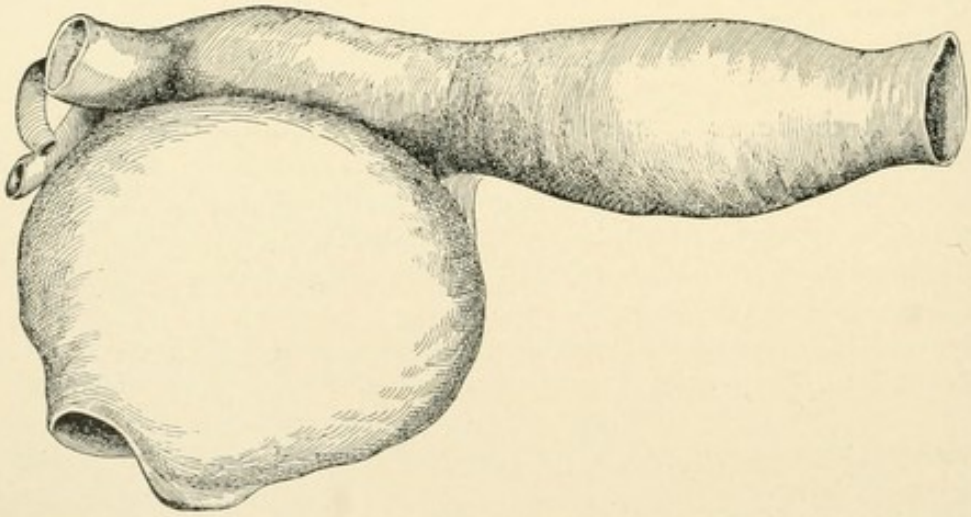


FIG. 3.—Sacculated aneurysm (Keen and White).

healthy artery give way under a sudden injury, forming a tumor, the sac of which is composed of the vessel-wall, the cicatrix, or a clot of blood which closed the wound. Idiopathic aneurysms are those which are produced by disease in the walls of the vessels. The sac is com-

posed of one or more of its arterial coats. When the shape is taken as the basis of classification two varieties are recognized: *sacculated* when the wall at one side of the artery is expanded into a pouch (Fig. 3), and *fusiform* when the coats are uniformly dilated in the whole circumference of the vessel and for a considerable distance in its length (Fig. 4). A *dissecting* aneurysm (Fig. 5) is a variety by itself.

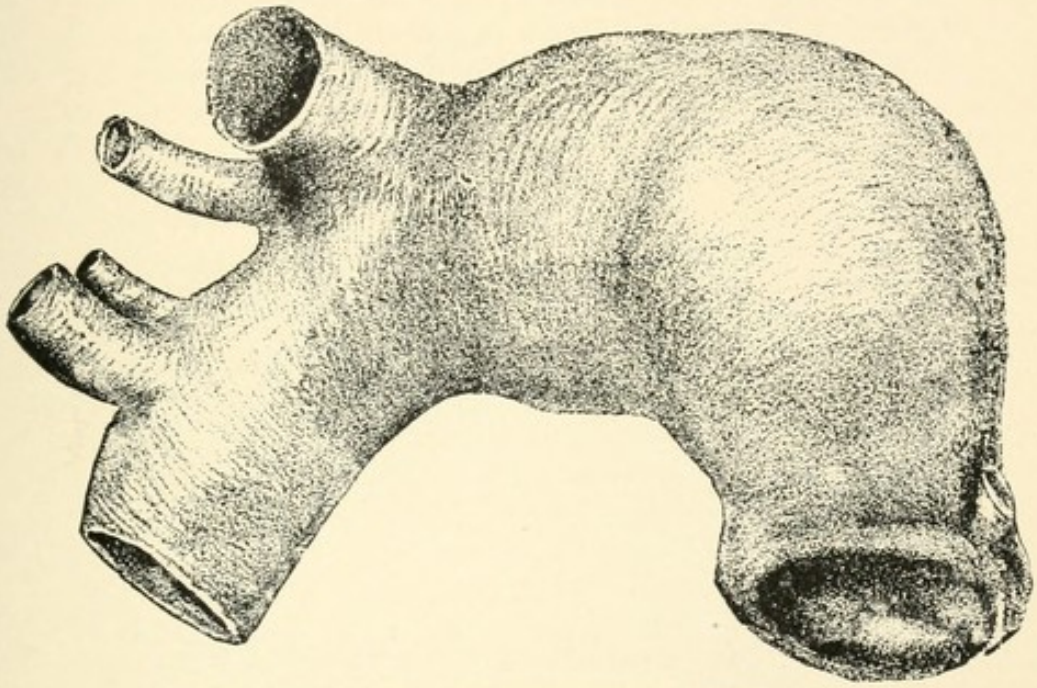


FIG. 4.—Tubulated or fusiform aneurysm (Keen and White).

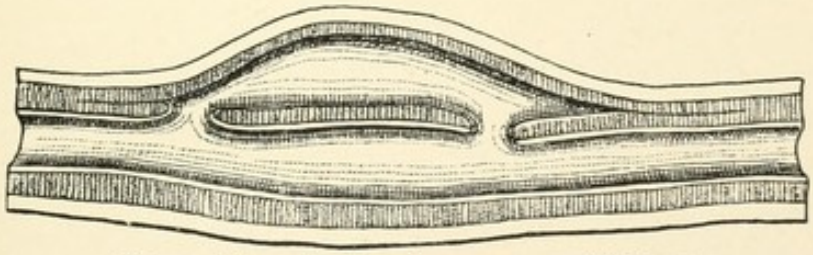


FIG. 5.—Plan of a dissecting aneurysm (Holmes).

It usually begins in the breaking down of an atheromatous ulcer. The blood makes its way between the arterial coats, stripping them asunder and forming a sort of fistula in the vessel-wall. After traversing the wall for some distance the stream finds its way back into the vessel or perforates all of the coats, and is extravasated into the surrounding tissues.

The terms *true* and *false* aneurysm are of little practical value. A *true* aneurysm is one in which all the coats of the artery enter into the formation of the sac. This is only possible when the aneurysm is of small size. A *false* aneurysm has the inner coat of the artery much altered and thickened, the middle and outer coats have disappeared, and the wall of the sac is formed by the thickened connective tissue of the surrounding parts.

In examining for an aneurysm our attention should be directed to

the vessels upon which the greatest strain is thrown. The larger vessels, too, are those generally affected. The arch of the aorta, the part where the external iliac becomes the femoral, the parts of the arteries from which branches arise, and the convexities of all the curves are the most common seats of aneurysm.

The arteries of the brain and those of the lower limbs, particularly the popliteal and the splenic, suffer frequently.

Symptoms.—Attention is usually directed to an aneurysm by the pain which the patient feels. It is generally severe, and may be described as sharp and lancinating (in that respect resembling carcinoma), or it may be aching or burning like the pain of ulceration. As the pain is due to pressure, the tumor is generally of considerable size before this becomes a marked symptom. At times a nerve—the popliteal, for instance—is flattened and stretched over the tumor. The pain

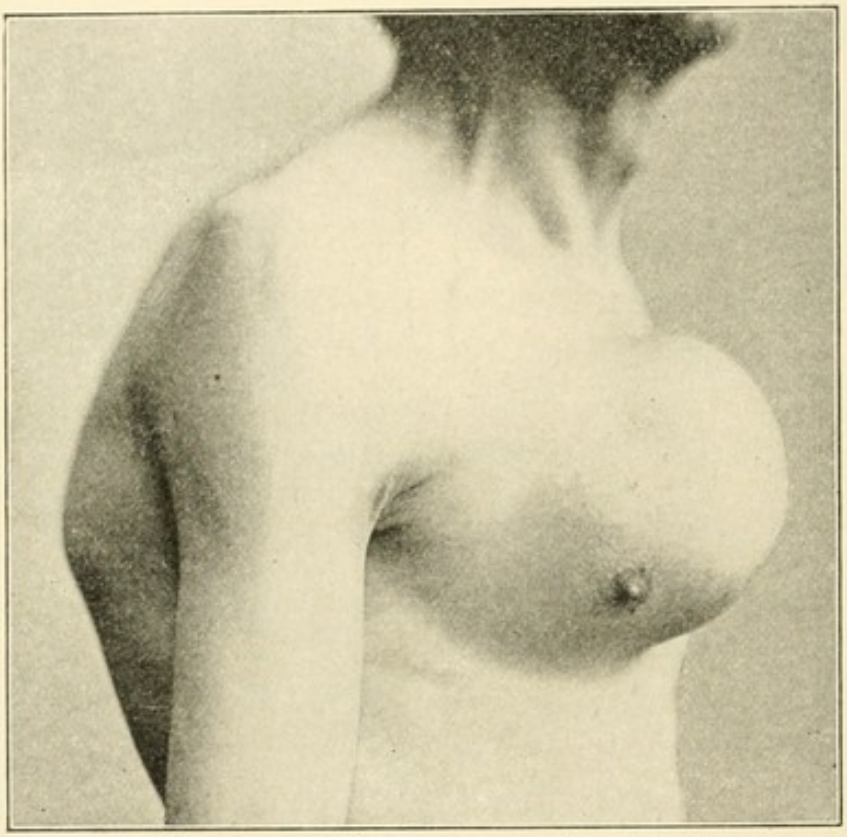


FIG. 6.—Aneurysm of the mammary artery (Jepson).

in such a case is intense, and is felt along the course of the nerve. If aneurysm is located on one of the limbs or in a superficial position, we expect to find a tumor (Fig. 6). The following questions must then be answered:

(*a*) Does the tumor pulsate? In the first stage of an aneurysm (that is, while the contents are fluid) distinct pulsation can be felt. The pulsation is peculiar; it is eccentric, expansile, and synchronous with the heart-beat. Place a hand on each side of the tumor, and with each pulsation the palms will be separated from each other. An abscess may have the fluid character of an aneurysm, and, if it happen to lie over the situation of an artery, a pulsation will be communicated to it. In this case the pulsation will be up and down, and not laterally.

(*b*) Has it a bruit? In an aneurysm, owing to the roughening of the lining of the sac and to the circumstance of the blood rushing into the cavity and out again, a peculiar sound can be heard, not only over the tumor, but also along the artery above and below the sac for a greater or less distance. Sometimes this sound is blowing in character, or it may be rasping like the noise made by a saw. There are malignant vascular tumors which have bruits that might be mistaken for aneurysm, but it must be borne in mind that the bruit of an aneurysm is heard *along* the course of the artery as well, while in the case of malignant tumor the sound is confined to the growth itself.

(*c*) Can the size of the tumor be changed by pressure upon the artery? If we can make pressure upon the artery on the side of an aneurysm nearest the heart, we find that the size of the tumor is diminished, for we cut off the supply-pipe which fills the cavity. If, on the other hand, we press upon the artery on the side farthest from the heart, the tumor is increased, because we obstruct the overflow-pipe and increase the tension in the sac.

If aneurysms were always filled with fluid blood, the diagnosis would be comparatively easy. It is only in their first stage that such is the case. As the disease progresses there is always a tendency to the formation of fibrinous layers, which by degrees change the character of the tumor from a fluid to a more or less solid mass. This is sometimes called the second stage. The effect of this solidity is naturally to render the pulsation less distinct, so that in some cases it is entirely lost. It may happen that the fibrin is not deposited evenly in the sac; in that case we may find pulsation in certain portions of the tumor, but not in others. The tumor being solid, it will not be changed in size by pressure above or below as in the case of an aneurysm in its first stage. Still, as a rule, we have the bruit to rely upon, for it can be heard not only over the sac, but above and below it along the course of the artery.

(*d*) Are there any pressure-effects? If the veins suffer from pressure, we will find edema of the limb below the tumor. This, if long continued, may terminate in ulceration or even gangrene. The effect of constant pressure is to produce atrophy; hence we have absorption of osseous tissue when bone is pressed upon, as, for instance, the sternum in thoracic aneurysms. Pressure upon the trachea produces difficulty of breathing, and almost a pathognomonic sign of aneurysm of the arch of the aorta is a peculiar, brassy, unfinished cough, due to pressure upon the recurrent laryngeal nerve of the left side. If the esophagus suffers pressure, difficulty of swallowing will result. Hiccough is produced by pressure upon the phrenic nerve, and when the sympathetic nerve is pressed upon we see capillary congestion. Pressure upon the thoracic duct prevents the chyle from entering the blood and may lead to death by starvation.

When, in spite of all these inquiries, you are in doubt, an exploration with an aseptic hypodermic needle may settle the point.

Mistakes to be Guarded Against.—Pulsating tumors which resemble aneurysm are most likely to lead us to a false diagnosis. These are the pulsating encephaloid, soft sarcoma, erectile tumors, and pulsating tumors of bone. The history of the case, the existence of arterial

degeneration in other parts of the body, and the characters already described will, however, as a rule, keep us from falling into error.

Treatment of Aneurysm.—Nature in many cases attempts the cure of aneurysm, but seldom succeeds. The process of cure consists in a filling of the aneurysmal sac by the deposit of successive layers of fibrin. Our aim in treatment must be to imitate Nature. If we can cause the circulation in the sac to become slower, either by occlusion of the afferent or efferent vessel or by obliteration of the sac itself, the object will be accomplished. Medical and surgical measures are at our disposal. Of the medical methods, Tufnell's is probably the best. It consists in confining the patient to bed in the recumbent position for several months on restricted diet, with the view of reducing the watery elements of the blood and increasing its solid constituents. The diet is restricted to ten ounces of solid and six ounces of fluid nutriment in each twenty-four hours. Opium is given to relieve pain, lactucarium to produce sleep, and compound julap powder to produce watery discharges from the bowels.

Surgical Methods.—1. *Compression.*—This is a very old method, having been used at least 200 years ago; its early employment, however, was confined to traumatic aneurysm. John Hunter in 1785 tied the femoral artery in Hunter's canal and established a new principle—viz.

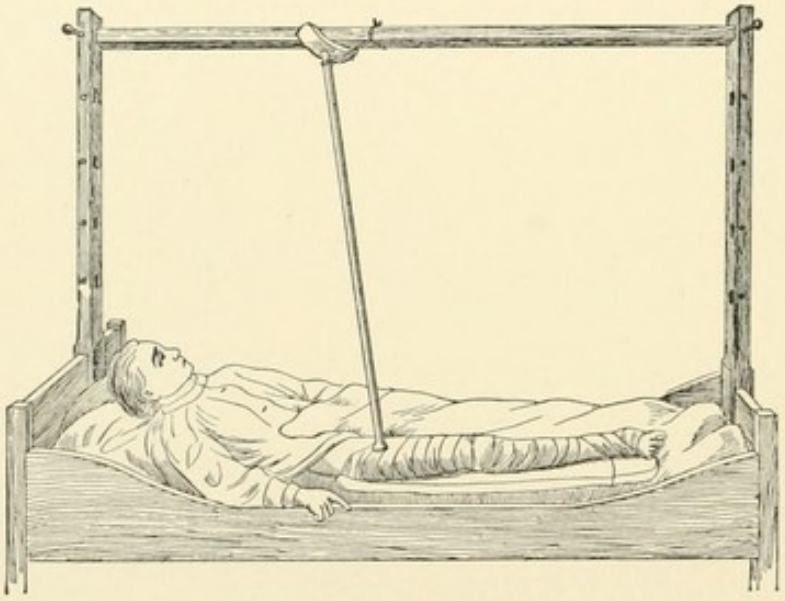


FIG. 7.—Compression of the femoral artery for popliteal aneurysm (after Esmarch).

that it is necessary only partially, and not completely, to intercept the current through the aneurysmal sac. This is the aim of compression, and it can be carried out at some distance from the seat of the disease, as, for instance, over the common femoral when the popliteal is the seat of aneurysm. Compression can be applied by the fingers (relays of assistants keeping up the treatment until the end is attained) or by compressing instruments (Fig. 7) or by flexion of the joints.

2. Rapid cure by tourniquet or by Esmarch's bandage.

3. *Ligation.*—(*a*) Hunter's method: The ligature is applied on the cardiac side of the tumor, one or more branches intervening between the ligature and the sac. (*b*) Anel's method: The same as the

preceding, without a branch between the ligature and the sac. (*c*) Brasdor's: Ligature on the distal side, without an intervening branch. (*d*) Wardrop's: The same as the preceding, with an intervening branch. (*e*) The old operation of Antyllus, in which the artery was tied, both below and above the sac, close to the tumor. This method is now adopted in cases of traumatic aneurysm only.

Other methods of treatment are galvano-puncture, the use of coagulating injections, and the introduction of foreign bodies, such as fine wire, into the sac.

V. SPECIAL ANEURYSMS.

Aneurysm of the Arch of the Aorta.—We cannot here follow the line of investigation laid down for superficial aneurysms. Pressure-symptoms play the most prominent part, and the structures pressed upon will depend upon the position of the aneurysm and upon its size. At the transverse portion of the arch there is less room for expansion than at the other divisions of the vessel, owing to the shallowness of the chest at this part. Consequently, the symptoms of pressure are most marked, and make their appearance earlier, in this form of the disease. In aneurysms of the ascending and descending portions the tumor has more room, and hence the symptoms of pressure are longer delayed.

(*a*) *Pain.*—From first to last pain is likely to prove the most prominent symptom. Some patients will describe a sudden tearing pain as of something "giving way" when in a violent effort the middle coat of the vessel is ruptured, and thus forms the starting-point of the aneurysm. Later, the pain is due to the stretching of fine nerve-filaments in the arterial coats or to pressure upon neighboring structures. Anything which increases blood-pressure in the sac will aggravate the pain, and under such conditions the suffering may be excruciating. When the tumor presses against the sternum in front or upon the spinal column behind, a constant boring, dull pain is experienced, and erosion of the bones results. In a small proportion of cases great pressure may be exerted, and yet the patient may never complain of pain.

(*b*) *Bruit.*—The characteristic bruit of aortic aneurysm is a soft, systolic murmur heard over the tumor and sometimes along both carotid arteries.

(*c*) *Pressure-symptoms.*—When the transverse or descending portion is the seat of aneurysm, the recurrent laryngeal nerve of the left side, which here winds around the artery, suffers from pressure. This produces its effect upon the laryngeal muscles, and the patient suffers from a peculiar cough. The character of this cough is, that it does not afford any relief. It has been aptly described as an "unfinished cough."

Hemoptysis is a result of aortic aneurysm under the following conditions: (1) The tumor may press upon the trachea, causing congestion and rupture of the vessels which traverse its mucous membrane. (2) The aneurysm may press upon the lung-tissue, cutting off the blood-supply to a portion of the pulmonary substance and causing it to break down. (3) The aneurysm may rupture into the trachea or

bronchial tubes. The amount and character of the expectorated blood will afford pretty fair evidence of its source. If it comes from the trachea, it appears as a simple staining of the mucus and the quantity of blood is never large. Coming from a portion of broken-down lung, it has the character of phthisical hemorrhage. When the aneurysm ruptures into the trachea or bronchi, the first appearance of blood may be trifling in amount; but after the lapse of a few hours, when the rupture has had time to enlarge, blood may be forced up in such quantities as to end the patient's life in a few seconds. This is the "bursting of a blood-vessel" which novelists love to describe.

Aneurysm of the Ascending Portion of the Arch.—The symptoms peculiar to this aneurysm are—

(*a*) The presence of a tumor which can be felt to pulsate to the right of the sternum in the second or third intercostal space. In exceptional cases the tumor may be found to the left of the sternum. At first it is obscure, but later, when by erosion the sternum becomes thinned or even perforated by constant pressure, the thrill and pulsation may be distinctly felt.

Aneurysm of this portion of the aorta is especially dangerous, owing to the anatomical fact that it is covered only by the thin serous layer of the pericardium which allows of the coats becoming rapidly distended and favors rupture into the pericardial sac.

In examining the tumor remove all clothing from the chest and place the patient in a strong light. Slight pulsations are best observed by viewing the chest transversely from the side, the examiner's eye being brought almost on a line with the front of the chest. Aneurysmal pulsation is expansile, not only rising and falling, but expanding laterally with the heart-beats. To demonstrate this lateral expansion the following simple expedients may be resorted to: (*a*) Cover the prominence with a piece of adhesive plaster which has a slit cut down its middle line. If the pulsation be expansile, the slit will be seen to widen with each pulsation (Fagge and Pye Smith). (*b*) Fix light paper columns or cones of cotton-wool to opposite points of the tumor: if these cones be found to diverge with each pulsation, the tumor is expansile; or two single stethoscopes can be used in a similar manner.

By palpation a pulsation or thrill may be felt. If this is observed in the upper part of the sternum, it may be set down as an aneurysm of the ascending or transverse portion of the arch.

(*b*) By auscultation a murmur may be heard over the aorta or aneurysmal tumor, but in some cases this murmur is absent. In such cases Sansom recommends that the patient place within his mouth the small chest-piece of the binaural stethoscope and close his lips over it. In this way a distinct or loud systolic murmur may be heard in the case of a thoracic aneurysm, the "vibrations being communicated to the trachea and thence directly by the air-column to the ears."

Pain is usually present, and there is tenderness on pressure over the seat of the aneurysm.

(*c*) The pressure-symptoms are manifested according to the growth of the tumor and its encroachments upon the neighboring structures. As it grows toward the right, the vena cava superior is the first to

suffer pressure, and as a result there are venous engorgement and edema of the upper limbs.

Toward the left it presses upon the pulmonary artery, and produces dilatation in the right side of the heart and pulmonary symptoms resembling phthisis. As the tumor grows upward it presses upon the upper lobe of the right lung or its bronchus. As evidence of this the breathing becomes impaired, and later, when the air is shut out of the lung, there is a dull area on percussion. If the recurrent laryngeal nerve be compressed, there will be the peculiar unfinished cough of aortic aneurysm.

It is not uncommon in large aneurysms to find the heart displaced to the left and downward. Pressure upon the inferior vena cava is a very rare symptom. It is manifested by edema of the lower limbs and ascites.

Aneurysm of the Transverse Portion of the Arch.—As this portion of the vessel lies behind the trachea, a tumor connected with it is almost sure to interfere with respiration. Hence its most frequent manifestations are a suffocative cough, severe dyspnea, and stridulous breathing. Sometimes the pressure is exerted upon the left bronchus, interfering with the expansion of the left lung and causing a deficient respiratory murmur. The esophagus may be pressed upon, causing difficulty in swallowing and symptoms of stricture. Pressure on the left recurrent laryngeal nerve causes paralysis of the left vocal cord. Sometimes the pupils are unequally dilated, the pupil of the affected side being contracted. This is due to pressure on the branches of the sympathetic nerve.

Tracheal tugging is an important sign of aneurysm in this locality. The simplest way of observing this sign is that of Ewart. The examiner stands behind the patient, who is seated in a chair with his head slightly thrown back and steadied against the examiner's chest. The tips of the index fingers are placed beneath the cricoid cartilage, which is gently raised by them. With each beat of the heart a tugging sensation is experienced by the fingers. Surgeon-Major Oliver's method is as follows: The patient is placed in the erect position, directed to close his mouth and raise the chin to the fullest extent. The cricoid cartilage is then grasped between the finger and thumb and gently pressed upward. When a tugging is felt an aneurysm is present.

In all cases of suspected aneurysm the voice should be carefully studied. A shrill or crowing voice or one lowered to a whisper or assuming a falsetto character should attract attention. A loud, brassy cough, which has been so well described as the unfinished cough of aneurysm, is especially significant, and is due to pressure upon the left recurrent laryngeal nerve. A laryngoscopic examination should never be omitted, for the vocal cords frequently give evidence of pressure when there are no other respiratory symptoms.

The evidence gained by the laryngoscope is thus summarized by Sansom: "On examination the observer may see that in ordinary inspiration there is little if any difference in the position of the two vocal cords; the left may be a little nearer the median line. The left capitulum Santorini and the left aryteno-epiglottidean fold may be on a somewhat higher level than their fellows on the opposite side. On

phonation, the patient being asked to make the sounds softly of "ah" and "ay," the left vocal cord may be seen to remain fixed, while the right advances to the median line, or the right vocal cord may be seen to advance to the middle line and project beyond it. It may encroach so far as to meet the flaccid left cord, the cartilages overlapping when a high note is sounded. Thus, while the whole of the right cord is in view, only a portion, about half or one-third, of the left cord can be seen."

The size of the pupils should be carefully studied in the diagnosis of thoracic aneurysm. In common with other intrathoracic growths, aneurysms may cause destruction of sympathetic nerve-elements by their pressure. Destruction of nerve-elements in the aneurysmal sac is followed by paralysis of the cilio-spinal branches of the sympathetic; there is a paralysis of the dilator muscle of the iris supplied by the sympathetic, and consequently an unopposed action of the sphincter of the pupil supplied by the third nerve (Sansom). The left pupil is the one usually contracted, and this should be regarded as a strong confirmatory sign of aneurysm. Examination of the arteries of the upper extremities and neck sometimes affords valuable evidence. The ascending portion of the aortic arch gives off no branches; the transverse portion gives off the innominate, the left carotid, and the left subclavian. If the aneurysm be confined to the first portion, the pulse-wave in the carotids, brachials, etc. will be unchanged. But let the innominate become involved, and the arteries on the right side will show a diminished pulse-wave, while those on the left remain normal. In palpating the arteries begin with those nearest the aorta—viz. the carotids; then the brachials; and lastly the radials. The points to look for are enfeeblement of the pulse-wave in the large arteries and *delay* in the radial pulse. *Aneurysm of the transverse portion of the arch involving the innominate, or an aneurysm of the innominate itself, produces a feeble pulse-wave in the arteries of the right side and a delayed or obliterated right radial pulse.*

Aneurysm of the Descending Portion of the Arch.—This portion of the aorta lies near the spinal column, and consequently its pressure-symptoms are associated with this bony structure. Pain is felt near the spine in one or both interscapular regions, and it may run round the chest-wall in the form of intercostal neuralgia. The pain is described as aching or boring, like all pain due to erosion of bone. When the destruction of osseous tissue has advanced far enough to allow of pressure on the spinal cord paralytic symptoms speedily develop. Other pressure-symptoms are—(*a*) upon the esophagus, causing dysphagia or even stricture; (*b*) upon the left bronchus, causing enfeebled respiratory murmur on that side, sometimes bronchitis, pneumonia, or symptoms resembling phthisis. The aneurysm may rupture into the esophagus, but more frequently into the pleura.

It is difficult to differentiate between aneurysm of the arch of the aorta and a similar condition of the innominate, left subclavian, and left carotid. The following points, as given by Wyeth, will aid in arriving at a diagnosis: The tumor in aneurysm of the ascending arch is usually first noticed to the right of the sternum, between the clavicle and the third rib. The pressure-symptoms do not affect the voice until the

tumor is recognizable in the right side of the root of the neck, where it involves the right recurrent laryngeal nerve. Respiration may be interfered with or cough produced by compression of the right bronchus. This condition will be recognized by the hissing râles distributed over the area of the right lung. Aneurysm of the transverse arch is usually first recognized to the left of the sternum at about the same plane as for the ascending segment. Laryngoscopical examination will demonstrate that whatever of muscular paresis exists is confined to the left vocal bands. If the tumor rises into the neck, its appearance will have been preceded by pressure-symptoms of longer duration and greater severity than in either innominate, carotid, or subclavian aneurysm.

Innominate aneurysm usually appears at the upper margin of the sternum in the space between the two tendons of origin of the right sterno-mastoid muscle or in the interclavicular notch. The disturbance of the circulation through this vessel so affected may be recognized by the difference in the force and character of the pulse-wave in the radial arteries of the two arms. In aortic aneurysm, when the innominate is not compressed by the tumor, the pulse-wave is the same in both arms. It must, however, be borne in mind that in sacculated aneurysms, springing, as they not infrequently do, from the arch in immediate proximity to the orifice of the innominate, and rising to the root of the neck in front of, or behind this artery, a positive diagnosis is scarcely possible. The pressure on the innominate may retard or weaken the right radial pulse.

Aneurysm of the left carotid artery first appears at the left sterno-clavicular articulation in the line of this vessel. The murmur is transmitted toward the distribution of the carotid, and is not heard in its fellow opposite.

When the left subclavian is involved, the swelling usually appears to the left of the sterno-mastoid muscle, and the pulse in the left radial differs from that of the right.

Treatment of Aortic Aneurysm.—The treatment of aortic aneurysm may be considered under the following heads:

Rest is the first consideration, and should be resorted to at the earliest possible period. It lessens the tendency to rupture of the aneurysm, and it helps to arrest the growth of the sac by diminishing the blood-pressure. A person in health having a pulse-rate of 70 while in the sitting posture will have a pulse of 78 when standing. The difference between the recumbent and erect posture in a person suffering from aortic disease is still greater; hence a saving of many pulsations may be effected in the twenty-four hours by keeping the patient at rest.

Diet.—Tufnell's method of feeding is the best yet adopted. It consists in giving ten ounces of solids and eight ounces of liquids in each twenty-four hours. The diet list for such a patient is as follows: breakfast, two ounces of white bread and butter and two ounces of milk or cream; dinner, three ounces of meat and three ounces of potatoes or bread, and four ounces of water or claret; supper, two ounces of bread and butter and two ounces of milk or tea.

Medicine.—Iodid of potassium has proved itself the best drug, and was first advocated by Balfour in Great Britain and Bouillaud in

France. To commence the treatment, five grains should be taken three times a day; at the end of a week this should be increased to ten grains, and later to fifteen or twenty grains thrice a day. These doses can be keep up for weeks, months, or even years. When there is excessive heart-action or palpitation, aconite in one- or two-minim doses given every hour affords great relief. Pain is controlled by hypodermic injections of morphine.

Anesthesia is recommended by Sansom, not only as indispensable during the operative procedures about to be described, but as a valuable therapeutic measure previous to, and perhaps in substitution of, surgical interference. The cases most suitable for treatment by anesthesia are those in which there is severe pain, either continuous or paroxysmal. Chloroform is given daily for several days, and the patient is kept under its influence for several hours each time. The effect of prolonged anesthesia is to allow time for coagulation of the blood within the sac.

Operative Measures.—Distal ligature is attended with a fair degree of success. When the transverse portion of the arch or the innominate or the portion of the aorta close to the innominata is the seat of aneurysm, the right carotid should be tied or the right carotid and right subclavian. Ligation of the left carotid has also been practised, and with good results in several cases. The operation is less dangerous than the tying of both vessels on the right side, collateral circulation being carried on more easily.

Galvano-puncture is attended with considerable danger, but, as the cases for which it is demanded are otherwise hopeless, the patient may justly claim the chance which it holds out. Of 114 cases in which it has been employed, 68 were improved (Petit, cited by Sansom). It is employed as follows: Having taken all the precautions required for making the operation antiseptic, two needles are pushed through the skin covering the tumor and into the sac. The needles are then connected with the poles of the battery and a current of from twenty to thirty milliampères turned on. The positive needle is then moved about in the sac so as to touch the wall of the aneurysm at different points. This is kept up for ten to twenty minutes, after which the current is gradually reduced and the needles disconnected. The positive needle is first to be withdrawn. Should it be covered with fibrin so as to prevent its withdrawal, the current must be reapplied in the opposite direction until the needle is loosened. The object of this operation is to cause coagulation of the contents of the sac.

The risks of the operation are—(*a*) The blood may coagulate in the center of the sac, the clot remaining soft, and finally breaking up in the blood-current. (*b*) Blood may spurt freely from the punctures made by the needles, and death may follow from inflammation of the sac. (*c*) Small coagula may be carried off in the circulation.

Introduction of Foreign Substances into the Sac.—Wire has been passed into the sac through a fine cannula, and the cavity filled with coils with the object of inducing coagulation. This measure has been so unsatisfactory that it is now practically abandoned. Nevertheless, one or two cases have been cured in this manner. Macewen introduces metallic needles into the sac, leaving them in position for twenty-four hours, and then withdrawing them.

Aneurysm of the Carotid.—The common carotid is liable to aneurysm at any part of its course, but more particularly at its bifurcation. This artery departs from the rule that aneurysm is more common in men than women, for in this case the sexes suffer equally. Some authors speak of two varieties, the high and the low, the low being confined almost entirely to the right side.

A tumor along the course of the common carotid with expansile pulsation and bruit is very likely to be an aneurysm. Further evidence would be the following pressure-symptoms: dyspnea, spasmodic cough, and hoarseness from pressure upon the trachea, the recurrent laryngeal, or the larynx; difficulty of swallowing from pressure upon the esophagus or upon the pharynx in the case of the internal carotid; neuralgia from pressure of the cervical nerves; contraction of the pupils from pressure upon the sympathetic; edema from pressure upon the internal jugular or, in rare cases, upon the left subclavian.

In most cases the diagnosis is very easy, but when low down in the root of the neck a positive opinion is difficult to arrive at, and in some cases a clear diagnosis is impossible. It is impossible at times to say that aneurysm of the carotid exists alone, for a similar condition of the subclavian, the innominate, or the arch of the aorta may strongly simulate it. The rules for differentiating already given may aid in coming to a decision. Cysts lying upon the common carotid should not lead any one into error, for the character of the pulsation is not expansile. Enlarged lymphatic glands are not likely to cause doubt, for these occur in groups and are lobulated. A rare condition which might give rise to a disastrous error is aneurysm of the internal carotid pressing upon the tonsil and simulating an abscess. Abscess of the tonsil is an acute disease, which, as a rule, runs its entire course in about nine days, while aneurysm is a chronic affection, and must have existed for many weeks before enlargement of the tonsil is produced. Besides this, tonsillitis is attended with high fever and other symptoms characteristic of local inflammation.

Treatment.—If there is sufficient room, the vessel should be ligated on the proximal side of the aneurysm, otherwise on the distal side.

Vertebral Aneurysm.—Aneurysm of the vertebral artery is, as a rule, of traumatic origin. It may be confounded with aneurysm of the carotid. The point may readily be settled by pressing upon the common carotid. If the artery be pressed firmly backward at its bifurcation, the circulation in the sac will be diminished if in a branch of the carotid, but unaffected if the vertebral is the artery involved.

It cannot be too strongly impressed upon the examiner that rough handling of an aneurysm is to be avoided, owing to the danger of detaching a clot which might be carried off in the circulation to form an embolus. That caution is particularly applicable to aneurysms in this locality, for a detached clot might readily be carried to the brain and produce disastrous consequences.

Orbital or Ophthalmic Aneurysm.—The ophthalmic artery may be the seat of aneurysm, either in the orbital cavity or within the cranium. Many of the cases of orbital aneurysm are not true dilatations of the artery, but pulsating tumors, angeiomata, or arteriovenous aneurysms. The diagnosis is readily settled by pressure upon

the common carotid. If pulsation ceases, it points to the treatment, which is ligation of the carotid—an operation which has been attended with about 75 per cent. of cures.

Subclavian Aneurysm.—The artery is divided into three parts: the first part on the right side ascends obliquely outward from the origin of the vessel to the inner border of the scalenus anticus muscle. On the left side it ascends vertically to gain the inner border of that muscle (Gray). The second part passes outward behind the scalenus anticus. The third part passes from the outer margin of that muscle beneath the clavicle to the lower border of the first rib, where it becomes the axillary.

Landmarks.—Near the outer border of the sterno-mastoid, and about one inch above the clavicle, the pulsations of the artery can be felt. Behind it is the first rib, against which the vessel can be readily compressed. Stand behind the patient's shoulder and make compression with the thumb in the downward direction and a little inward.

The third portion of the artery is the part most frequently involved. Next in order comes the first part, while the middle portion, owing to its having the firm, resisting scaleni muscles in front of it, is least likely to be the seat of aneurysm. The right side is much more frequently affected than the left. Generally speaking, the first indication of aneurysm of the subclavian is a tumor felt behind the clavicle and to the outer side or behind the sterno-mastoid muscle. In its full development it forms an elongated tumor behind and above the clavicle, and has a tendency to rupture before attaining a large size.

Errors in diagnosis are apt to occur—first, by mistaking a glandular or other tumor for an aneurysm, just as in the case of the carotid. The absence of expansile pulsation and the fluidity of the tumor should remove all doubt. Second, it may be difficult to determine from what vessel the aneurysm springs. The history will help us. An aortic aneurysm produces pressure-symptoms, and often causes death long before it reaches the position of the subclavian. On the right side, therefore, the question is easily settled. On the left side aneurysm of the subclavian is rare, but the diagnosis is more difficult. Attention to the following points may be of service: A tumor in the neck appears *early* in the case of subclavian aneurysm, *late* in the case of an aortic. The return circulation in the arm is interfered with in the case of the subclavian; not at all or late when the aorta is affected. The radial pulse is changed in rhythm and volume on the affected side in subclavian aneurysm, while if the second or third portion of the arch of the aorta is the seat, there is no change in the radial pulse until the branches are affected.

Treatment.—Tufnell's treatment should first be tried. Compression on the proximal side of the aneurysm is only possible when the third portion is involved. Ligation of the artery is most successful when applied to the distal side. As a last resort the artery may be tied at the proximal side of the aneurysm and the arm amputated at the shoulder-joint.

Axillary Aneurysm.—The right side is much more frequently affected than the left, and in most cases the aneurysm can be traced to an injury. The growth of the tumor is rapid, and may be found pro-

jecting downward into the axilla, inward and against the thorax, in some cases causing absorption of the ribs from pressure; or upward under the clavicle, in which case the shoulder is elevated. The movements of the arm are interfered with, the head is drawn to the same side, and the elbow is abducted. The more prominent pressure-symptoms are pain running down the arm from the brachial plexus, and edema from interference with the return circulation through the axillary vein.

Treatment.—Compression, either digital or instrumental, to the third portion of the artery should first be given a thorough trial. Failing in this, the vessel should be ligated at this point.

Aneurysm of arteries below the axillary are rare, and usually the result of injury. They present no special difficulty in diagnosis, and can be recognized by the general principles already laid down.

Aneurysm of the Abdominal Aorta.—Any part of the artery may be the seat of aneurysm, but the most common position is near the diaphragm. The whole artery may be expanded in the form of a large fusiform aneurysm, or the tumor may be of the dissecting or sacculated variety. One or other of the branches of the aorta may be involved or even obliterated by pressure.

History.—There is generally a history of injury or severe muscular effort or continued laborious employment. If the aneurysm is idiopathic, the disease of the vessel is likely to be extensive. In the early period the symptoms are obscure.

Pain varies in character, sometimes continuous, sometimes paroxysmal—in some cases running along the course of the nerves, in others confined to one fixed position. When pain is continuous, it is due to erosion of the spinal column, and is characterized as gnawing or boring, referred to the back, sometimes at a fixed point over one of the vertebræ. This pain is relieved when the patient assumes the recumbent position with the face downward: it is aggravated by localized pressure and by such movements as stamping or riding in a jolting vehicle. An advanced stage of erosion may result in paralysis due to involvement of the spinal cord.

Pulsation.—The pulsation is expansile and attended with a bruit, which can be heard not only in front, but behind. The most distinct pulsation is found a little to the left of the middle line and near the ensiform cartilage. This is especially the case when the aneurysmal sac bulges forward. Pulsation, on the other hand, may be absent if the sac points laterally and posteriorly. If the tumor is high up and shielded by the pillars of the diaphragm, it may attain an enormous size without showing signs of pulsation. In such cases the diagnosis must rest upon the subjective symptoms, especially pain. In rare cases a heaving pulsation is apparent near the dorsal and lumbar vertebræ and the adjoining ribs and intercostal spaces.

Pressure-symptoms.—Pressure upward against the diaphragm produces dyspnea; against the stomach and intestines, dyspepsia, colic, or other disorders of digestion; against the bile-duct, jaundice. One or other of the abdominal organs, such as the liver or kidneys, may be pushed aside. The tumor does not move with the diaphragm. Although it generally increases in size in the direction of least resistance, a small

proportion of cases press directly upon the spinal column, producing erosion of the bones.

Errors to be Avoided.—In thin persons the abdominal aorta is readily felt, and a strong pulsation, with a slight amount of expansion at each diastolic movement, can be readily mistaken for aneurysm. Abdominal pulsation, according to Douglas Powell, is due to vasomotor disturbance, and may be induced by hemic, emotional, malarial, and reflex causes. The advice of Sir William Jenner is worth bearing in mind: "Instead of being your first, it should be your last idea that abdominal pulsation is due to aneurysm."

Aneurysm of the Branches of the Abdominal Aorta.—Any of the branches may be the seat of aneurysm, but the vessels most commonly affected are the celiac axis and the superior mesenteric. In our decision we must be guided by the general character of aneurysm

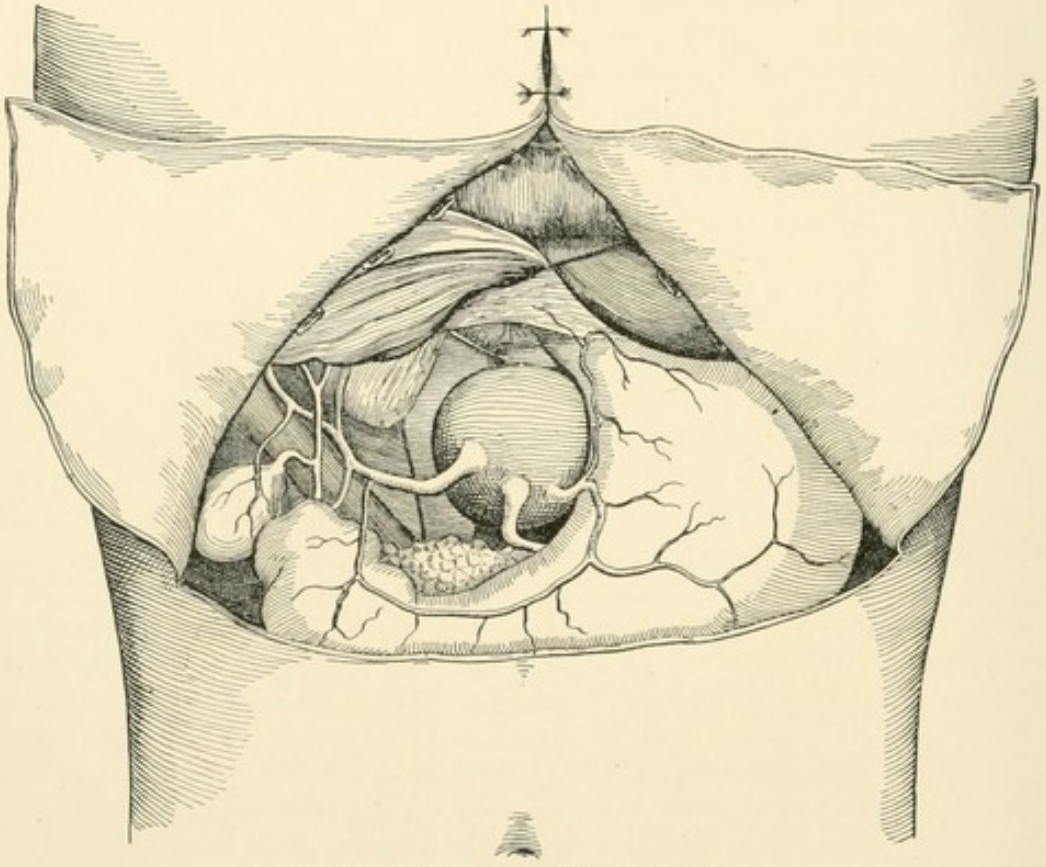


FIG. 8.—Aneurysm of the celiac axis.

and the position of the tumor. When the celiac axis is the seat of the disease the tumor projects forward toward the right side under the liver. In the only case of this form of aneurysm that has come under my observation the tumor was on the left side near the middle line. The post-mortem revealed an aneurysm of the celiac axis about 4 inches in diameter (Fig. 8). When the superior mesenteric is involved the tumor is more movable, except when the origin of the vessel is the part dilated.

Iliac Aneurysm.—The common iliac or the internal or external branch may be the seat of aneurysm. The tumor is soft, circum-

scribed, expansile, and the bruit can be heard along the course of the artery. Pain is not severe, except when the genito-crural or obturator nerve is involved. Owing to the room for expansion, the pressure-symptoms are not marked until the tumor has attained a large size. In a few cases the veins have been obstructed, resulting in edema and gangrene. Additional evidence can sometimes be gained by an examination per vaginam or rectum.

The errors in diagnosis to be guarded against are—1. Abscess in the neighborhood of Poupart's ligament. The error is more liable to occur from the fact that an aneurysm may contain pouches, which, lying beneath the ligament, may fluctuate, but do not pulsate. Lancing

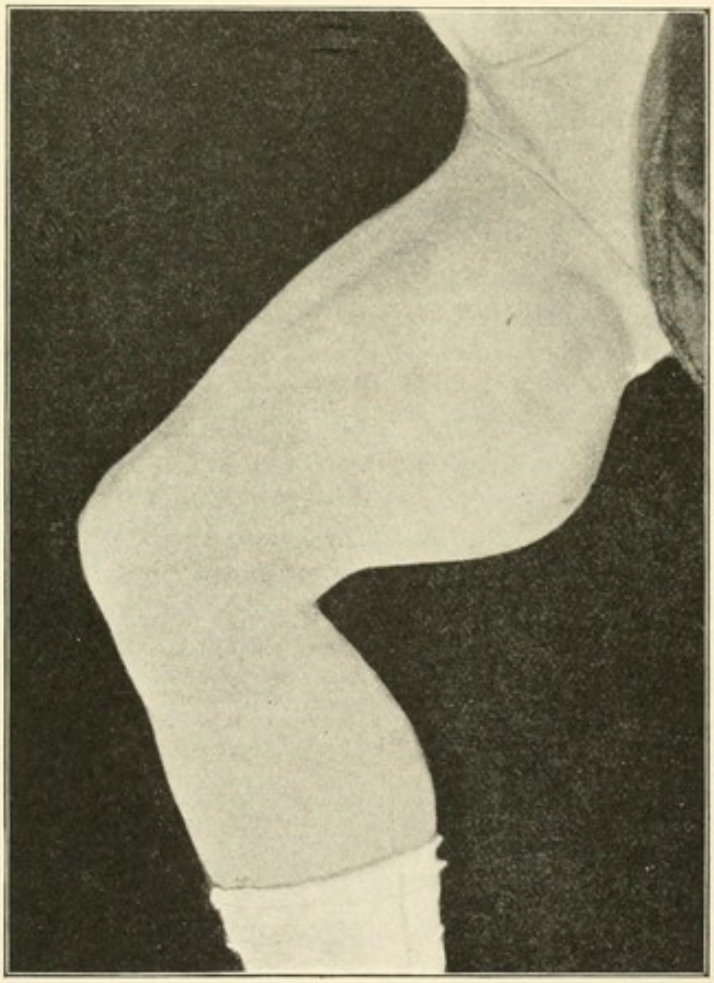


FIG. 9.—Femoral aneurysm (photographed by Dr. Brown).

a supposed abscess under these circumstances would be a serious blunder. 2. Pulsating sarcomata and tumors growing from the bones are difficult to distinguish from aneurysm. Our reliance must be placed upon the position of the tumor, its connection with bone, the want of the characteristic bruit, and the general characters already described.

Treatment.—In the common iliac, Tufnell's treatment should be tried. If this fail, proximal, with or without distal, pressure may be successful. In the external iliac the same treatment should be employed, failing which the external or common iliac may be ligated. Distal ligature in this locality has never been successful.

Femoral Aneurysm.—*Landmarks.*—At a point midway between the anterior superior spine of the ilium and the symphysis pubis the artery can be felt pulsating. From this point to the spur-like tubercle for the insertion of the adductor magnus on the inner side of the knee draw a straight line. The femoral artery lies under the upper two-thirds of this line. The profunda rises about 1½ or 2 inches below the ligament.

The common, superficial, or deep femoral may be the seat of aneurysm. As regards the common trunk there is little trouble in diagnosis, as the usual signs are well marked (Fig. 9). It is, however, difficult to decide whether the dilatation is situated upon the superficial or deep branch. If the pulsation of the superficial can be felt overlying the deep vessel, the point is settled, but this is not always possible. It is well to remember that the superficial is the branch most commonly affected.

Treatment.—1. Proximal pressure; 2. Ligation If in Hunter's canal, ligate the artery higher up; if in Scarpa's triangle or if the profunda is involved, either the common femoral or the external iliac may be tied.

Popliteal Aneurysm.—*Landmarks.*—A line drawn down the middle of the ham will overlie the vessel. The guide to it is the outer border of the semi-membranosus muscle, under whose fleshy belly the artery lies. Pressure upon the vessels should be made against the bone nearer to the inner than the outer hamstring, and considerable force is required to obstruct the flow of blood.

Next to the aorta, this artery is the most common seat of aneurysm. This may be accounted for on the following grounds: 1. The artery is more subject to atheroma. 2. It is but slightly supported by surrounding parts. 3. It is readily overstretched by undue extension of the knee and compressed by forced flexion. 4. Embolus is liable to lodge in it from the fact that the vessel breaks up into a number of branches. Cases are not infrequent in which both limbs are affected either simultaneously or consecutively. Both fusiform and sacculated tumors occur, but the latter is more common. The progress of a popliteal aneurysm is usually rapid, except when the dilatation takes place on the front of the artery and presses against the bone, in which event its growth is slow.

The patient who is the subject of a popliteal aneurysm has probably complained of supposed rheumatic pain in his knee, with stiffness of the joint and weakness of the limb. Next a swelling is observed, and later it is discovered that the swelling pulsates. In many cases the disease develops suddenly as the result of some violent exertion. The sac is easily emptied by pressure on the artery above the tumor, and distended by compression on the distal portion of the vessel. The bruit is distinct and runs down the course of the artery. If the sac becomes filled with clots, these signs may be wanting, but there will still be the history of a time when pulsation was distinctly felt, and in a certain proportion of cases pulsation ceases to return after a greater or less time. Synovitis is a complication likely to arise when the sac presses forward against the joint. This aggravates the pain and impairs movement.

Treatment.—Flexion, proximal compression, elastic bandage, or ligature.

Traumatic Aneurysm.—In the forms of aneurysm already described the starting-point is a diseased condition or an overstretching and partial rupture of the arterial coats. Traumatic aneurysm is the result of a direct injury, a stab, or complete rupture of the artery, with escape of its contained blood into the surrounding tissues; that is, the formation of an arterial hematoma. At first the blood may escape freely from the vessel, but as it infiltrates the tissues the pressure increases until it checks the hemorrhage.

The symptoms denoting traumatic aneurysm are the formation of a pulsating, painful tumor immediately following a wound or injury of an artery (Fig. 10). The bruit is generally distinct, and the pulsation in the artery beyond the tumor is usually lost. Tension is a marked symptom, and the skin shows a red, inflammatory character, with increased temperature.

Should pyogenic organisms gain entrance, the formation of an abscess will result, which on being opened is attended with dangerous hemorrhage. Besides this danger, sloughing and even gangrene may occur when an important artery is the seat of lesion or when tension is not relieved.

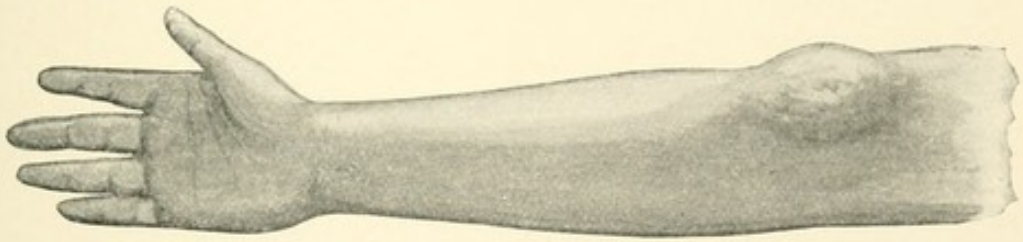


FIG. 10.—Diffuse traumatic aneurysm of the brachial artery (White).

Errors in diagnosis may be made by mistaking an abscess for aneurysm. Although the resemblance may be close, we must remember that an abscess cannot form in an artery as an immediate result of injury. The stages of inflammation and suppuration must take several days, while traumatic aneurysm occurs in a few hours. In cases of doubt the introduction of an exploring needle will settle the point.

Treatment.—Apply an Esmarch bandage on the proximal side of the aneurysm and cut down upon the tumor, turn out the clots, divide the vessel completely at the injured points, and ligate both ends. Dress the wound antiseptically. If the aneurysm is so situated that an elastic bandage cannot be applied, dissect down upon the tumor, make an opening large enough to admit the finger, and search for the bleeding point. The flow of warm blood will act as a guide to the finger. When the opening is found press upon it to stop further hemorrhage, enlarge the wound, and turn out the clots. Now by means of an aneurysm needle pass a catgut ligature around the artery above, and another below the point compressed by the finger. In gunshot wounds especially, when the aneurysm is on one of the arteries of an extremity or when a large artery is involved near the trunk, and the blood-supply to the limb is evidently cut off, rendering gangrene inevitable, amputation is the proper treatment.

Other blood-tumors bearing a close relation to aneurysm, but not falling strictly within the definition, are certain tumors.

Cirsoid aneurysm is a tumor consisting of a number of small-sized arteries elongated and dilated. The tumor is soft, bluish in color, irregular in shape, and pulsating. It is always superficial, and is readily distinguished from true aneurysm.

Arterial varix is to an artery what a varicose condition is to a vein. It is a single small artery dilated and elongated.

Aneurysmal varix is a communication between an artery and a vein without the intervention of a sac. We do not see it often now-a-days, but in the good old days when bleeding was universal the condition was quite common. If, instead of opening the vein alone, an unskilful operator incised both artery and vein, and then, as was the custom, applied a firm compress to arrest hemorrhage, an aneurysmal varix was a common result. It occurs in this wise: By inflammatory action the artery and the vein become adherent, leaving the wound in each still permeable, allowing arterial blood to pass through at every pulsation of the heart. The force of this current of arterial blood against the weak wall of the vein causes dilatation, but no sac is formed. A peculiar bruit attends this condition. Prof. Spence of Edinburgh was in the habit of comparing it to the sound of a blue-bottle fly in a paper bag. Valentine Mott compared it to the purring of a kitten. Besides the bend of the elbow, aneurysmal varix may affect the carotid and internal jugular and the common femoral vessels.

Treatment.—Many cases require no treatment, except an elastic bandage to prevent further enlargement. In cases attended with pain and disturbance of the circulation pressure at three points may be employed—viz. on the artery above, on the vein below, and over the aneurysmal varix. This failing, operate as follows: Expose the varix by dissection, place a ligature above and below the opening in both artery and vein, and cut out the aneurysm.

Varicose Aneurysm.—It is always puzzling to the student to distinguish between aneurysmal varix and varicose aneurysm. They are alike in this respect, that in both conditions there is a communication between an artery and a vein. Both have a like cause—that is to say, a wound of the artery and the vein. The results of that wound, however, are different. In aneurysmal varix the walls of both vessels become adherent and there is no sac. There is really no aneurysm, and you will notice that it is not called an aneurysm. It is the adjective "aneurysmal" that is employed. In varicose aneurysm a real sac is formed by the outpouring of blood between the artery and the vein, while the opening in both vessels remains as in the former case. It is a real aneurysm, and is so designated, for the noun "aneurysm" is used.

Treatment.—The most satisfactory is that employed by Spence, who cut down upon the artery above the sac, and also below it, ligating the artery at each position. This operation shuts off the current from the sac and allows coagulation to take place.

CHAPTER III.

INJURIES AND DISEASES OF THE OSSEOUS SYSTEM.

In examining the osseous system we shall consider fractures, dislocations, inflammations of bone, tumors of bone, and deformities.

I. FRACTURES.

As a rule, the diagnosis of fractures is not difficult. In many cases the diagnosis is made by the patient or his friends before the arrival of the surgeon. This is usually the case in fracture of the femur, the humerus, or both bones of the forearm or of the leg. There are some fractures, however, which require considerable skill and judgment to decide upon their nature, owing to the obscurity of the symptoms, the amount of swelling, and the position of the bone.

As fractures come into the class of cases which we may designate as emergencies, I shall take this opportunity to say a few words upon emergency cases in general.

An accident, as a rule, creates a panic. Everybody "loses his head," and the young surgeon is often perplexed and embarrassed. When a messenger summons you to such a case do not allow his haste to disconcert you. Compel him to take time to tell you the three following things: 1. The correct name and address of the injured person, which you must carefully write down; 2. Whether or not he has been removed from the scene of the accident; 3. What the nature of the injury is. Sometimes the messenger will tell you he ran off in such a hurry that he did not wait to ask what had happened. As a rule, however, he can give some idea of the condition of things. He can tell whether the injured person is bleeding and whether he is conscious. If he can state how and under what circumstances the accident occurred, the surgeon can form a fairly correct idea as to the probability of fracture or dislocation. These inquiries need occupy but a few moments, and frequently save much time and annoyance.

A business-like young surgeon will always have his satchel well stocked and ready for emergencies. He should have in it at least the following: Needles, prepared catgut, corrosive-sublimate tablets, iodoform and sublimate gauze, absorbent cotton, a few bandages, two bistouries, six hemostatic forceps, a pair of scissors, a male catheter, a hypodermic syringe, a bottle of chloroform, Esmarch's inhaler, a 4 per cent. solution of cocain, a half ounce of collodion, a razor, a nail-brush, and two plaster-of-Paris bandages.

When the patient has not been removed from the scene of the accident before the arrival of the surgeon, a brief examination must be made to ascertain the character of the injuries. If hemorrhage be profuse and a vessel of considerable size be wounded, a tourniquet may be applied temporarily until the patient is removed to his home or to a hospital. If a limb be fractured or severely lacerated, a temporary splint must be applied. The patient may complain of cold, and no amount of clothing heaped upon him can make him comfortable.

A hypodermic of morphine acts speedily and effectually, allaying pain, causing the patient to feel a sensation of warmth and comfort. It is also an excellent remedy for shock—better than alcoholic stimulants.

If the patient be unconscious, place him on his back with the head slightly raised, care being taken to give the lungs free play by unbuttoning the clothing over the chest and removing the neckwear.

The utmost care should be observed in moving the injured person. In a fracture of the lower extremity the fragments are liable to lacerate the tissues or may even perforate the skin, thus converting a simple into a compound fracture. One attendant should support the fractured limb, and before transporting the patient on a stretcher the two limbs should be tied together to prevent the injured member from rolling outward by its own weight, or a blanket or coat may be rolled up and placed against the outside of the limb as a support.

Arrived at the sick-room, the surgeon will find it to his advantage to select two or, if necessary, three of the most intelligent of the bystanders, while he quietly but firmly asks all the rest to retire. This will relieve him of a crowd of critical observers, while the favored few who are asked to remain, feeling that a compliment has been paid them, fall into line as willing helpers.

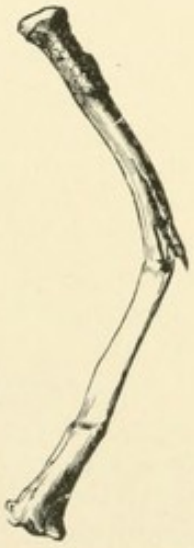


FIG. 11.—Partial or green-stick fracture of the radius (Stimson).

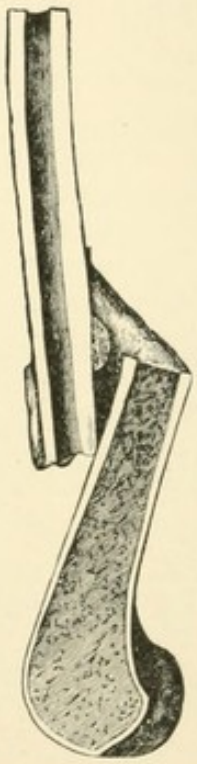


FIG. 12.—Transverse fracture of the femur (Gurlt).

In removing clothing the sound arm should be slipped out of the sleeve first, after which the injured arm can be liberated without much trouble. In cases where much pain is suffered the scissors can be used to rip up seams and remove the garments with the least disturbance possible.

Classification of Fractures.—Fractures are classified as follows:

1. *Incomplete Fractures.*—This class comprises fissures of flat bones, such as those of the cranium, in which the line of fracture does not extend completely across the bone nor through its entire thickness. It

can also occur in long bones when the continuity has not been entirely lost, as in the so-called "green-stick" fracture (Fig. 11). Then there may be a simple depression of a part of a bone as when a blow is received upon the head which bends a portion of the bone inward. The separation of a splinter of bone or of an apophysis is sometimes spoken of as an incomplete fracture. We often hear of a bone being simply splintered, but, as rule, such a diagnosis is evidence of doubt

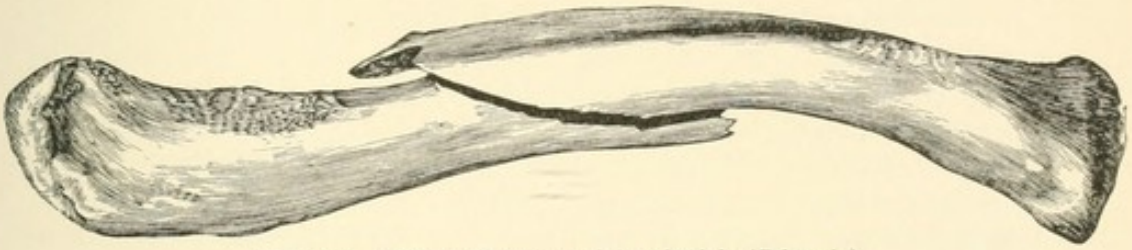


FIG. 13.—Oblique fracture of the clavicle (Stimson).

in the mind of the surgeon as to the existence of fracture. When a bone is splintered, it is usually by direct violence, as in the case of a sword or bullet wound. The forcible contraction of a muscle may splinter a bone at the point of insertion of the muscle.

2. *Complete Fractures.*—In this variety there is a complete breach of continuity of the bone. According to the direction of the line of fracture it is spoken of as transverse (Fig. 12), oblique (Fig. 13), longi-

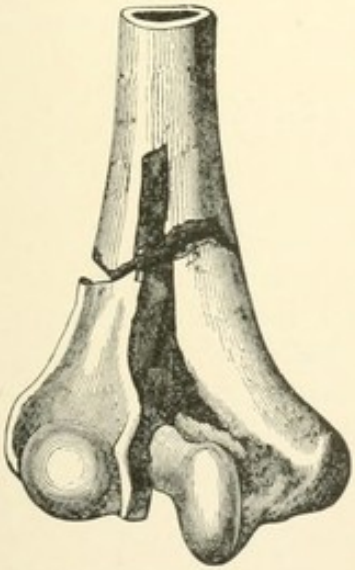


FIG. 14.—Intercondyloid fracture of the humerus (Stimson).

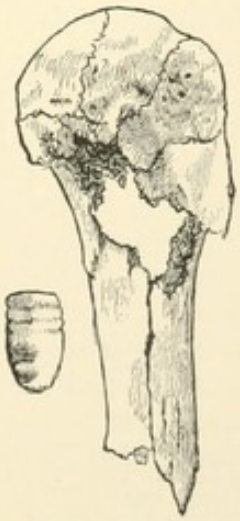


FIG. 15.—Comminuted perforating gunshot fracture of the head of the humerus (Army Med. Mus.).

tudinal, toothed, V-shaped or T-shaped. When the seat of fracture is taken into consideration, we speak of fracture of the neck, shaft, condyle, etc. When in the vicinity of a joint the fracture is spoken of as intracapsular (within the capsular ligament), extracapsular (without the capsule), or when extending into the joint as intra-articular. The most common example of this is in longitudinal fracture of the lower end of the humerus, when the fracture extends into the elbow-joint

(Fig. 14). When a bone is broken into a number of fragments it is said to be comminuted (Fig. 15).

3. *Compound fractures*, in which the broken bone communicates with the exterior through a wound of the soft parts.

Diagnosis of Fractures in General.—In taking the history of the case—which in the first instance may be oral—care should be taken to note the nature and direction of the force which caused the injury. Fractures occur by—1. Direct violence, as when a falling body strikes the clavicle, fracturing the bone. 2. Indirect violence, as when a person falls, the shoulder first striking the ground and thus fracturing the clavicle. 3. Contre-coup, as when a blow upon the head causes fracture, not at the point of contact, but at the opposite point of the skull. 4. Muscular action, as when the patella is broken by powerful contraction of the quadriceps. A violent effort in throwing a ball has broken the humerus, and a desperate kick at a dog, which all too nimbly gets out of harm's way, has been known to fracture the femur. Forcibly throwing the head backward has broken the neck. The ribs have been broken by violent coughing, and the sternum during the pains of labor. The coracoid process has been wrenched off by the contractions of the coraco-brachialis, pectoralis minor, and short head of the biceps; so has the posterior part of the calcaneum by the action of the muscles of the calf.

The evidences necessary to prove the existence of a fracture are—1. Deformity; 2. Abnormal mobility; 3. Crepitus.

Make your examination gently and systematically; at the same time, do not allow your fear of causing pain to prevent your satisfying yourself as to the real condition. The patient who makes a loud outcry when you try to elicit crepitus will be just as ready to cry out against your reputation should you make a mistake in diagnosis. Take the sound limb for a model, and, comparing the injured member with it, satisfy yourself upon the following questions:

1. Is there deformity? In many cases a glance will settle this point. When a long bone, such as the femur, is broken, an angle more or less obtuse is formed by the fragments, and the segments of the limb show a corresponding change in direction. When the fragments slip past each other there may be seen a bunching caused by the contraction of the muscles, and the limb is shortened.

To satisfy ourselves more thoroughly on this point measurements should be made. In the forearm and the leg both ends of the bones can be felt and the measuring tape applied. In measuring the femur fixed points on other bones must be taken. Place the patient flat upon his back with both limbs close together and perfectly straight. Apply the tape to the anterior superior spinous process of the ilium, and carry it down to the top of the inner malleolus. In the case of the humerus the acromion process is taken as a fixed point, and the tape carried to the lowest point on the external condyle. It must, however, be borne in mind that in many persons there is a difference in the length of the limbs which may be unknown to the persons themselves. This rarely amounts to more than a quarter of an inch, but in some instances it reaches an inch or even more. Another source of possible error is previous disease or injury which may have shortened one of the limbs.

Swelling is an almost constant accompaniment of fracture and a source of deformity. It is often attended with heat and redness. On the second or third day large blebs, filled at first with a yellow and later with a bloody liquid, sometimes appear. These are more apt to occur in fractures of the leg and forearm. Fractures caused by direct violence are liable to have injury of the soft parts, either immediate or showing at a later period in the form of sloughing. Fractures by indirect violence are often followed by extravasations of blood beneath the skin (ecchymoses), and, as a rule, at some distance from the seat of fracture.

2. Is there preternatural mobility? If a joint-like movement is found in the shaft of a long bone, the evidence of fracture is complete. When the bone is broken near one or other extremity, however, this abnormal mobility is not so easily recognized. A fracture at or near a joint may be attended with an abnormal range of movement of the joint or with a movement in an unnatural direction.

3. Is there crepitus? This is a pathognomonic sign of fracture. It is the rough, grating sensation which is conveyed to the ear and hand of the surgeon, and with accentuated force to the feelings of the patient, when the broken ends of a bone are rubbed together. Crepitus is discovered by grasping the bone firmly above and below the seat of fracture, and causing sufficient movement of the fragments against each other to produce the grating sensation already described. The moment this is found cease further manipulation, for it will only do harm. Indeed, in some fractures we should not try to find crepitus; in others we cannot find it if we try. In fracture of the neck of the femur with impaction we shall do positive injury by seeking for crepitus, and in immovable fractures, such as those of the cranium, crepitus is out of the question.

4. What is the nature of the displacement? When the line of fracture is transverse to the long axis of the bone it is called a transverse fracture, and the displacement, if any, is lateral or it may be overlapping. If the line of fracture runs for some distance more or less exactly in the same direction as the long axis, it is called a longitudinal fracture, and in that case there is usually no displacement. The direction of the fracture may be intermediate between these two, and then it is called oblique. The tendency in this case is for the fragments to slip past each other, causing shortening of the limb, while the ends of the bone cannot be so distinctly felt as when there is a transverse fracture with overlapping of the fragments.

The discovery of the Röntgen or *x* rays has placed in our hands a most satisfactory means of diagnosing a fracture and of demonstrating the actual position of the fragments. It is of especial value in fractures in the neighborhood of joints, in ununited fractures (see Plate I.), and in old injuries having an obscure clinical history.

Besides the foregoing signs, which are objective, there are certain subjective symptoms which should be taken into account; these are—

(*a*) *Pain.*—This is a constant accompaniment of fracture. A simple contusion or a sprain is also attended with pain, and you may often find it impossible to say whether the injury is a simple bruise or a fracture. The safe rule in such a case is to give yourself and patient

the benefit of the doubt and treat it as a fracture. Perfect immobilization in splints is excellent treatment for a contusion or a sprain. The removal of the apparatus on the second or third day will probably show the case in a new light, with swelling abated and pain absent. Then, if you can satisfy yourself that the bones are unbroken, your error has been on the side of safety. Pain, to be of any value to us as a symptom of fracture, must be constant and limited to one particular spot. If after a severe wrench of the foot, pain is felt over the fibula an inch or two above the ankle, much increased on pressure, even if every other symptom is wanting, we are justified in diagnosing a fracture. When pressure upon one point of a rib causes pain at another point, the evidence is strongly in favor of fracture.

(*b*) *Helplessness of the Part.*—As a rule, the patient can make no use of a fractured limb. The least motion causes suffering, so that pain or the fear of it compels him to keep the part at perfect rest. This has a salutary influence, for the movement of a fracture may be attended with considerable danger. A person suffering from fracture of the tibia may, by attempting to walk, force the fragments past each other and out through the skin, thus converting a simple into a compound fracture. The same is liable to happen in fracture of the fibula or of the clavicle. If there be marked impaction, or if the periosteum remain intact, or if one of a pair of bones is broken, it is possible for the patient to use the limb. I had a patient who walked several hundred yards after sustaining fracture of the neck of the femur, which was firmly impacted, and cases are reported of persons walking about for days in the same condition. In some cases of fracture of the clavicle it is possible for the person to raise the arm above the head on the affected side.

Errors in diagnosis are liable to occur by our not distinguishing between fractures, separation of epiphyses, dislocations, contusions, and sprains.

The greatest difficulty arises when the injury is in the neighborhood of a joint, and especially when there has been time for swelling to take place. Another disturbing element is the presence of previous disease in the joint, such as synovitis or rheumatoid arthritis.

(*a*) *Separation of Epiphyses.*—This occurs in young children: the injury is near the extremity of the bone; when crepitus can be felt it is of a softer character than that which is found in fracture; in infants crepitation is wanting. The displacement is slight, for, as a rule, the periosteum remains intact and steadies the separated epiphysis. When the bone is near the skin its end can be felt, and it is rounded and smooth, not sharp and rough as in fracture. The most important practical point in the diagnosis of this accident is that separation of an epiphysis is liable to be followed by arrest of development. Repair usually takes place by osseous tissue; hence the bone ceases to grow at the injured end, and if the patient has not completed his growth permanent shortening will result. In a case which came under my observation the femur was shortened one inch and a half in a young man sixteen years of age, who sustained this injury when a child. In a single long bone, such as the femur or humerus, this shortening is not so serious as when it occurs in one of a pair. When the accident

occurs at the lower end of the radius, an arrest of development follows, the styloid process of the ulna becomes abnormally prominent, the use of the hand is seriously interfered with, and a most disagreeable deformity is the result. If our diagnosis is separation of the epiphysis, this danger should be pointed out to the friends of the little patient.

(*b*) *Dislocation.*—Except in the presence of considerable swelling the diagnosis between fracture and dislocation is not difficult. In dislocation the joint is fixed, and cannot be moved except by force. When the deformity is rectified there is no tendency for it to return. True crepitus is wanting. It may be simulated by joint crepitus, effusion into the sheaths of tendons, emphysema, and by the grating of osteophytes in chronic osteo-arthritis. True crepitus, having once been felt, can hardly afterward be mistaken by the surgeon. The greatest difficulty will arise at the elbow in cases where both dislocation and fracture exist.

(*c*) *Contusions.*—The pain and helplessness caused by a severe contusion may closely simulate a fracture or a dislocation. The pain, or fear of it, compels immobility, and the rigidity of the muscles about a joint under these circumstances is puzzling. Putting the patient under an anesthetic will greatly help us by relieving muscular contraction and pain.

If, in spite of a painstaking examination, you are still uncertain, treat the case as a fracture and wait for two or three days.

Complications of Fracture.—There are numerous conditions which may complicate fracture. They may be considered under three heads:

1. *Complications due to a General Effect upon the System.*—Of these the most important is shock. The violence which causes fracture may be so severe as to affect the nervous system seriously, not only on account of injury to the bone, but to the soft parts as well. The nervous excitement and mental condition also play an important part. Shock is readily recognized by coldness of the skin and pallor of the face; frequent, irregular pulse, the artery appearing to empty itself after each beat. The temperature is below normal, and may go down to 95° or 94° F. The breathing is shallow.

Fever very frequently follows a fracture, and may partake of the character of fermentative or traumatic fever, due to the extravasation of blood and the absorption of the blood-ferment set free by the injured tissues. The temperature rises to about 100° or 101° F. by the evening of the second day, and is identical with the fever which follows aseptic surgical operations. In the case of compound fractures, where suppuration is allowed to take place, the character of the fever is different and is persistent.

Retention of urine is a complication to be watched for, particularly in fractures about the pelvis. A catheter should always be passed; if instead of urine a little blood escapes, while the patient states that the bladder was full at the time of the accident, we may infer that the bladder is ruptured. If, however, the rent in the bladder is small or occluded by a loop of intestine, clear urine may collect in the bladder and come away through the catheter.

Fat-embolism is, fortunately, a rare complication. In the process of

repair fatty degeneration takes place in the medulla, and perhaps in the subcutaneous tissue. Under ordinary circumstances and in the vast majority of cases this gives rise to no symptoms. But it occasionally happens that through the open mouths of veins which have been torn across a large number of these broken fat-cells are taken up and carried back to the right side of the heart, and from there sent to the lungs. The symptoms produced are collapse, coming on after an interval of several days and not immediately, as is the case in shock. It is a sort of secondary shock. The earliest indications are transient attacks of dyspnea with irregularity of the heart-beat, and in some cases slight hemoptysis. The pulse is small and rapid, and the breathing shallow and sighing in the advanced stage, running into the Cheyne-Stokes respiration. The mind becomes dull, weakness increases, and in many cases convulsions intervene before the approach of death.

2. *Complications Due to Confinement of the Patient to his Bed.*—Except in those suffering from other diseases or debilitated from age the confinement necessary during the repair of fracture is well borne. Constipation is very common, varying in degree from a simple inactivity to obstinate constipation, attended with jaundice or gout. Congestion of the lungs is likely to appear in old or feeble persons whose circulation is languid and who cannot bear to remain long in the recumbent posture. Bed-sores constitute one of the most troublesome and distressing complications; they appear only in the debilitated. The sacrum is the most common position, but they may occur over any of the bony prominences where pressure is made either by the weight of the patient or by ill-adjusted splints. Cleanliness is of the utmost importance in the prevention of bed-sores. The use of an air-cushion is also a great help, and when it can be possibly avoided the aged and feeble should not be treated by rigid confinement.

3. *Local Complications.*—Laceration of the soft parts occurs to a greater or less degree in almost every fracture. Attending this laceration is extravasation of blood, but except when this is severe no attention need be paid to it. The torn tissues speedily undergo repair and collections of blood are rapidly absorbed. Even when a considerable quantity of blood is poured out, forming a hematoma and raising the skin above the subjacent tissues, simple pressure and patience will bring the parts back to their natural condition. When, however, a larger vessel is torn, we have what is, practically, a traumatic aneurysm, and it must be treated as such. As long as the parts can be kept in an aseptic condition a moderate amount of extravasation of blood is not serious, but in compound fractures especially, where infection of the wound may occur, it adds a dangerous element. Simple fractures may also become infected by absorption of septic material through a bruised skin covering, as in a case of direct violence in which cleanliness has been neglected. Dead blood-cells and lacerated tissues form a most fertile culture-soil for septic bacteria. Where such collections can be got at in compound fractures, they should be carefully washed out and drained. If they extend along the limb, enlarge the opening and make incisions if necessary.

Laceration or rupture of the main arterial trunk of the limb is a most serious complication. The most common accident of this kind

occurs when the lower end of the femur is fractured and one of the fragments is driven backward upon the popliteal artery. Even when the bone fails to cut through the vessel, the inner and middle coats of the artery may be ruptured, curling themselves up within, and the vessel thus weakened gives way at a later period. Sometimes the rupturing of the inner and middle coats may favor the formation of a clot; in such a case hemorrhage rarely occurs. When an arterial trunk is thus divided the symptoms develop rapidly. Swelling of a tense elastic character, steadily increasing, pain that is frequently excruciating, pulsation above, but none in the artery below the injury, rendering the limb cold, edematous, and benumbed,—these are the prominent symptoms. When there is a wound the blood flows freely, coming in jets when the opening is large and the vessel exposed, but when the external wound is small and tortuous the blood may come away in a steady stream.

In compound fractures when a large vessel is torn we have two courses before us—either to find and ligate the vessel above and below the laceration, or, failing in this, to amputate the limb. Bleeding under such circumstances is difficult to check. In fractures by direct violence we expect more laceration than in those caused in other ways. The crushing of the soft parts, as when a car-wheel runs over a limb, destroys not only the main vessel, but the collateral circulation. The skin, owing to its toughness and greater resisting power, may seem but little the worse of the bruise. Do not be deceived by this, for the vessels and nerves may be utterly destroyed.

Treatment of Lacerated Arteries.—Place a tourniquet upon the limb. Enlarge the wound and find the bleeding point. It is always difficult to find an artery that is torn in this manner. If the vessel cannot be found in the wound, it is of no use to ligate it higher up, for, if the collateral circulation be good, bleeding will continue; if the collateral circulation cannot be maintained, gangrene is a certain consequence. We should, however, give a fair trial to compression of the vessel higher up, for it will settle the question of collateral circulation, and in many cases it has been successful in permanently arresting the hemorrhage.

In simple fracture, when we can feel that the circulation is not completely arrested, the limb retaining its warmth and sensation, it is best to wait. The bleeding may cease, owing to pressure of the tissues, or the wound in the artery may close and the extravasated blood become absorbed. The limb should be placed in an elevated position, wrapped in cotton to maintain an even temperature, and only such bandages and splints applied as are necessary to keep the parts at perfect rest with gentle compression.

If, however, the limb is found to be cold, the artery below the injury pulseless, and the swelling tense and rapidly spreading, it is evident that gangrene will supervene, and the only course is to amputate.

Rupture of veins is rare. A fracture of the clavicle sometimes tears the subclavian vein, and the popliteal vein has been ruptured by a fragment of the femur. But, as a rule, the veins escape much more frequently than the arteries. The cases in which they suffer are those

in which the injury is severe and both arteries and veins are implicated. The symptoms are very similar to those already mentioned, with the exception of pulsation. The treatment consists in making a free opening into the swelling, turning out the clots, and ligating both ends of the vein. Thrombosis and embolism are also complications which must be taken into account. In one case reported by Southham thrombosis appeared on the seventeenth day, in another on the sixteenth, and in one reported by Tyrrell on the twelfth day.

Injury to Nerves.—The nerves, owing to their strength and toughness, are seldom injured in fracture. A nerve may slip between the fragments, not only suffering injury itself, but preventing the union of bone. The most common complication, however, is at a later stage, and due to the nerve being caught in the callus, which in the process of ossification exerts sufficient pressure to cause pain and interrupt the nerve-function. Of all the nerves, the musculo-spiral is the one which is the most frequently involved. When the nerve is simply irritated the symptoms are neuralgia, spasmodic contraction, and hyperesthesia. When the nerve is compressed, the pain is constant, and, as degeneration takes place, there is loss of power, wasting, and diminished sensibility.

Diagnosis and Treatment of Special Fractures.

The Nasal Bones.—A violent blow upon the nose, followed by copious hemorrhage, should lead us to suspect fracture of the nasal bones. This fracture is frequently overlooked both by patients and surgeons. The swelling, which comes on rapidly, obscures the symptoms, and, as the nose is a very sensitive organ, patients are often reluctant to submit to a thorough examination. The commonest situation of the fracture is near the lower ends of the bones. The fragments are driven backward, but sometimes they are found to be forced to one side, and the septum is frequently involved. The fracture is often compound, the fragment perforating the skin, the mucous membrane, or both. Besides local pain, there are severe headache, copious hemorrhage, and sometimes emphysema in the surrounding cellular tissue.

In your examination look for deformity. This may be both seen and felt, but may be masked by swelling. If not satisfied with an examination of the external parts, look into the nostrils, and, if they are filled with blood, explore them gently with a probe. Crepitus can be felt, but usually the symptoms are clear enough without this, and the manipulations necessary to find it might cause further laceration and do harm.

Treatment.—If properly replaced, fractures of the nasal bones unite very rapidly. Hippocrates declared that perfect union took place in six days. Hamilton relates a case in which a cure was effected in seven days.

Take a small, strong instrument, such as a director or fine sound, and press the fragments upward from the inside, while the finger and thumb of the other hand mould the parts from without. It must be borne in mind that the nasal passage at the point where pressure is required is very much narrowed, owing, not only to the displaced frag-

ments, but also to the swelling in the mucous membrane. The canal is so small that it will not admit objects much larger than a probe. A lead pencil or an instrument wrapped in cotton is not suitable. When such is used, it is stopped before it reaches the point at which pressure is required, and the operator pushes upward against the nasal process of the superior maxilla. Finding a resistance which cannot be overcome, he, after repeated attempts, leaves the case with the bones unreduced. When the fragments do not remain in position after being replaced, a nickel-plated needle may be passed through the nose from side to side just below the fractured bones, and the parts held in place by a rubber band crossing the nose from one end of the needle to the other.

Hemorrhage can be stopped by injecting the nares with ice-cold water or by the application of an ice-bag. If the hemorrhage cannot be thus controlled, the posterior nares should be plugged. A good method of effecting this is either by the india-rubber inflating tampon or by the assistance of Bellocq's sound. By the former method the india-rubber tube which is used has two dilatations upon it, so shaped that when inflated they accurately fill the posterior and anterior nares respectively. It is passed in while flaccid by means of a long probe, and inflated when in position by means of a small syringe or by the mouth. Reinflation is necessary from time to time. By the latter method a pledget of lint or cotton-wool rather larger than the aperture to be filled is taken, and round the middle of this is tied a doubled piece of stout thread, a long loop being thus left on one side and two ends on the other, one of which is cut off short. The sound is then armed with a separate length of thread and passed closed through the nostril, and when the end has reached the pharynx the spring is projected, coils around under the soft palate, and appears with the thread in the mouth. The thread is then pulled through the mouth, thus leaving one end through the mouth, the other through the nostril. By making traction on the nose-end of the thread the pledget is guided by the finger in the mouth into the posterior nares. The loop of thread is firmly tied to an anterior loop, which is forced into the anterior nares, and the other end is allowed to hang in the pharynx or outside the mouth.

Fracture of the Malar Bone.—The most common position for fracture of this bone is at the zygoma, and it is always caused by direct violence. The prominence of the bone and the sharp outline of its orbital margin make diagnosis comparatively easy. As a rule, this bone is fractured in some serious injury which involves other bones of the face and skull.

Fracture of the Upper Jaw.—The whole bone may be driven in by direct violence, causing extreme deformity, or the wall of the antrum may be fractured, or the fracture may run along above the alveolar margin, so that the teeth are movable as if they were a set of false teeth. The diagnosis must be based upon the deformity, the nature of the accident, hemorrhage, and mobility of the part. A guarded prognosis should be given, as the brain or bones of the skull may be seriously involved.

Treatment.—It frequently happens that direct pressure with the

fingers is sufficient to correct the displacement and no retentive apparatus is necessary. When the alveolar border is the seat of fracture and the fragment is movable, it may be necessary to maintain the parts in proper position by wiring the teeth in the detached bone to those which are still in position.

Fracture of the Lower Jaw.—This fracture may result from direct or indirect violence. The most frequent seat of injury is near the canine tooth and immediately in front of the mental foramen. The angle, the symphysis, the neck of the condyle, and the coronoid process must all be examined. When the fracture is compound the breach of the soft parts is generally in the mouth. The teeth are frequently loosened or completely separated. By passing the fingers over the surfaces of the bone any irregularity can be felt, and in most cases crepitus can be produced. When the fracture is through the horizontal ramus one of the fragments drops to a slight extent, owing partly to its weight, but chiefly to the action of the muscles attached to the hyoid bone. When the bone is broken at its neck the condyle is drawn out of its socket by the action of the pterygoid, while the rest of the jaw is drawn toward the opposite side by the other muscles.

Pain is severe, and particularly when any attempt is made at mastication. The patient finds it difficult to speak, and steadies his jaw with one hand.

Treatment.—In simple cases the parts are easily kept in position. A good retentive apparatus is the following, which I quote from Mansell Moullin: "One webbing strap is placed beneath the jaw, carried upward on either side over the temporal region, and fastened a little in front of the vertex; and a second is placed horizontally around the forehead and below the occipital protuberance. Where they cross a slit should be cut in the horizontal one to allow the other to pass through, or they should be sewn together, and for additional security they may be connected by a tape over the sagittal suture. Buckles, protected underneath with little wash-leather pads, should be used to secure them. In ordinary cases there is no tendency to displacement forward; but if, owing to the convexity of the lower margin of the jaw, the vertical band is inclined to slip too far back, it may be secured in position by a tape stitched to it and passed in front of the chin." The four-tailed bandage is a time-honored appliance, but much inferior to the above method, as it has a tendency to become loose and untidy.

A splint of gutta-percha moulded to the part is an excellent method when, owing to the obliquity of the fracture, lateral pressure has a tendency to displace one of the fragments inward.

Interdental splints of various kinds have been invented, and excellent results have been obtained by wiring the fragments, either through the medium of the teeth or by drilling holes in the jaw itself.

Fracture of the Clavicle.—Of all fractures, this is the one met with most frequently. It occurs generally as the result of indirect violence, as when the patient falls to the ground, alighting upon his shoulder.

The most common position of the fracture is in the middle of the bone or a little farther toward the outer end. By direct violence any part of the bone may be broken. The position assumed by a person

with a fractured clavicle is so characteristic that a diagnosis can almost be made from that alone. The head is inclined toward the injured clavicle, and the free hand is used to support the arm on the injured side. The shoulder slopes more than in health, and is drawn nearer the middle line of the body. A projection may be seen over the clavicle, and if not seen it can be readily felt by passing the fingers along the bone, when the exquisite pain at that particular point and the presence of a sharp projection leave no doubt of the nature of the injury. It is not worth while looking for crepitus and increased mobility, as the patient's sufferings are greatly aggravated by any manipulations. The only exception to be made is when the fracture is at the coraco-clavicular ligament. Here the symptoms to be relied upon are tenderness and slight crepitus when moderate pressure is made.

In children the fracture is often incomplete, the so-called *green-stick* fracture.

Displacement.—When the fracture is incomplete there is a simple elevation about the middle of the bone. When the fracture is complete the displacement is much more marked. The inner fragment remains undisturbed, for it is steadied by the rhomboid ligament and the costo-coracoid membrane below and the sterno-mastoid muscle above. Sometimes, however, the outer end of this fragment is drawn upward against the skin, which it may even perforate. The outward fragment is the one which is displaced—first, downward by the weight of the arm; second, inward by the action of the pectoral muscles; third, forward by the action of the serratus magnus and pectorals, which rotate its outer end until it forms an angle with the true axis of the bone.

Treatment.—To effect reduction the shoulder must be drawn in the direction exactly opposite to the displacement—viz. *upward*, *backward*, and *outward*—and the parts must be kept in this position. The simplest appliance for this purpose is Sayre's dressing. Take two strips of adhesive plaster (spread on moleskin; cotton is too weak) three inches wide and of sufficient length to go once and a half around the chest. Pass the end of one strap around the arm of the affected side just below the axilla, and fasten securely, but not tight enough to interfere with the venous circulation. Draw the shoulder well back and carry the strap around the chest, so as to hold the arm with the elbow a little behind the axillary line. Now place the forearm of the injured side across the chest, so that the fingers point to the opposite shoulder. Carry the second strip from the uninjured shoulder across the back to the opposite elbow, and up along the forearm to the place of beginning; at the same time the elbow must be pressed forward, inward, and upward (Fig. 16). Absorbent cotton or other suitable material should be placed between the forearm and chest, lest retained moisture cause irritation and perhaps ulceration of the skin. The parts may be still further supported by a few turns of a bandage about the arm and chest.

Velpeau's bandage (Fig. 17) is a time-honored method of treating fractured clavicle, but has no advantage over Sayre's dressing. Should you happen to be so situated that suitable materials are not at hand, a very efficient appliance can be made by the use of two good-sized handkerchiefs or pieces of calico about one foot and a half square. Fold each handkerchief till two opposite corners meet, then fold it into

a band about four inches wide. Around each shoulder pass a handkerchief thus folded, and tie the ends in a single knot over the scapula. Now draw the shoulders well backward, and retain them in this position by tying the two ends of the right handkerchief to the two ends of the left. The arm is next flexed across the chest, and a sling applied to support the forearm and elbow. When Sayre's and Velpeau's methods are objectionable, the patient may be placed in the recumbent position with a sand-bag under the scapula of the affected side. The shoulder is then weighted with anything that will steady the parts. The fragments naturally coapt themselves in this position. When union has partially taken place suitable bandages are applied until repair is complete.

Union may be expected in about four weeks in adults, but it is well to warn patients that there is always more or less deformity resulting from thickening of the bone. The thickened bone may even make

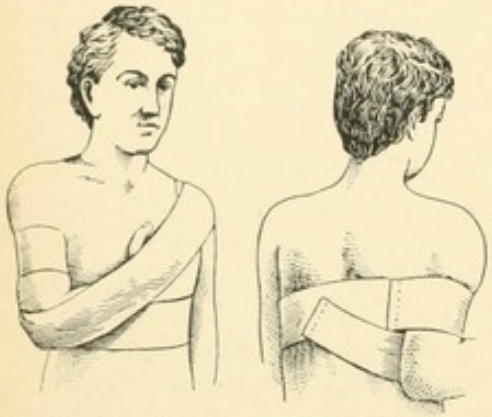


FIG. 16.—Sayre's adhesive-plaster dressing for fracture of the clavicle (Stimson).



FIG. 17.—Velpeau's bandage.

pressure upon the nerves of the brachial plexus, as occurred in two cases which came under my notice. This result is uncommon.

It is seldom that any complications attend fracture of the clavicle. But it is possible, particularly in fracture caused by direct violence, to have injury to the vessels and nerves, and even perforation of the lung.

Laceration of the subclavian vein or the internal jugular is a serious accident, and unless promptly treated is attended with fatal results.

Fracture of the Hyoid Bone.—This is a rare fracture. It often occurs in hanging, in which case the body of the bone is broken, or by the force of the thumb and finger when the throat is grasped by an assailant. In this case one of the greater cornuæ is the part to suffer, or at the junction of the body with the cornua. Blows upon the throat and even muscular contraction have been observed as causes.

Symptoms.—The victim may feel a sensation as if a bone had broken; severe bleeding may take place, more especially if a fragment has perforated the mucous membrane. There is difficulty in swallowing, dyspnea, salivation, and inability to speak. Severe pain may be felt in moving the tongue, and in some cases the tongue is drawn to one side. The greatest danger is in death from edema of the glottis.

Treatment.—Pass a finger into the throat and draw the base of the tongue as far forward as possible, while with the other hand the depressed bones are moulded into proper position. No retentive apparatus can be applied, and all that needs to be done is to keep the parts at rest for a few days by not using the voice and swallowing no food. Nourishment can be administered by the rectum.

Fracture of the Sternum.—Look for this fracture at or near the junction of the manubrium and the body of the bone. It has been produced by lifting heavy weights, by severe straining during labor, or by excessive bending of the body. It is usually simple and transverse, but may be multiple. Two cases which I have attended were produced by direct violence. The symptoms are not usually well marked. Displacement may be slight, for the periosteum on the inner surface of the bone is usually untorn. When the body of the sternum is fractured it is usually in its upper half.

Diagnosis must be based upon the history of the injury, localized pain, and displacement felt by pressing the fingers over the bone. Dyspnea and irregularity of the heart have been noted as symptoms. The head and shoulders are bent forward to relieve the pain.

Treatment.—While the patient makes a deep inspiration force the bone into position by direct pressure, aided, if need be, by extension of the trunk. A broad band of adhesive plaster around the chest, with a pad between the shoulders, is the best appliance for retention.

Fracture of the Ribs.—When a rib is fractured it breaks completely, green-stick fracture being rare. The man who can diagnose fracture of the ribs and never make a mistake is a good surgeon. I have seen more errors made in this fracture than in any other. The ribs most liable to suffer are those from the fifth to the ninth. The first of these is probably broken more frequently than is recognized; the remaining upper ribs are seldom fractured, and the false ribs perhaps never, except in gunshot wounds. One or several ribs may suffer, and one or several may be broken at two points each. Do not expect to see any deformity unless several ribs are fractured and the chest-wall, as sailors say, "stove in." External violence is the commonest cause, and it may act in one of two ways: directly, as happened to a patient of mine, who, while riding along in an open buggy, received a severe blow from the end of the pole of a carriage which was following too closely behind; or indirectly, as when the chest is compressed and the natural curve of the ribs is thus forcibly increased. Muscular action has produced fracture in fits of severe coughing—a rare occurrence.

Diagnosis.—Our suspicion of fracture should be aroused if the patient after an injury to the chest complains of pain on drawing a deep breath or on coughing, and especially when pressure is made on one particular spot in the chest-wall. Place your hand upon the painful spot and ask him to take a deep inspiration; when fracture exists a sensation of crepitus is felt by the hand, and the patient also feels the sensation in his side. With the point of the fingers find the tenderest spot and feel for any irregularity in the bone at that place. Next place a finger on the suspected rib on each side of the fracture, and you will perhaps find that movement communicated to one frag-

ment is not transmitted to the others. Place your stethoscope or ear over the suspected spot, and crepitus may be detected on deep breathing. Expectoration of blood is a common symptom, and so is cellular emphysema. As a rule, emphysema, when it occurs, extends over several square inches of the surface, but a few cases are recorded in which it spread over nearly the whole body. If the fracture is compound, we often find the intercostal artery wounded. The most common seat of fracture of the ribs is at or near the angle, about four inches from the vertebral column.

A contusion may closely simulate fracture, for it will produce pain and difficulty of breathing which is diaphragmatic. A fracture may show nothing more, for there may be no hemoptysis, and in some cases it is impossible to elicit crepitus. When uncertain, give fracture the benefit of the doubt; immobilization of the chest-wall will give the greatest comfort in contusion, and is also the proper treatment for fracture.

Treatment.—Take a band of adhesive plaster about six to nine inches broad and carry it around the chest, overlapping about one-half. If this is not convenient, use several narrow strips of plaster, and get complete immobility of the affected portion of the chest-wall by applying strips vertically.

Fracture of the Scapula.—Great force is necessary to break the scapula, for behind it are the elastic ribs and a cushion of muscular tissue over which it readily slides when subjected to a blow. Swelling occurs speedily, and makes the diagnosis more difficult than in most bones, and hence errors must be guarded against.

Seven different fractures of the scapula are recognized—viz: 1. The body; 2. The inferior angle; 3. The superior angle; 4. The spine; 5. The acromion process; 6. The coracoid process; 7. The neck.

The Body.—Pass the fingers along the posterior border of the scapula, at the same time placing the bone in such positions as elevate its margins and render them more prominent. If fracture exist, there will be overlapping of the fragments. Grasp the lower angle and crepitus may be found, but it must be remembered that overlapping on the one hand and wide separation on the other will prevent our finding crepitus.

The Inferior Angle.—Lay the forearm across the back, and the angle is thrown out so that the fingers can be easily pushed behind it. If the angle is broken off, the displacement is forward and upward by the action of the attached muscles.

The Superior Angle.—Place the hand of the injured side upon the opposite shoulder, with the forearm lying across the chest. This throws the superior angle into prominence, when it can be examined. The symptoms of fracture here are obscure, as there is little displacement and often great swelling. The treatment consists in keeping the arm immobilized.

The Spine.—In thin persons the spine of the scapula can be readily felt, particularly when the injured arm is placed behind the back. By direct violence the spine may be broken off throughout its entire length, including the acromion process, or a portion of it may be broken off, leaving the acromion process attached to the body. The

displacement is slight, and the evidence must rest upon the mobility of the fragment detached. The treatment is immobilization.

The Acromion Process.—Fracture of this portion of the bone is produced by direct violence, by indirect violence as when the humerus is pushed violently upward, and possibly by muscular action in violent contraction of the deltoid. Mobility, when it exists, is the most important symptom; there may also be crepitus, and there is always tenderness on pressure. An error in diagnosis is apt to be made in cases where the epiphysis at the external end of the spine has failed to unite. This condition, combined with a contusion, might readily be mistaken for fracture. Beginning posteriorly, run the fingers along the spine toward the acromion to search for any irregularity, fissure, or depression. The acromion may next be grasped to test its mobility and to elicit crepitus. Three separate lines of fracture are to be recognized—viz. in front of the clavicle, through the articulation with the clavicle, and posterior to the articulation. In the first of these the clavicular attachment is not interfered with, and hence the position of the arm in its relation to the body will not be changed. In the two latter forms the clavicle is involved, and the result is that the shoulder assumes the very position which it takes in fracture of the clavicle—viz. downward, forward, and inward. *Treatment.*—Immobilize the arm at the side of the body, the elbow a little forward, and the humerus pressed well upward against the acromion.

The Coracoid Process.—The coracoid process can be felt in the space between the anterior border of the deltoid and the pectoralis major. When fractured by muscular action, as sometimes happens, the displacement is downward by the action of the coraco-brachialis. When not detached, the finger resting upon the tip of the process can detect mobility, and perhaps crepitus. The *treatment* is immobilization of the arm against the chest, with the elbow drawn slightly backward.

The Neck.—The most prominent symptom in this variety of fracture is a falling down or flattening of the shoulder. The humerus sinks down, owing to the loss of support from the triceps. When the arm is pressed upward this deformity disappears, to return as soon as the arm is left unsupported. Follow the axillary border of the scapula upward, and in the axilla you will find a movable, hard lump. By an upward and backward movement crepitus can be detected. The indication for treatment is to prevent sinking of the humerus. This can be accomplished by the application of a Velpeau bandage or a strip of adhesive plaster passing into the flexed elbow and over the shoulder of the same side.

Fracture of the Humerus.—Fracture of the SHAFT of the humerus is very easily diagnosticated. The deformity is usually well marked. Pain is intense and helplessness complete. The fragments can be felt through the skin and crepitus is readily detected. The brachial artery is rarely injured, but the musculo-spiral nerve not infrequently suffers, either by direct injury at the time of the accident, or at a later period it may be compressed in the callus. In children the fracture is generally transverse, and this is often the case also when due to muscular exertion. In adults the common direction is obliquely from above downward and outward. When the fracture is above the

insertion of the deltoid, the upper fragment is drawn inward by the muscles of the chest; the lower fragment is drawn outward and upward by the action of the deltoid. When the bone is broken below the insertion of the deltoid, the relation of the fragments is not much disturbed, for the muscles antagonize each other.

Probably, of all bones this is the one in which non-union or a false joint is most likely to occur. The reason of this is not to be sought in any fault of the bone itself, but from the fact that, owing to the great leverage of the lower fragment, it requires the utmost care to keep the parts completely immobilized. Non-union is also due in many cases to the interposition of muscle or fascia between the fragments.

Treatment.—Bend the elbow to a right angle, and by extension in the axis of the bone, aided by direct manipulation, replace the fragments. Sometimes a considerable amount of traction is necessary to effect this, and in the case of compound fractures the ends of the fragments may have to be cut off. A good retentive apparatus is the shoulder-cap splint, long enough to reach the elbow and enveloping two-thirds of the circumference of the arm (Fig. 18). If narrower than this, a short internal splint should be used. The arm is to be carried in a sling and the elbow left unsupported. A weight may be attached to the elbow when the patient is able to go about, and this is especially indicated when he is a muscular man. Plaster of Paris is an excellent dressing. It need not be made so bulky as to render it objectionable from its weight, on account of which some writers have condemned it.

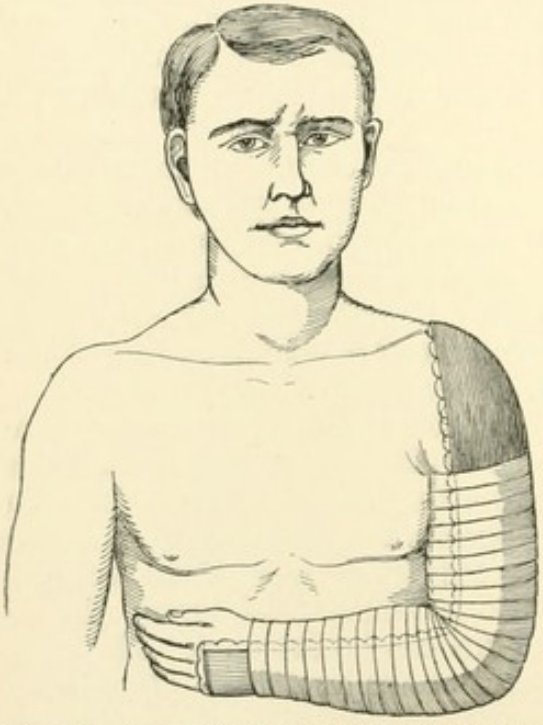


FIG. 18.—Apparatus for fracture of the humerus at any point above the condyles.

FRACTURES OF THE UPPER END OF THE HUMERUS are divided into those of the head, of the anatomical neck, of the tuberosities, sepation of the epiphysis, and fracture of the surgical neck.

1. Fracture of the **head** cannot be recognized during life.

2. Fracture of the **anatomical neck** is a rare accident. When an anterior dislocation of the shoulder takes place, it is possible for the anterior lip of the glenoid cavity to act as a wedge against which the head of the humerus is broken off. The same thing can occur when a strong force applied to the elbow drives the humerus upward against the scapula. It may also be the result of muscular action.

Diagnosis.—Grasp the tuberosities of the humerus, which can be felt through the fibers of the deltoid, and rotate the arm. If the tuberosities move with the shaft and crepitus is found, the fracture is at the anatomical neck. When dislocation also exists the head can be felt to move independently of the shaft.

Treatment.—The action of the deltoid and other muscles of the shoulder tends to draw the shaft upward, while the head at the same time slips downward. To obviate this, the proper treatment is to make traction from the elbow and immobilize the arm. In most cases the shoulder-cap with a folded towel in the axilla is a good appliance.

3. Fracture **through the tuberosities** is usually the result of direct violence, and the bone is often comminuted and the fracture complicated with extensive injury of other structures. When the greater tuberosity is broken, it is generally as a complication of anterior dislocation. It is recognized by the want of voluntary outward rotation, by crepitus, pain, and swelling.

4. **Separation of the epiphysis** does not occur in persons over twenty years of age. The symptoms are the same as those of the surgical neck, except that true crepitus is wanting, and the end of the bone, when it is possible to feel it, is more rounded than when fractured.

5. **Fracture of the Surgical Neck.**—While the preceding fractures of the humerus are rare, this one is quite common. It is produced by direct violence or by a fall upon the elbow or hand. Grasp the head of the humerus with the thumb and fingers of one hand and rotate the elbow with the other. If crepitus and increased mobility are recognized, the case is clear. The displacement may be such as to give the appearance of dislocation at the shoulder. The point is easily settled by means of Dugas's test. Place the hand of the affected side on the opposite shoulder and bring the elbow to the side of the chest. *If this can be done, there is no dislocation.* Another method is by *Callaway's test.* Pass a tape around the acromion and under the axilla; if there is dislocation, the affected side will measure about two inches more than the sound one.

Treatment.—Considerable difficulty may be found not only in reducing this fracture, but in keeping it in proper position. Firm traction must be made until the lower fragment can be got into line with the upper. A wedge-shaped pad formed of a towel in the axilla, with a cup-shaped shoulder-splint, will usually prove satisfactory. If, however, displacement recurs, a weight must be attached to the elbow. About five pounds is sufficient. A sling supporting the wrist is needed in all cases.

When fracture and dislocation both exist the usual practice is to attempt to reduce the dislocation, under an anesthetic, by direct manipulation. Failing in this, two other courses are open: either to set the fracture in the hope of reducing the dislocation at the end of four or five weeks, or allowing a false joint to take place. Both of these methods are unsatisfactory. A method which promises to give much better results is one employed by Dr. McBurney in a case reported in the *Annals of Surgery* for April, 1894. He thus describes it: "An incision should be made through the soft parts down to the bone, a hole drilled in the bone, a stout hook inserted, and direct traction made upon the upper fragment in the proper position" (Fig. 19).

Having reduced the dislocation, the fracture must be treated in the ordinary way.

When impaction is found to exist, no attempt should be made to

reduce it, for it will ensure bony union. In cases where no impaction takes place there is a risk that nothing better than fibrous union will be obtained.

Fractures at the Lower End of the Humerus.—When the elbow is bent at a right angle three bony prominences are arrayed in line at the back of the joint. These are the internal condyle, the olecranon process of the ulna, and the external condyle. Any disturbance of this relation will show that something is wrong.

The fractures to be met with at the lower end of the humerus are clinically divided into—(1) those that are external to the joint, and (2) those that involve the joint.

The fractures external to the joint are three in number—viz.: 1. Transverse fracture above the olecranon fossa; 2. Separation of the external epicondyle; 3. Separation of the epiphysis of the same.

The fractures which involve the joint are—

1. T-shaped fracture;
2. Separation of the internal condyle;
3. Separation of the external condyle;
4. Separation of the lower epiphysis.

Transverse fracture above the condyles is produced by falls upon

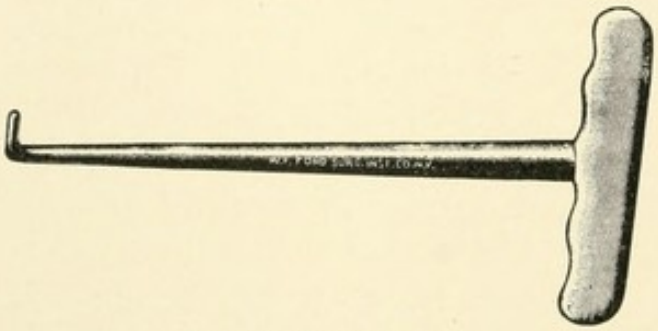


Fig. 19.—Fracture-hook.

the elbow, by direct violence, or by overextension of the elbow. The direction of the line of fracture is sometimes transverse; at other times it is oblique from above downward and forward. At first sight the deformity resembles that of dislocation of both bones backward. But if the relation of the bony points already referred to is found to be undisturbed, there cannot be dislocation. Besides this, the position of the deformity is farther up the arm, causing an apparent shortening of the humerus. The elbow-joint is flexed with the hand, generally in pronation. In front there is a prominence, which is the lower end of the upper fragment, while posteriorly there is a depression above the olecranon which is bridged over by the tendon of the triceps. Add to this the existence of shortening of the humerus, the presence of preternatural mobility, and, as a crucial test, crepitus, and no doubt can remain as to the existence of fracture.

Treatment.—When the line of fracture is oblique it is difficult to prevent shortening, as the action of the muscles tends to cause overlapping of the fragments. Both diagnosis and treatment are often interfered with by excessive swelling, which must be got rid of before the application of a permanent dressing. If the case can be seen and

the fracture set immediately after the injury, this swelling will be prevented. If seen later, the swelling can be reduced by cold applications, followed after a few hours by gentle compression. For this purpose absorbent cotton and a bandage are the best, great care being taken to watch the fingers, lest circulation in the arm be interfered with. The best splint is strong pasteboard, cut in a rectangular form, running from the axilla to the wrist. After soaking in hot water this can be moulded to the parts, and it closely adapts itself to the limb. The splint should be applied along the posterior aspect of the arm and the under surface of the forearm. A short anterior splint should be applied down the arm, with a thick padding opposite the bend of the elbow, with a view to prevent forward displacement of the upper fragment. The arm must be carried in a sling.

Passive motion should be employed about the end of the second week. Great care must be taken lest the newly-formed callus be broken up and a failure of union result.

Fracture of the internal epicondyle may be a complication of dislocation, or may occur by itself as a result of direct violence or by muscular action. The diagnosis is often obscured by swelling, but in many cases the bone may be grasped by the thumb and finger and crepitus elicited. When external to the capsule of the joint, as the separation of this process of bone usually is, the accident is not of serious moment. Besides crepitus, the other symptoms are pain on pronation and also on extreme flexion and extension, while a moderate degree of either of the two latter movements is free from inconvenience.

Treatment.—Carry the arm in a sling with the elbow at a right angle.

Fractures into the Joint.—1. The most important of this group is a transverse fracture of the lower end of the humerus, with a vertical fracture running from it into the joint. For convenience' sake we speak of this as a T-shaped fracture. The cause is always direct violence. The lower end of the humerus is split between its condyles by a wedge, and the wedge which splits it is the olecranon process of the ulna. From the tip of this process, running backward along the greater sigmoid cavity, is a ridge which, when driven with great force against the humerus, cleaves the bone from its articular surface upward and breaks it off transversely, producing the T-shaped fracture.

Diagnosis.—The symptoms are very similar to those of supracondyloid fracture, of which this may be regarded as an aggravated form. The lower end of the humerus being split, the condyles are spread apart, and consequently the end of the humerus appears to be wider than normal. The radius and ulna are displaced upward and backward, but the three bony points are still in line, so we have no dislocation. The humerus is shortened and there is increased mobility. Crepitus can be detected in two places—at the transverse fracture and also when one condyle is rubbed against the other.

This is one of the most difficult of fractures to deal with. So rapidly does swelling come on that it interferes with the diagnosis. Reduction may be by no means easy, while union without more or less stiffness in the joint is rare. The patient and his friends should be explicitly warned on all these points the moment the nature of the

injury is made out. Violent inflammation in the joint and around it may be looked for, and deformity with bony ankylosis is exceedingly common in spite of the most careful attention.

Treatment.—So unfavorable has been the prognosis in this fracture that surgeons have been in the habit of putting the arm in the position which would give the least embarrassment should bony ankylosis result. That position is at a right angle or a little more. The first part of the treatment will probably consist in dealing with a greatly swollen and inflamed joint, more particularly if the injury is not seen almost immediately after its occurrence. Reduction must, if possible, be effected at once. Extension and counter-extension will disengage the olecranon (the wedge which has split the humerus), and the condyles which have been spread apart can then be pressed back into position. The fragments must be brought into line with the shaft of the humerus, and moulded, as it were, by direct manipulation. For the first week this will need frequent attention, so that a faulty position can be rectified. At the end of the second week the callus will have become so firm that no further readjustment can be made. It has been the common practice to put this fracture up in exactly the same kind of splint as that recommended for fracture above the condyles.

Within the last few years the treatment of fractures in the neighborhood of the elbow-joint has received considerable attention. The method of setting the fracture with the arm in the extended position has been strongly recommended, and several cases have been recorded to demonstrate the superiority of this plan. Unfortunately, the matter has not been satisfactorily disposed of, for the success of the extended position is by no means uniform. Dr. James S. Wight in the *Annals of Surgery* for August, 1893, reports 10 cases treated in this manner, in all of which bony ankylosis followed; 5 of these joints had to be resected, and 4 others were treated by *brisement forcé*.

If the advocates of the straight position could show that uniformly good results were obtained by this method, it would be wrong not to adopt it, but that evidence is wanting. In the mean time, the safer course is to put the arm up in that position in which, should ankylosis take place, the limb will be most useful. Midway between flexion and extension, in the main, gives the best results. I have had 3 cases so treated in which the usefulness of the limb is perfectly restored and the deformity insignificant

Fracture of the Internal or External Condyle.—Owing to its prominence the internal condyle is broken more frequently than the external. When a person falls backward, as upon an icy sidewalk, it is the internal condyle that is likely to be the first to come in contact with the ground. The fracture is apt to run into the trochlear surface of the joint. The external is rarely fractured: it may be the result of direct violence or of a fall upon the hand.

The symptoms are very similar to those found in the T-shaped fracture, but not nearly so severe. In the case of the internal condyle the fragment is displaced upward and backward. This throws the external condyle into undue prominence. By grasping the condyle between the thumb and fingers crepitus can be discovered. When placed in position, contraction of the triceps tends to renew the displacement.

The same result follows pressure upon the ulna near the elbow. For this reason the arm, when carried in a sling, should be supported only at the wrist.

Treatment.—Carefully replace the fragment, and apply a rectangular moulded splint along the back of the arm and forward to the wrist. The forearm rests upon the splint with the palm downward, in order to relax the flexors and the pronator radii teres.

The complications of this fracture are dislocation of the radius backward and the formation of exuberant callus, which may impair the movement of the elbow after union has taken place. Fracture of the external condyle is treated by immobilization in a posterior rectangular splint or a plaster-of-Paris cast.

Separation of the Epiphysis.—At the lower end of the humerus are four centers of ossification—viz. one at the radial portion of the articular surface, which appears about the end of the second year and extends inward to form the chief part of the articular end of the bone; one to form the inner part of the articular surface, appearing about the twelfth year; one for the internal condyle, appearing about the fifth year; one for the external condyle, appearing about the thirteenth or fourteenth year. The outer condyle and both portions of the articulating surface unite with the shaft at the age of sixteen or seventeen years. The inner condyle becomes joined at about the age of eighteen.

In infants a common accident is to have the whole of the cartilaginous mass at the lower end of the humerus separated from the shaft. The same may occur in children, and the joint may or may not be involved. The most common cause is excessive adduction or abduction of the forearm with hyperextension.

The *treatment* is the same as for supracondyloid fracture.

Fracture of the Ulna.—The olecranon may be fractured by a blow or a fall upon the elbow, or it may be wrenched off by forcible contraction of the triceps muscle. If the periosteum remains intact, the displacement is slight, but otherwise the fragment may be drawn upward by the triceps to the extent of two inches or more.

Symptoms.—Diagnosis of this fracture is generally attended with little difficulty. The nature of the accident and intense pain over the point of the elbow are very suggestive. If there is no displacement, crepitus can generally be felt; if the fragment is drawn upward, its absence from the normal and presence in the new position leave us no longer in doubt.

Treatment.—When the periosteum is intact and the fragment remains in contact with the ulna, no other treatment is necessary than a sling, with immobilization of the arm or a plaster-of-Paris cast. In most cases, however, the displacement will be considerable, and this treatment will not suffice. The elbow must be placed in almost full extension, immobilized, and the fragment drawn down to its proper position. The simplest way of doing this is by means of a piece of adhesive plaster cut in the form of the letter **U**. The curve is placed on the back of the arm just above the fracture, and the sides are drawn down and applied to the sides of the forearm. Cutting down upon the fragment and wiring it to the olecranon has been practised, but the cases in which this should be resorted to are rare.

Fracture of the coronoid process is rare. It occurs, as a rule, when there is backward dislocation of both bones. A fall upon the hand when the elbow is extended will also produce it, and of course it can be produced by direct violence. Muscular action does not cause it, for the only muscle that is attached to it is the brachialis anticus, and this is also attached to a considerable portion of the shaft of the ulna. For this reason there is little displacement when the process is broken off.

Symptoms.—Extend the elbow-joint and the bones of the forearm become displaced backward. Traction upon the arm brings the bones to their proper place, but the moment this force is relaxed the bones return to their abnormal position. Swelling exists to a considerable degree. There is intense pain on pressure and also on flexion.

Treatment.—Flex the joint to a little less than a right angle and immobilize with plaster of Paris or splints. Passive motion should be gently begun at the end of a week. Union is generally ligamentous.

Fracture of the Shaft of the Ulna.—The ulna is weaker below the middle than in its upper portion, and, as a consequence, fracture is most common in the middle or lower third. From its exposed and subcutaneous position the bone is most frequently broken by direct violence and the fracture is often compound. When the radius remains unbroken the displacement in fracture of the ulna is not very marked. The arm is comparatively helpless and movement is painful.

Treatment.—A plaster-of-Paris cast or a moulded pasteboard or gutta-percha splint, grasping the whole of the forearm and the ulnar side of the hand, is sufficient in ordinary cases. When the displacement is angular and the fragments approach the radius, the treatment must be the same as when both bones of the forearm are broken. A practical point worth bearing in mind is that when the forearm is carried in a sling the pressure falls upon the ulna and tends to displace the fragments toward the radius. When firm splints or a plaster cast are employed the ulna is guarded against this danger.

Fracture of the Radius and Ulna Together.—This fracture is readily recognized. It occurs mostly in the lower and middle thirds of each bone. The radius is, as a rule, broken higher up than the ulna. The common cause is a fall upon the hand. Muscular action is very rarely a cause.

In children a partial or green-stick fracture occurs more frequently here than in any other bone.

The *symptoms* are pain, swelling, helplessness, mobility, and crepitus.

Treatment.—In green-stick fracture the child should be placed under an anesthetic if necessary, and the bone straightened. When the fracture is complete, traction is employed and the fragments adjusted by direct manipulation. When the fracture is in the upper third of the radius and above the insertion of the pronator radii teres, the biceps supinates the upper fragment. This must be corrected by putting up the forearm in the supine position; otherwise the power of supination in the limb will be lost. Another mishap to be avoided is the tendency of the bones to approach each other. When the reduction has been effected deep pressure should be made by the fingers before and behind to ensure separation of the bones. The best retentive apparatus is an

anterior and posterior splint a little wider than the diameter of the arm, and carefully padded down the center to keep the bones apart. The splints are made wide, so that when the bandage is applied it exerts no lateral pressure. The forearm must be carried midway between pronation and supination. A notable and expensive lawsuit occurred a few years ago for the alleged reason that the doctors neglected the maxim "thumbs up."

For the first week the limb should be frequently examined, and the bones separated should they show a tendency to approximate. At the end of the second week a light plaster-of-Paris cast can be applied. Passive motion (pronation and supination) should be commenced about the end of the third week. In this fracture, as well as in all other conditions requiring immobilization of the forearm, care must be taken to apply the bandage while the elbow is flexed. If applied in the extended position and the limb be afterward flexed, the bandage is thereby tightened and there is a danger of gangrene. Another risk run in this accident is that the radial and ulnar arteries are readily compressed by the displacement of fragments of bone.

Fracture of the Radius Alone.—The head of the radius is fractured mainly as a complication of dislocation of the elbow. Fracture of the neck has been observed in a few cases. The injury is detected by the examiner placing his fingers on the head of the radius and rotating the forearm, when it will be found that the head does not move with the rest of the bone. Additional evidence of the fracture is gained when pronation and supination are lost and when pain is felt at the seat of the injury by movement of the hand in either direction.

Treatment.—A rectangular splint with a firm pad over the front of the forearm; passive motion about the third week.

Fracture of the Shaft of the Radius Alone.—The pronator radii teres is inserted into the rough ridge in the middle of the outer surface of the bone, and plays an important part in fracture of the shaft. When fracture takes place above the insertion of this muscle the upper fragment is displaced by the supinator brevis and the biceps, and the lower fragment by the pronators; consequently, the relative position of the radius and ulna is not the same above and below the seat of injury. When the bone is broken below the line of the insertion of the muscle, the upper fragment is but slightly, if at all, displaced, the pronator radii teres holding it in position; the lower fragment, however, is tilted inward toward the ulna through the action of the supinator longus and the pronator quadratus.

Symptoms.—There is but slight displacement so long as the ulna remains intact. Other convincing signs, however, are not wanting. There is pain over the seat of the injury. Grasp the forearm just above the wrist and rotate, and you will find that the upper part of the radius does not move with the rest of the bone. Crepitus can be felt and pronation and supination are lost.

Treatment.—When the fracture is above the insertion of the pronator radii teres, the arm should be put up in a position of complete supination. The upper fragment is in this position already, and we cannot change it; so we put the lower fragment in the same form, thus bringing them into line. This is all very well in theory, but the posi-

tion is a trying one, and patients can seldom be induced to submit to it. Lying in bed with the arm fully extended and the palm upward will serve the purpose. Or a rectangular splint may be applied to the posterior aspect of the arm and forearm, the limb being carried in a sling with the elbow drawn back, so that the middle of the forearm is at the lateral middle line of the body.

When the fracture is below the insertion of the pronator radii teres the indication for treatment is to prevent the upper end of the lower fragment from being drawn inward. This might result in union with the ulna, and as a consequence the loss of power to pronate or supinate. Straight, flat splints wider than the diameter of the arm are to be applied back and front, with carefully formed interosseous pads, and the arm carried in a sling "thumb up." The hand should be unsupported.

Fracture of the Lower End of the Radius, or Colles's Fracture.—With the single exception of the clavicle, this is the most common of all fractures. A person thrown from a carriage or running

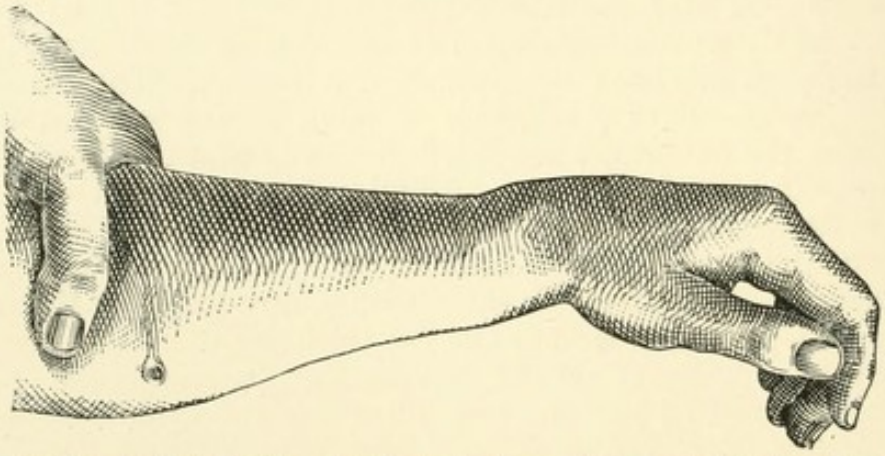


FIG. 20.—"Silver-fork" deformity of Colles's fracture, photographed half an hour after the accident (Keen and White).

and falling forward instinctively puts out his hands to save himself. The weight of the body thus comes upon the wrists. A tremendous strain is thrown upon the joint; something has to give way, and it must be either ligament or bone. Clinical evidence has shown that when it comes to a contest between ligament and bone, the bone must yield. In this case the radius is the bone to suffer, and it breaks about one inch from its lower extremity. The accident occurs at all ages, but is more common in advanced life.

The direction of the fracture is usually transverse, and it is generally impacted. It may be oblique, and the obliquity may be in either direction. The displacement most generally met with is that of the lower fragment driven backward.

Examination.—The accident happened by a fall forward or from a height upon the hand, which received the weight of the body. When the force came upon the bone the forearm was nearer a vertical than a horizontal position. The patient carefully nurses the wrist on the palm of the other hand. Pain is felt at the lower end of the radius. The wrist and hand are helpless. A marked and peculiar deformity is

apparent, which resembles a "silver fork" (Fig. 20), and is so called. Look at the dorsum of the forearm and wrist. The back of the hand appears strangely long. Just above the carpus is a prominence. This is the lower fragment driven backward. Immediately above it is a depression, because the lower fragment is not in line with the upper. Next examine the palmar surface. Just above the carpus is a depression where the lower end of the radius would be if it had not been driven backward. Immediately above this is a prominence which is the lower end of the upper fragment. Stand at the patient's elbow and look toward the hand, and the appearance is very remarkable. The hand is drawn toward the radial side, for impaction and displacement have shortened the radius. The ulna looks as if it were about to come through the skin. The fingers are flexed. Pronation and supination are impossible. To find the line of separation make firm pressure along the outer border of the radius. It will be found from one-third to three-fourths of an inch above the articular edge.

Errors.—Do not mistake this for a severe sprain. A sprain cannot show the same deformity. The patient may think he has a dislocation of the wrist. A dislocation of the wrist is a very rare accident, and cannot be confounded with this fracture except by the careless or uninformed.

Treatment.—Reduction is difficult, owing to the impaction, which must, in all cases, be relieved. Grasp the patient's hand with yours as in the act of handshaking, make strong traction, and bend the wrist at the same time toward the ulnar side. If this fail, place the wrist in forced extension, and, while the hand is drawn upon, push the fragment into place by direct manipulation. It is of the utmost importance to the after-appearance of the limb that the posterior displacement should be fully corrected.

When once the fracture is reduced there is no danger of its being again displaced, and on this account the matter of splints is of minor importance. When preferred, the posterior splint may end at the wrist: the anterior one may end at the same level, or may be carried to the palm with a pad at its lower end, over which the fingers may rest or grasp. A plaster-of-Paris dressing is often employed, but excellent results are obtained by using no splints at all. A band of adhesive plaster about the wrist gives support and allows motion of the fingers from first to last, which is a very important point.

When the anterior or posterior lip of the radius is broken off it is known as Barton's fracture.

Fracture of the Metacarpal Bones.—These bones are broken by direct violence, as in fistic encounters. The displacement is slight, and crepitus may be wanting. The diagnosis is made by pain on pressure and by pressing the corresponding finger upward.

Treatment.—A palmar splint, well padded, to correspond with the natural concavity of the metatarsal bones.

Fractures of the phalanges are usually compound and the result of direct violence. The diagnosis is easy, as the usual signs of fracture are present. The treatment consists of the application of small palmar splints well padded.

Fracture of the Pelvis.—Serious injuries are often met with

about the pelvis. They may be caused by a loaded wagon running over that part, or by the fall of heavy bodies, such as timber, rock, or earth, or by the pelvis being crushed while in the act of coupling railway cars, or by the kick of a horse. It is puzzling, even to the most experienced, to discover exactly the extent to which the parts have suffered. In all cases of this kind there are contusion and pain. Fright often plays a prominent part, for the terrible sensation of feeling that he is about to be crushed to death is sufficient to put an ordinary person into a condition approaching collapse. The pelvis is strong, and so constructed that it can resist a great force or bear an enormous weight, but it has its weak points. The injuries for which we must be on the lookout in accidents occurring in the manner described are—

Fractures of the pelvic bones;
Separation of the symphysis pubis;
Rupture of the urethra;
Rupture of the bladder;
Injuries of the abdominal viscera.

The Pubic Bone.—A crushing force may fracture this bone. The line of fracture runs through the upper ramus, just inside the ilio-pectineal eminence, and through the lower ramus near its junction with the ischium. Besides giving way in front, the pelvis may give way posteriorly, either in the ilium behind the acetabulum or in the sacrum, or partly in either bone and partly in the sacro-iliac synchondrosis. Instead of fracturing the bone, the force may cause separation of either the pubic or sacro-iliac symphysis, or both. From a clinical standpoint this is equivalent to a fracture.

Symptoms.—The displacement is sometimes very marked, not only to the touch, but to the eye. In the absence of this evidence we rely upon pain under direct pressure or when movement is made by grasping the wing of the ilium. If blood escapes from the meatus, we know the urethra has been injured. A catheter may be passed, and if no urine escapes, then the bladder is ruptured. This, however, may be the case where there is no pelvic fracture: the same accident may happen from a kick on the abdomen, especially when urine has not been voided for some time before the injury is inflicted. The patient is unable to raise the leg from the bed.

Treatment.—Immobilize the pelvis by a firm, broad girdle or plaster-of-Paris cast. When double vertical fracture exists, employ Buck's extension upon the limb as in fracture of the femur. If the fracture is compound, see that drainage is perfect and asepsis maintained. Rupture of the urethra will probably require perineal section.

The Sacrum.—Fracture of this bone is rare. The direction is usually transverse, and it is always the result of direct violence. Common complications of the injury are paralysis of the rectum, the bladder, and the lower limbs. The displacement is angular, and correction is made by pressing the coccyx forward. The coccyx, when fractured, presents the same symptoms as dislocation of the bone, and requires the same treatment This injury is almost invariably fatal, as the sacral plexus of nerves is involved.

The Coccyx.—Fracture of this bone is more often met with than the last named, the result of falls, kicks, or gunshot wounds. Neur-

algia of the coccygeal nerves is often present, due to pressure upon them. The pain is continuous, and is called coccydinia.

Treatment.—The same as that for fracture of the pelvis. The addition of a V-shaped strip of adhesive plaster to hold the bone steady may often be found beneficial in relieving the pain.

The Ischium.—A fall upon the buttock may fracture the tuberosities or the entire bone.

The Ilium.—A crushing force may break off the crest of the ilium. Muscular action or direct violence may fracture the anterior superior spinous process. The posterior inferior and the posterior superior spinous processes may be broken by direct violence. The fracture is recognized by the presence of a movable fragment with crepitus.

Treatment.—In all these injuries the pelvis must be immobilized and the patient kept quiet in bed. Complications must be treated on general principles.

Fractures of the Femur.—The Neck of the Femur.—When

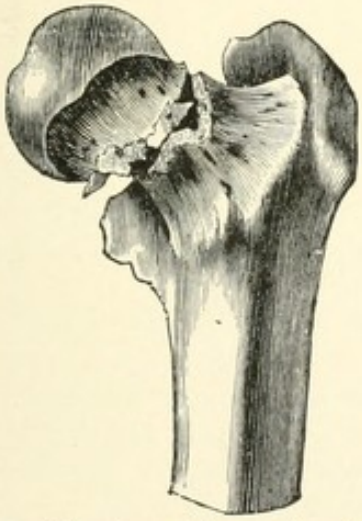


FIG. 21.—Fracture of the small part of the neck of the femur (Stimson).

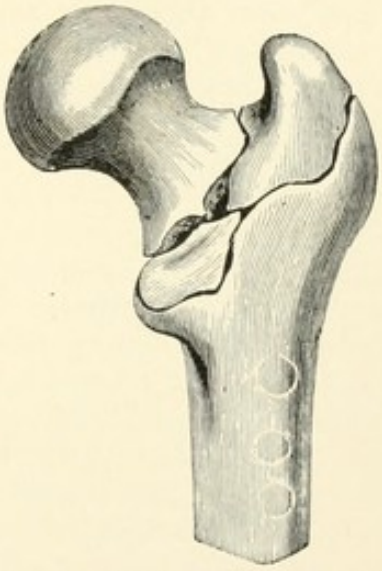


FIG. 22.—Fracture at the base of the neck of the femur, with splitting of the great trochanter (Stimson).

called to an old person who has fallen, be it in ever so simple a way, and who suffers pain at the hip, be on the lookout for fracture of the neck of the femur. A misstep or tripping over a slight obstacle such as a mat, or even an attempt to prevent a fall, is sufficient to cause this fracture in elderly people. The young and middle-aged, however, are not exempt, but in them a greater force is necessary to break the bone. It is more common in women, as is Colles's fracture.

The old classification of this calamity was into extra- and intracapsular fracture. This does not cover the ground, for many of the cases partake of the characters of both divisions. It is better to speak of fracture at the small part of the neck (Fig. 21), and fracture at the base of the neck (Fig. 22). The practical difference between these two is this: In fracture at the narrow part of the neck impaction rarely takes place, and bony union is possible, but not probable. In fracture at the base of the neck impaction is the rule (often with rotation out-

ward), and bony union is the rule. The symptoms of both are the same.

Examination.—The patient lies in bed or on the spot where he fell, complaining of great pain at the hip, particularly when any attempt is made to move him. In some cases, however, the pain is slight, and the limb can be raised from the bed. This is where there is impaction. It is possible also for the patient to walk.

The rule, however, is that the limb is helpless, and as it rests straight upon the bed and you compare it with the other limb, the foot is seen to be everted. If the foot is not everted, you will find the patient cannot evert it as well as he can the uninjured member. Impaction must be taken into account, for if this occur with the limb in the position of inversion, the foot will remain in that position. The thigh at its upper part has an unusual fulness and roundness. Pushing the limb upward from the ankle or knee produces pain, as also does pressure upon the neck or the trochanter. Pressure over the neck of the bone in front shows that the tissues cannot be so easily depressed as they can upon the other side. Measure the limb from the anterior superior spinous process to the outer malleolus, and the injured limb will show a shortening of one-fourth of an inch to two inches. To prove that the shortening is at the neck, apply Nélaton's measurement as follows: From the anterior superior spinous process to the tuberosity of the ischium. The trochanter on the injured side occupies a higher position in reference to this line than does its fellow of the opposite side. Bryant's line can next be used—viz. around the pelvis from one anterior spine to the other. The distance from the tip of the trochanter to this line will be found shorter on the injured side.

These cases are fruitful sources of malpractice suits, for it has often happened that the evidence of fracture was obscure; the patient was disabled, but the injury was supposed to be only severe bruising. Do not run any risk, but treat it as a fracture if you are in any doubt.

Signs of Impaction.—The foot is everted, the leg is shorter than normal, pain is localized, and there is marked flattening of the trochanter on the impacted side. When these conditions are present, crepitus should never be sought for.

Treatment.—Union in old and enfeebled persons is doubtful. Should they show the bad effects of confinement to bed, we must make the treatment of the fracture a secondary matter and attend to their general health. Traction should be employed gently, and impaction, if existing, should not be disturbed. Make the patient as comfortable as possible, and guard against bed-sores. Sand-bags or cushions may be used to steady the limb, or a plaster-of-Paris cast to include the whole limb and the pelvis. Buck's extension, with a five-pound weight, will allow the patient to sit up in bed, and will keep up just enough traction to make him comfortable.

Fracture of the great trochanter may occur as a result of direct violence. The line of fracture falls outside the joint, and the patients are able to walk, notwithstanding the injury.

The *diagnosis* is made by the existence of localized pain and by the presence of a fragment which moves independently of the shaft of the bone.

The *treatment* is immobilization and rest. If the fragment be drawn upward by muscular action, a bandage accurately applied will overcome this tendency.

Fracture of the Shaft of the Femur.—This is a fracture which answers all the characteristics of fractures in general. It may be produced by any of the ordinary causes of fracture—direct violence, indirect violence, or muscular action. The direction of the line of fracture is usually oblique, but in children it may be transverse (Figs. 23, 24).

Symptoms.—As the patient lies in bed the limb shows more or less deformity. The muscles are bunched up and the thigh is shortened. The fragments usually overlap, and this displacement is increased by

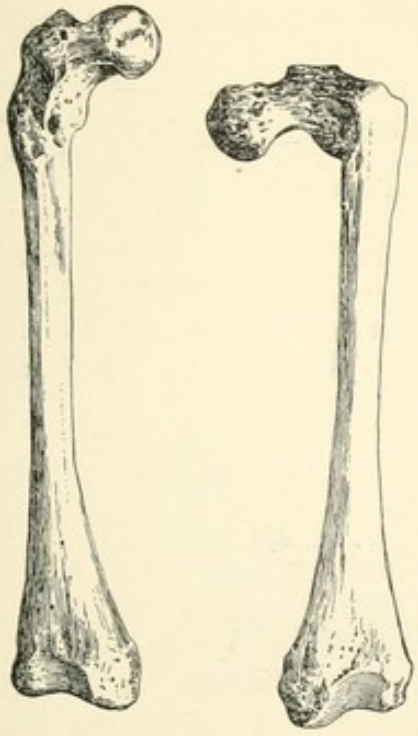


FIG. 23.—Transverse fracture of the shaft of the femur immediately beneath the trochanter.

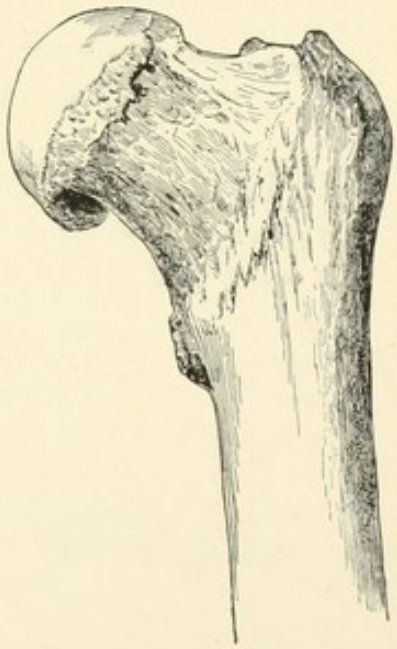


FIG. 24.—Fracture of neck at junction with head.

the contraction of the muscles. The foot falls outward in eversion, simply from its weight. When an attempt is made to lift the limb intense pain is felt and abnormal mobility is apparent. Crepitus is readily detected, but the other symptoms are so clearly evidences of fracture that this symptom is unnecessary. Measurement from the anterior superior spinous process to the outer ankle shows shortening. Bryant's and Nélaton's measurements prove that this shortening is not at the neck of the femur. When the hand is passed over the seat of fracture and the limb is gently raised, the abnormal mobility is apparent. Grasp the thigh gently, rotate the limb below, and you will find that the upper portion does not share in the movement of the lower.

Treatment.—Make steady traction until the shortening is overcome. Should a fragment of the bone pierce the muscle and skin, flex the thigh upon the pelvis and the leg upon the thigh. This will relax the muscle and the fragment will return to its place. Traction contin-

uously maintained in one form or other is the best treatment, and the most satisfactory mode of traction is Buck's extension. The extending force is a weight suspended by a cord which passes over a pulley. It is applied in the following manner: Take a strip of strong adhesive

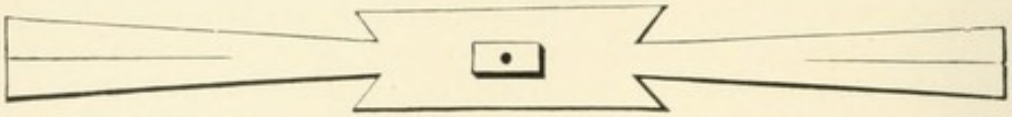


FIG. 25.—Adhesive plaster cut for Buck's extension (Stimson).

plaster four inches in width and long enough to reach from above the knee down the limb, around the sole of the foot (where it is left loose), up the other side, opposite to the place of beginning (Fig. 25). A piece of wood five inches by three inches, with a perforation in its center, is

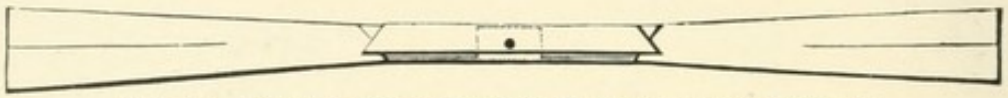


FIG. 26.—Adhesive plaster folded for Buck's extension (Stimson).

placed opposite the sole of the foot, and the adhesive plaster attached to it by folding its edges over the wood (Fig. 26). Through the opening in the wood a stout cord is passed, and a knot tied upon it to prevent its being pulled back by the weight. The foot and lower third of

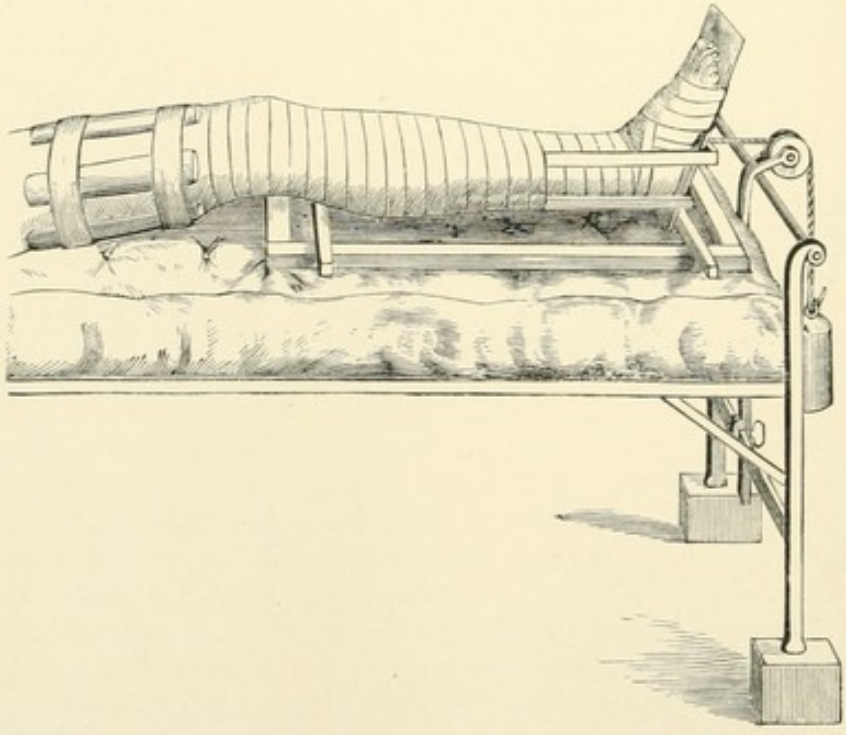


FIG. 27.—Buck's apparatus with Volkmann's sliding rest for fractures of the thigh.

the leg are next bandaged by a roller bandage; over this the adhesive strips are applied and attached to the sides of the limb as far as they reach up the thigh. The bandage is continued upward over the plasters, thus supporting them against the limb. The cord is next carried over a pulley attached to the foot of the bed, and a weight varying accord-

ing to circumstances is attached to its free end. The weight should run about a pound for each year of age from five to twenty. To provide for counter-extension the foot of the bed is raised. To prevent outward rotation the most convenient appliance is Volkmann's sliding rest (Fig. 27). It is formed of two side-pieces eight inches apart and two feet in length. They are united by two cross-pieces, and on these rest a posterior splint and foot-piece. To this splint the leg is attached. Various other methods of treating this fracture are in vogue, such as Cripp's splint, Nathan R. Smith's anterior splint, which is an improvement on the old double inclined plane, and Hodgen's splint, which combines the principle of the double inclined plane and Buck's extension. The two latter methods are of great advantage when the fracture is just below the insertion of the psoas and iliacus, and counteract the bad effect of tilting forward of the upper fragment, which is common in fractures at this part of the femur.

Fractures of the Lower End of the Femur.—Fractures at the lower end of the femur bear a close analogy to those at the lower end of the humerus. The bone may be broken above the condyles (supracondylar). This fracture may be complicated by another at right angles to it and running into the joint, a T-shaped fracture; one or other of the condyles may be detached, and lastly the epiphysis may be separated. The lower end of the femur may be split by the wedge-like action of the patella.

Supracondylar and T-shaped Fracture.—The direction of a fracture just above the condyles is generally oblique, and the especial danger is that one of the fragments may injure the popliteal vessels. The obliquity is generally from above downward and forward. The lower fragment is rotated by the gastrocnemius, and its fractured surface is directed backward. If while the fragment is in this position any traction be made upon the leg, the vessels are almost sure to be injured. When the displacement is in the opposite direction—that is, with the lower fragment projecting forward—the vessels are exposed to danger from the pressure of the lower end of the upper fragment.

Diagnosis.—The pain and deformity, if any, are lower down toward the knee than in other fractures of the shaft. Shortening is usually apparent. Even with impaction the symptoms are easily recognized. When the fragments are free, abnormal mobility and crepitus add additional testimony. Grasp a condyle in each hand, and if the fracture is T-shaped the condyles can be moved backward and forward upon each other. Besides this, they are spread apart, giving the appearance of a greater width to the lower end of the femur. When the joint is involved another important sign is observed: the synovial cavity becomes distended with blood. If you find the popliteal space rapidly filling up and an immense swelling forming, and, in addition to this, the leg becoming cold and pulseless, you may know that the popliteal artery is torn and bleeding profusely into the tissues. When the artery is simply pressed upon, the limb also becomes cold, but this takes place gradually, and the swelling in the popliteal space is wanting.

Treatment.—This must vary according to the conditions present. Be careful in making extension lest the vessels become pressed upon

or torn. Gentle traction with direct manipulation is generally safe. When the upper fragment projects backward, Buck's extension is a suitable dressing. When the lower fragment has a tendency to backward displacement, the gastrocnemius is the disturbing element which must be disposed of. This can be done either by dividing the tendo Achillis or by treating the fracture on a double inclined plane. In general, a plaster-of-Paris cast, with anterior and posterior coaptation splints under the plaster, will fulfil all the requirements. When the knee-joint is involved, the effusion and swelling must be got rid of by pressure, cold applications, and, if necessary, by aspiration. Passive motion of the joint should be begun not later than the end of the fourth week.

Laceration of the popliteal vessels is a very serious complication. When it occurs a tourniquet should be applied to the femoral artery, the vessel cut down upon and tied above and below. The vein should receive careful attention, as it may be injured as well. In this event amputation is the only treatment.

Fracture of the Patella.—A fall upon the knee, or a fall or blow combined with a strong effort on the part of the patient to save himself, is likely to cause fracture of the patella. The direction of the fracture is generally transverse. The line may be across the middle or near the upper or lower end. Sometimes it is stellate or star-shaped, and in rare cases it is split from top to bottom. An oblique fracture is very rare. When caused by direct violence the fracture is often either compound from the first, or it may become so at a later period by sloughing of the soft parts covering the bone. When the fracture is transverse the upper fragment is drawn upward by the action of the quadriceps, and a gap exists at the seat of fracture.

It fortunately sometimes happens that the periosteum remains intact, and thus little or no separation takes place.

Symptoms.—After such an accident (a fall upon the knee, a blow, or struggle to avoid falling) pain is felt over the patella, and the patient cannot extend the leg. The fragments are independently movable, and a distinct transverse gap exists between them, which can be closed up by moving the fragments toward each other.

Treatment.—If the periosteum has not given way and there is little or no separation, a plaster-of-Paris cast from the ankle to the upper third of the thigh is a good dressing. With wide separation something more than this is necessary. A long list of appliances might be named to meet the requirements of these cases. A posterior splint is applied, and by oblique turns of a roller bandage the fragments are maintained in their proper position. The patient must keep his bed with the foot raised, thus counteracting the action of the quadriceps extensor tendon.

A very useful and easily constructed appliance is Agnew's splint (Fig. 28). A piece of board thirty inches long, five inches wide at one end and four at the other, is slightly hollowed out to fit the thigh and calf, leaving the middle plain to correspond with the flat surface behind the knee. Four pegs are fitted into the sides in such positions as to give attachment to the bandage which draws the fragments together. The method of its application is seen in Fig. 29.

Should the above methods fail or should it be found impossible from the first to keep the fragments in apposition, operative measures should be resorted to. Several operative procedures have from time to time been employed—for instance:

1. Open arthrotomy, with suturing of the fragments with silver wire. This has been very successful in a large number of cases. It has led to suppuration and fatal results have been reported. Under strict antisepsis and in healthy subjects the risk to be run need not be considered great. The operation consists in making a free incision across the patella to expose the fragments. If the fracture is an old one, the broken surfaces must next be freshened. Any fibrous tissue which has recently formed, or any fascia or other tissue which has come between the fragments, should be carefully removed. Holes are drilled into the bone by directing the drill through the anterior surface of each fragment obliquely from the attached border toward the posterior edge of the fractured surfaces. Three sutures of silver wire are sufficient, and when perfect approximation has been effected the ends of the wire are cut off, and either hammered into the bone or left protruding from the wound to be withdrawn later.

2. Subcutaneous suture has proved satisfactory and is easily performed. The method is as follows: After thorough disinfection of the limb a long, half-curved Hagedorn needle, carrying a strong silk suture, is inserted at one side of the ligamentum patellæ, and carried through the ligament to the corresponding point on the other side; the needle is then reinserted at the latter point, and carried up along the edge of the fragments to a point above the patella, then through the tendon of the quadriceps to the corresponding point on the other side, and back to the place of beginning. The fragments are now accurately approximated by means of tenacula, the suture drawn tight, tied, the ends cut off, and the knot pushed beneath the skin. The knee is dressed antiseptically, and placed upon a posterior splint for one week, after which a plaster-of-Paris cast is worn for a month constantly, and for another month during the daytime.

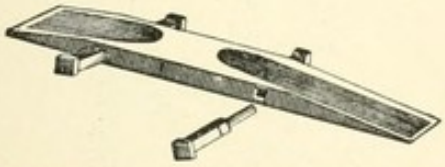


FIG. 28.—Agnew's splint for fractured patella.

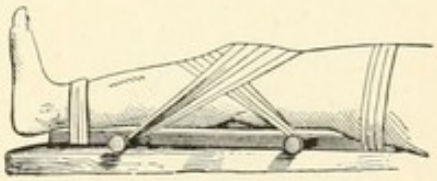


FIG. 29.—Agnew's splint applied.

Barker's operation is probably an improvement on the ordinary subcutaneous suture. The method of operating is as follows: With the finger and thumb of the left hand steady the lower fragment, and at its lowest point in the middle line of the ligamentum patellæ make a small incision by means of a narrow-bladed knife through the skin and into the joint. Through this opening a stout-handled pedicle-needle is passed into the joint behind both fragments. The upper fragment is now pushed down as closely to the lower as possible, and the needle thrust through the quadriceps tendon at the upper edge of the fragment. The point of the needle, becoming apparent beneath the skin, is

cut down upon and pushed to the surface. A stout silk thread is passed into the eye of the needle, which is withdrawn, carrying the thread behind the fragments (Fig. 30). The end of the thread is withdrawn from the needle's eye and left emerging from the lower opening. Again the needle is passed through the lower opening, but this time it is made to pass in front of both fragments and out at the upper opening. It is threaded with the upper end of the silk and withdrawn, leaving the thread in front of the fragments (Fig. 31). The fragments are approximated and rubbed against each other to displace clots; the ligature is securely tied, cut off short, and the wounds closed. The bone unites, in the great majority of cases, by fibrous tissue, and on this account the after-treatment is more important in this fracture than perhaps in any other. Although the separation of the fragments may, at the outset, be to the extent of only half an inch, it is not uncommon to have this distance increase until, at the end of several months, it may

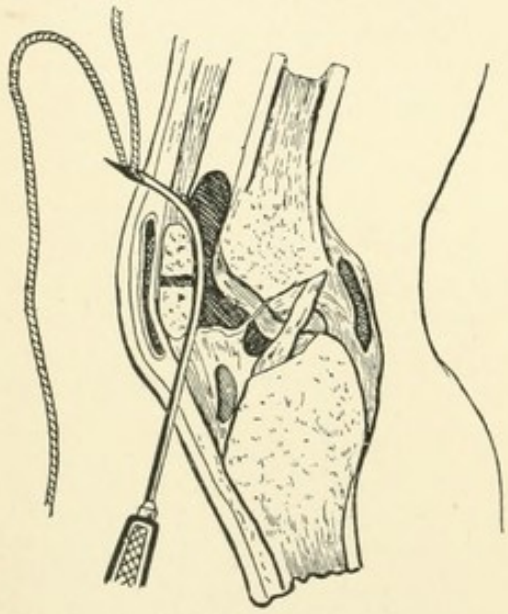


FIG. 30.—Barker's operation for transverse fracture of the patella (first stage).

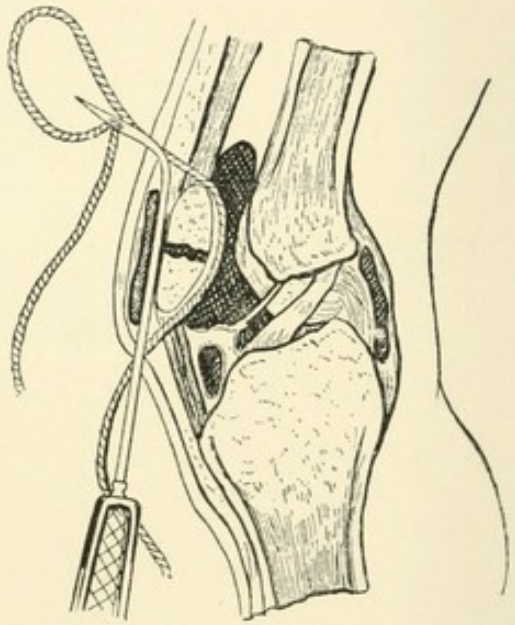


FIG. 31.—Barker's operation for transverse fracture of the patella (second stage).

reach five or even six inches. This may be explained in two ways—either that no union has taken place at all, or the newly-formed fibrous tissue has been stretched by allowing the use of the knee at too early a period. In all cases of transverse fracture perfect immobilization of the knee should be maintained for eight weeks, after which an apparatus should be worn to prevent flexion for six months. The stiffness in the knee resulting from such long-continued disuse passes off gradually, and the fibrous tissue becomes so firm that it will not stretch.

Fractures of the Leg.—The weakest part of the tibia is at the junction of the middle and lower thirds, and here it is most frequently broken. When both bones are fractured the fibula gives way higher up. Comminuted fracture is common even when the cause is indirect violence. The tibia, for a considerable portion of its length, is covered by little more than skin, and on this account it is specially liable to

compound fracture. When both bones are broken by direct violence, it is generally on the same level and the direction is transverse. When the violence is indirect the fracture is oblique and the fragments are pointed. Beware of letting a patient attempt to walk when there is suspicion of such a fracture, for there may be no apparent deformity until his weight comes upon the limb. Then the oblique fragments slip past each other, and, perforating the skin, a compound fracture is the result.

Symptoms.—Deformity is generally so clearly marked as to be apparent at the first glance. Pain is a prominent symptom, and is greatly intensified on the slightest pressure. If the patient has to be moved from the scene of the accident, be careful to secure the limb, lest the skin give way. A pillow placed lengthwise under the leg and tied around with several handkerchiefs makes a very soft and easy applicance, while firmness can be given by placing strips of lath, shingle, or similar pieces of wood at each side and behind.

Treatment.—A fracture-box slung from a cradle is a very comfortable apparatus for this fracture, but the most convenient of all is a plaster-of-Paris cast. The form known as the Bavarian splint makes an excellent dressing. It is thus employed: Take two pieces of flannel (coarse house flannel is the best) long enough to reach from the popliteal space to the balls of the toes, and three inches wider than the circumference of the limb; sew them together down the middle line for the length of the leg; for the remainder of their length they are cut in two, to be applied to the foot. Place the leg upon the flannel, so that the seam runs down the back and ends at the heel; fold the inner layers over and fasten them together down the front. Keeping the foot exactly at a right angle, fold the end-pieces over it. Now place the leg upon one side and you are ready for the plaster. The plaster should be mixed to the consistence of cream. Spread over the inner layer from the seam behind to the place where it is folded in front, and press the outer one down upon this before it has time to set. As soon as this has become firm turn the leg over and repeat the proceeding upon the other side. When the plaster has properly set undo the fastening in front; you now have two side-splints admirably moulded to the leg and united by a hinge formed by the seam at the back. All that remains now is to trim off the edges and fasten the inner layer down to the outer on the surface of the splint.

Fracture of the Tibia Alone.—The only difficulty in diagnosis of fracture of the tibia alone is when the bone is broken transversely, and where the swelling prevents our feeling the crest. Under other circumstances fracture of the tibia is readily diagnosed. The inner malleolus may be broken, the tubercle torn off by the action of the quadriceps, and the spine or the head of the bone broken off or split by the action of the crucial ligaments in violent twists of the knee. False joint is liable to occur in fracture of this bone if the patient has been attempting to walk or if complete immobilization of the fracture has not been maintained. Fracture of the upper end of the tibia is often transverse, and when so is the result of direct violence. The soft parts are contused. The fracture may take the form of a T inverted, the vertical part extending into the joint, causing synovitis. The frag-

ments may be separated by a blood-clot which may extend into the synovial sac.

Treatment for Fracture of this Form.—Apply cold compresses to remove effusion and swelling. The leg should be put up in the double inclined plane, care being taken not to have the incline too acute, as the upper fragment may protrude through the skin, thus creating a compound fracture. When the joint is not implicated a plaster-of-Paris bandage will suffice. If there are good reasons for keeping the leg uncovered, then one splint (Cline's) on the inner side of the leg will do, as the fibula when intact will serve as a splint on the external side.

Fracture of the Fibula Alone.—This is sometimes called the "railroad fracture" or "street-car" fracture, because it is so commonly caused by jumping from a vehicle in motion. When a person jumps from a rapidly-moving street-car, and comes forcibly upon his feet with the toes pointing at right angles to the line in which he was moving, a severe strain is thrown upon the fibula. Either the lateral ligaments of the ankle or the bone must yield, and, as usual when a contest between ligament and bone occurs, the bone is found to be the weaker structure and is forced to give way. The bone may also be broken at any part by direct violence and by violent contraction of the biceps muscle.

Diagnosis.—When the fracture is at the upper end it is due to muscular action, except when caused by direct violence. The displacement, if any, is a drawing upward and backward of the upper fragment by the biceps. Fracture in this part of the bone is of interest, owing to the liability to injury of the peroneal nerve either at the time of the accident or later by being caught in the callus. This complication is recognized by pain along the nerve or paralysis of the peroneal group of muscles. When the shaft is broken the displacement is angular and the fragments overriding, with the lower end of the upper fragment forward. The prominent symptoms are pain and tenderness at one particular spot. Mobility is difficult to recognize, and crepitus often impossible. To examine the bone press alternately with the thumbs side by side over the seat of injury or forcibly twist the foot. In this way mobility and crepitus may be found, and, even if they are not, the loss of the natural spring of the fibula will be wanting. Instead of springing back to its place, it will yield before the pressure. The weakest spot in the fibula is two to four inches above the ankle, and this is the commonest seat of fracture. To this special form the name of Pott's fracture is given. Forcible eversion and abduction or inversion and adduction will produce it. In the typical Pott's fracture three separate lines of fracture exist: first, the fibula, two to four inches above the upper part of the malleolus; second, the inner malleolus; third, the outer lower edge of the tibia. The prominent symptom is the displacement of the whole foot outward, carrying with it the external malleolus, which is thus separated from the fibula. The internal malleolus is thus rendered very prominent. Three points of localized pain can be found, corresponding to the three lines of fracture above mentioned. The skin over the inner malleolus is stretched, and may even be perforated by that bony point. The foot moves too freely from side to side in the space between the tibia and fibula, which is

now greatly widened. In some cases the foot slips backward, so that the body of the astragulus lies behind the tibia.

Treatment.—For fracture of the upper end all that is needed is immobilization with the knee flexed in order to relax the biceps. In the shaft any displacement must be reduced by traction and direct manipulation. Immobilization by a Volkmann's splint for a day or two, and then by a plaster-of-Paris cast, will give good results.

Pott's fracture requires particular care, for the displacement is greater and the deformity is more liable to return than in any other fracture of the fibula. Grasp the leg firmly with one hand and the foot with the other. Draw the foot forward and inward until the astragalus can be felt lying up against the internal malleolus. Be careful to correct any backward displacement, for this is often overlooked.

Dupuytren's splint has had a long and useful career in the treatment of this fracture. It is a lateral splint applied to the inside of the leg and extending two or three inches below the foot. A wedge-shaped pad is placed between the splint and the leg, the thick end of the wedge being a little above the malleolus. By means of a roller bandage the foot is drawn well toward the tibia, and, continuing the bandage up the leg, immobilization is secured.

A neater and more steady appliance can be secured by moulded plaster-of-Paris splints. The first of these is applied along the back of the leg from just below the knee to the heel, along the sole of the foot and beyond the toes; the second begins on the dorsum of the foot, runs obliquely to the outer side under the sole, and up the inner side of the leg. Circular turns secure the splints just above the ankle and below the knee. Care must be taken to keep the foot in good position while the plaster is setting.

Fracture of the External Malleolus.—An inward twist of the foot will cause the astragalus to force the malleolus outward and produce fracture. It gives way about an inch or an inch and a half above the end of the bone.

Diagnosis.—Tenderness and pain on pressure and when the foot is turned inward are the chief symptoms; abnormal mobility and crepitus are not readily found.

Treatment.—Immobilization.

Fracture of the Astragalus.—Diagnosis is uncertain, except where there is also dislocation or when the fracture is compound. If the latter, it is best to remove the fragments when displaced, as good results follow their removal.

The calcaneum may be broken by a fall or by muscular action. When caused by the latter a fragment is broken off and carried upward by the action of the powerful muscles of the calf. When caused by direct violence the fracture is generally comminuted. Have the patient kneel and then compare the heels. The injured one is flattened and broadened, and the tendo Achillis is relaxed.

The *treatment* is massage and immobilization, with use of the limb as early as possible.

The metacarpal bones, when fractured, present few difficulties. Pressure at the broken point causes pain, as also pressing of the corresponding toe backward. In the first and fifth toes crepitus and

mobility are usually present. The displacement is so slight that in simple cases all that is needed is rest, with the foot elevated, and massage.

Compound Fractures.

The diagnosis of compound fractures presents no special difficulty. In no department of surgical practice is better judgment or more prompt action required than in their treatment. It is here that modern surgery has obtained some of its most brilliant results. In uncomplicated cases a thoroughly antiseptic dressing converts a compound into what is practically a simple fracture. The first dressing is of the utmost consequence, for upon it depends to a very great extent the success or failure of treatment.

When the fracture is the result of indirect violence, or when a simple has been converted into a compound fracture *by undue movement of the fragments*, there is little injury to the soft parts. In a compound fracture by direct violence there is usually bruising, crushing, or laceration, which adds to the seriousness of the injury. The dressing in this form of fracture should be as carefully carried out as the details of a major operation. All instruments that are likely to be required should be disinfected; the parts in the neighborhood of the wound should be washed and sterilized, as in any other operation. Most cases require anesthesia. The wounded tissues demand the utmost care in their purification. If plastered with dirt, machinery-grease, and other foreign substances, olive oil should be applied, followed by alcohol, soap and water, and corrosive-sublimate solution, 1 : 2000. Shreds of tissue or structures which cannot possibly retain their vitality should be cut away; splinters and broken-off pieces of bone should be removed; bleeding vessels should be ligated and all hemorrhage stopped. Bear in mind that to leave a nerve, a muscle, or a tendon unsutured is as gross a piece of negligence as to leave a fracture unreduced. Having attended to all these matters, the fracture is next in order. Before reduction of the fragments can be effected they may have to be trimmed off by bone-forceps or even a portion removed by a saw. Drainage must be secured by counter-openings, if necessary, and the cutaneous wound sutured. A copious antiseptic dressing is applied, and a retentive apparatus suitable for the particular fracture. When possible, an appliance which allows dressing of the wound without disturbing the splints should be employed. Plaster of Paris can be made to fulfil most indications, and suspension is also a valuable aid. If, in spite of all our care, suppuration takes place, the wound must be dressed daily, thorough drainage established, and the parts brought into an aseptic condition as speedily as possible.

Amputation after Injury.

One of the most perplexing questions for the surgeon to meet is "when to amputate." No rules can be laid down, for each case must be judged upon its merits. A consideration of the following points may help us:

1. Is the blood-supply permanently cut off? When the main artery

and its accompanying veins are destroyed, gangrene is sure to follow an attempt to save the limb (Fig. 32). When the artery alone is lost, the collateral circulation may be trusted to nourish the part.

2. Are the tissues devitalized? The soft parts may be extensively cut up, and yet if they are incised wounds good apposition of the different structures may be obtained and the part may be saved. It is different if the parts are crushed and mangled. The wheels of a heavy railway car in running over a limb not only comminute the bone, but crush the very life out of muscles, nerves, vessels, and tendons. The same may be said of powerful machinery. The skin may remain intact and show nothing more than an unusual paleness, but it soon sloughs, and, together with the deeper parts, becomes gangrenous.

3. Is it possible to prevent suppuration and septic infection? As a rule, this question can be answered in the affirmative. A thorough purification of these parts, followed by a careful antiseptic dressing



FIG. 32.—Gunshot wound of forearm; circulation cut off (from a photograph in the collection of Dr. Lincoln, Wabasha, Minn.).

with provision for drainage, will warrant us in attempting to save limbs which in preantiseptic days would have been sacrificed. In cases of doubt, therefore, we can wait a few days without exposing the patient to great risk.

4. If saved, will the limb be useful?

5. Do the age and general condition of the patient admit of saving the limb? In children we can attempt much more than in adults. The kidneys should receive careful attention. If the urine is of low specific gravity or contains albumin, the chances of saving the limb are very much lessened.

II. DISEASES OF BONE.

Inflammation.—From a clinical standpoint the composition of bone differs from other parts in only one particular—namely, the

presence of lime salts, which give firmness and hardness to the structure. The pathological changes are the same in inflammation of bone as in other tissues of the body—viz. hyperemia, dilatation of the blood-vessels, increased rapidity of the circulation followed by stasis. Lymph pours out through the walls of the vessels, the tissues become engorged, but swelling can take place only to a very limited degree. Pain is more acute and persistent, because the products of inflammation are confined by unyielding tissue, which does not allow of expansion. Pus, when formed, is long retained, because its pressure does not cause atrophy rapidly, and it cannot get to the surface as readily as is the case in soft tissues.

Any one of the three structures of which a bone is composed may be the seat of inflammation—viz. the periosteum (periostitis), the bony tissue (ostitis), and the medulla (myelitis). Periostitis alone very rarely occurs, and the same is true of myelitis. The bony tissue is affected in either case. So we speak of *osteoperiostitis* and *osteomyelitis*.

Inflammation is due to a variety of causes:

1. The result of injury. More or less inflammation attends every fracture. There is in this case no suppuration.

2. The presence of pyogenic organisms. The staphylococcus aureus and the streptococcus pyogenes are the germs most commonly found. They may find a portal of entrance by an open wound, by the blood-stream which carries them from a distant pus-dépôt, by the lungs, or by the digestive tract. The presence of these germs produces inflammation with suppuration.

3. A general infective disease, such as typhoid fever.

4. Special diathetic states, as syphilis and tuberculosis. These two are not attended with suppuration, but liquefaction is quite common.

Osteoperiostitis.—Most of the cases of periostitis (so called) come under this head, for when the periosteum is inflamed the superficial layers of the bone are also involved. The common causes are exposure to cold and wounds or contusions. The bones which are the most superficial are those most likely to suffer, and on this account diagnosis is more simple. In no class of cases, however, are errors more frequently made, and the results are often serious. If the condition is not recognized and promptly treated, the periosteum becomes thickened, the vessels going to supply the underlying bone become occluded, pus or inflammatory products separate the periosteum from the bone, and death of bone follows. Prompt treatment prevents all this, and allows the parts quickly to resume their healthy condition.

Diagnosis.—The bone most commonly affected is the tibia. When the inflammation is non-suppurative, the constitutional symptoms are not prominent. There is always pain, and it is worse at night. Pass your fingers over the painful part: the pain is increased on pressure, and more or less swelling can be detected, giving the bone a spindle shape. The soft parts covering the bone are red and edematous. When there is suppuration there are marked fever, often chills, and severe constitutional disturbance.

Treatment.—Keep the part at rest, and apply cold or warmth as the patient finds one or the other more comfortable. If the symptoms continue, puncture the part in several places with a disinfected needle.

When suppuration is taking place, lay the part freely open by an incision down to the bone and through the thickened periosteum. This should be followed by a moist antiseptic dressing. When syphilis is the cause of the disease, the constitutional treatment of syphilis should be carried out, and incisions are unnecessary.

Osteomyelitis.—This is the most common form of inflammation in bone. The medulla is rarely affected alone, and hence myelitis need not be considered clinically. Both bone and medulla are simultaneously affected, and we name the condition osteomyelitis. The inflammation may be local, general, or septic. Slight injuries may produce inflammation of bone which ends by resolution, leaving the bone-layers unchanged. In the severer forms, and particularly in chronic inflammation, destruction of bone takes place. If death of bone occurs in mass, it is called *necrosis;* if it is molecular, we call it *caries.*

Septic Inflammation of Bone.—This occurs under two conditions. The first variety is seen in adults and is associated with an open wound. Before the days of antiseptic surgery, amputations, compound fractures, and many cases of open wound connected with bone were followed by septic osteomyelitis. Fortunately, these cases are now comparatively rare. After amputation in which septic infection of the bone takes place, the medulla is observed to be discolored, bleeding readily and protruding beyond the bone, so as to form a fungus-like growth. The discharge is abundant, sero-purulent, and of a very offensive odor. In very severe cases the destructive process is rapid, and the patient dies of pyemia or septicemia in two or three days.

The second variety is a disease especially common in childhood. It occurs without wound or fracture, and has its starting-point at or near the epiphyseal line. The femur and the tibia are the bones most commonly affected. Boys suffer three times as often as girls. About half the patients are between thirteen and seventeen years of age. The pyogenic germs gain access, not by an open wound, but by the vascular or lymphatic system.

Diagnosis.—Although the symptoms of osteomyelitis are generally very plain, the most serious errors in diagnosis are quite common. A young adult is seized with intense pain in the thigh, and in a very high fever is compelled to lie in bed. A careless practitioner may diagnose his case as rheumatism, forgetting that acute rheumatism attacks the joints, and not the shafts of the long bones, and that it is seldom confined to a single joint. Weeks or months later a large portion of necrosed femur has to be removed by operation. Sometimes the febrile symptoms impress the attendant to the exclusion of local conditions, and a diagnosis of typhoid fever is made. Another case may show marked redness of the skin, which of itself is sufficient to lead some persons to a diagnosis of erysipelas. Except in the early hours or days of the disease these mistakes are unpardonable.

The *symptoms* are—

1. High fever, with or without a chill. The temperature is high from the beginning, and does not show the gradual daily increase with morning remissions so characteristic of typhoid fever.

2. Pain of a peculiar gnawing or boring character, worse at night.

This pain is situated in the shaft of the bone near a joint, but not in the joint. Movement causes intense pain, due to the action of the muscles upon the inflamed area, and not to friction in the joint. *There is always sensitiveness on pressure.*

3. Changes in the overlying parts. When the inflamed area is deeply seated no change in the soft parts is observed in the early stage of the disease. After several days the superficial layers of bone become affected, then the periosteum, and lastly the overlying soft parts. By this time the swelling can be observed—redness of the skin and fluctuation indicating the presence of pus. When the outer layers of bone are first affected these symptoms occur earlier. In either case delay in treatment is disastrous, for hour by hour the periosteum is being separated from the bone, and with it the nutrition of the osseous tissue is cut off. Necrosis is the inevitable result. The neighboring joint is in imminent danger, for, sooner or later, the inflammatory process will extend to it, distending the capsule with effused fluid, into which pyogenic organisms may be brought through the blood-vessels or lymphatics.

After the formation of pus and its evacuation through a natural opening or by incision an exploration can be made with a probe. When healthy bone is touched the probe produces a dull sound and the periosteum gives a firm and roughened sensation. Carious bone is gritty, and the probe can be easily driven into it. Necrosed bone gives a clear, high-pitched note, is usually smooth, and, if separated, the diseased portion is movable.

Treatment.—There are few diseased conditions in which delay in treatment is so dangerous as here. Fomentations, iodin, cold applications, and medication are delusive and a waste of valuable time. These are cases in which symptoms should not be treated. The pain may be the leading symptom, and in an unguarded moment you may give a hypodermic injection of morphin. The patient feels better for a time, but the destructive process is still going on. A high temperature may induce you to give one of the coal-tar derivatives, such as acetanilid. This also is a mistake. A profuse perspiration, with a fall of temperature, may follow, but the security is such as the ostrich finds when he hides his head in the sand.

The only treatment that can prove of any avail must be radical. The bone must be cut down upon, drilled, or trephined, and a free exit given to the pent-up products of inflammation. Tension once relieved, pain will soon cease. Evacuate the pus, scrape out the bone-cavity, irrigate with corrosive-sublimate solution to destroy remaining germs, and pack with iodoform gauze. The temperature will speedily fall. When the medulla is extensively diseased it is well to trephine at two or more points and scrape out the intervening tissue. It is better to take too much than too little, and the whole medullary canal of a long bone, such as the tibia, is often removed with advantage.

The after-treatment consists in keeping the limb at rest on a suitable splint, securing perfect drainage, and guarding against sepsis. The constitutional and hygienic treatment consists in nourishing diet, cod-liver oil, quinin, and fresh air.

Necrosis.—One of the objects of early and radical treatment of

the inflammatory process in bone is the prevention of necrosis. The stripping off of the periosteum, or the pressure produced by hyperemia and the other processes in the Haversian canals or the medulla, cuts off the blood-supply to a greater or less area of bone. This portion dies, and the process is called necrosis. It is gangrene of bone. Two or three months usually elapse before the dead portion of bone becomes detached. During this time profuse suppuration is taking place, which is a great tax upon the patient's strength. As soon, therefore, as the dead bone has become detached, or even before in certain cases, no time should be lost in removing it. The necrosed piece of bone is called a *sequestrum*, which simply means that it is separated from the sound portion. If the process is long delayed and nature has had time to make attempts at repair, more or less new bone is thrown out. This is especially the case when the periosteum and the outer layers of bone remain healthy. The new bone forms an osseous envelope around the sequestrum, and to this envelope the name *involucrum* is given. It is often found to be pierced by one or more openings, due to ulceration through the periosteum and bone-layers outside the sequestrum. These openings are called *cloacæ*. In removing dead bone these are important. Through a cloaca we can pass a probe or finger and determine the existence of a sequestrum, and by cutting away a sufficient area of the involucrum we can remove the sequestrum.

Sequestrotomy, or the operation for the removal of necrosed bone, is performed as follows: When the bone to be removed is in one of the extremities, the limb should be elevated for four or five minutes and a rubber bandage applied on the proximal side of the disease. Should the sequestrum present at one of the cloacæ and be of small size, it may be grasped by forceps and pulled away. In most cases a free opening will have to be made by first cutting through the soft parts and then chiselling away the involucrum. The sequestrum can then be taken away as a whole or in pieces. The next procedure will be to scrape away the granulation tissue which lines the cavity. The parts are well irrigated and packed with iodoform gauze, which must be changed about twice a week, or more frequently if there is much discharge.

Chronic Inflammation of Bone.—Cases of chronic inflammation are for the most part tubercular, pyogenic, syphilitic, or malignant, and follow a chronic course from the beginning.

Chronic suppurative osteomyelitis may occur as a primary affection or it may take place at the site of a former acute attack. It has a decided preference for the long bones, and its victims are generally children and adolescents. The cancellous tissue near the extremities of the femur and the tibia is often the starting-point. The disease is generally circumscribed, and has a tendency to produce two opposite conditions, one being abscess and the other overgrowth. Abscess is liable to form in the interior of the bone, and especially in the lower end of the femur and either end of the tibia. Overgrowth is due to the constant irritation which chronic inflammation produces. The increase in the growth may be considerable, and is sometimes sufficient to cause deformity. In tubercular cases the bone may be lengthened, but shortening and atrophy are more common.

Symptoms.—Pain is the most prominent symptom. It is of a gnawing or boring character and often very severe. There is always increased pain on pressure over a limited area, and this sign is of great value in forming a diagnosis. The pain is worse at night. It may disappear at times, giving the patient a respite for days, weeks, or even months, to return again with its former severity. If you grasp the bone, it will be found to be enlarged.

Treatment.—When a case presents the characters above described there is only one thing to be done, and that is to get rid of the pus which is confined and secure drainage from the diseased area. In my collection of specimens I have a small piece of bone removed by trephine from the lower end of the tibia of a boy fourteen years of age. The portion of bone removed contained a small abscess large enough to admit the end of the little finger, and this comprised the whole of the diseased area. Recovery was rapid.

When the tender point is found an incision should be made over it down to the bone. The periosteum having been separated by an elevator, the bone can be explored by a fine drill at different points. If pus is found, or even a suspicion of it, a trephine is applied and a piece removed, going well into the center of the bone. Should there still be no appearance of an abscess, the drill may be used to penetrate the walls of the trephined cavity. When pus is reached, a free exit must be given to it, and all the diseased part scraped away with a Volkmann's spoon. After thorough irrigation with 1 : 2000 solution of corrosive sublimate the cavity is packed with iodoform gauze and an antiseptic dressing applied. Even if no pus be found after cutting into the bone, benefit will result, for, tension having been relieved, the terrible gnawing or boring pain will cease. If the operation be done with proper antiseptic care, it will do no possible harm. Better that a mistake be made by trephining a healthy bone than that a diseased bone should go unrelieved. *In case of doubt, trephine.*

Tubercular Ostitis.—The favorite situations of this form of disease are the bones adjacent to the hip-, the knee-, and the elbow-joints, and also the bones of the wrist and ankle. The progress of the disease is ordinarily slow, and in its early stages very insidious. The pain is often spoken of as "starting" in character. In some cases it is so light as to be scarcely noticed, but pressure always reveals its existence. The early symptoms may be little more than an impairment in the movements of the limb with rigidity of the muscles of the neighboring joint. Local elevation of temperature may be observed. Tubercular inflammation tends to the formation of fluid in the part affected. This collection is sometimes erroneously spoken of as an abscess. It contains vast numbers of the tubercle bacilli, but the micro-organisms of pus are wanting. Should such a cavity be laid open without antiseptic precautions and pus-germs find entrance, a double infection will be the result, and the most serious consequences are liable to follow. This is why the older surgeons found it so disastrous to open tubercular joints or psoas abscesses.

The *symptoms* that distinguish tubercular from other inflammations of bone are—

1. Atrophy of the muscles. The parts both above and below the

seat of disease become wasted to such a degree that simple disuse is not sufficient to account for it.

2. Spasm of the muscles. This is generally observed when the patient is dropping off to sleep. The muscles acquire a persistent rigidity which is very noticeable in the early stages of spinal caries and in hip-joint disease. Flexion of joints is almost sure to occur, the flexor muscles gradually overcoming the extensors until serious deformity results.

Treatment.—Tuberculosis is greatly influenced by keeping the part at rest, and if adopted in the early stage of the disease immobilization may be sufficient to produce arrest of the tuberculous process. Confinement to bed, plaster-of-Paris dressings, and suitable splints will fulfil this indication. The general principles of treatment in tuberculosis will also need to be kept in view, such as good hygienic conditions, nourishing food, and remedies directed to the improvement of the patient's strength. Some excellent results have been obtained by local injections of iodoform, of chlorid of zinc, or of acid phosphate of lime. Clinical experience has shown that in most cases where arrest of the tuberculous process has taken place the bacilli have been encapsulated by infiltration of the healthy tissue surrounding them. They have been, as it were, enclosed by a wall which they cannot break through. The object of the injections above mentioned is to produce this condition, and at the same time to destroy the vitality of the bacilli. Iodoform is probably the least irritating and the most satisfactory of this class of remedies. It can be used in a solution containing one part of iodoform and ten of glycerin. By means of a needle long enough to reach the diseased area this fluid is injected in small quantity every three, seven, or ten days.

A method of treatment has been recommended by Bier which is worth consideration. Clinical evidence having shown that tubercles do not multiply in parts supplied by too much blood, an artificial chronic congestion is secured by wearing an elastic bandage above the seat of the disease. This bandage is applied at more and more frequent intervals, and as tightly as the patient can bear it, until at last he is able to wear it almost constantly.

When the above methods are unsuitable, or in cases where they have failed, an operation should be resorted to for the removal of the diseased area. Scraping and removal of the infected tissues must be more thorough here than in pyogenic ostitis. The walls of every sinus, the medulla of infected bone, and every suspected deposit of tubercle in the soft parts, such as the skin, tendon-sheaths, or synovial cavities, must be thoroughly scraped. When the disease extends into a joint the question of resection or amputation will have to be considered.

Syphilitic Diseases of Bone.—The bones most liable to this form of ostitis are the long bones and those of the skull and the face. The frontal is the one most frequently affected of all the bones. Pain, worse at night, is an early symptom, and may even appear before the eruption on the skin. At first it has the character of a periostitis, but later smooth, firm, flat elevations about one or two centimeters in diameter can be felt; these are tender on pressure. They yield readily to treatment, but run on for an indefinite period if let alone. Iodid of

potassium and the mercurials act as specifics. No operative interference is required.

Fragilitas Ossium.—An abnormal brittleness of the bones by which they are liable to fracture on the slightest cause is known as fragilitas ossium. This condition may be congenital, the bones even in utero being fractured, and the fragility continuing until mature life, when it may cease. The disease may also be the result of debilitating conditions which compel long confinement to bed. Other causes are syphilis, malignant tumors, the early stage of rachitis, general paralysis, and tabes.

Treatment.—Nothing can be done further than to guard against accident and to treat the fracture in the ordinary manner.

Rachitis.—Rachitis, or rickets, is a disease of infancy and childhood having as its leading features a deficiency of lime salts in the bony framework and absorption of bone already formed. It is generally seen among the poor in crowded, unhealthy portions of cities, where



FIG. 33.—Rachitic curvature before operation.

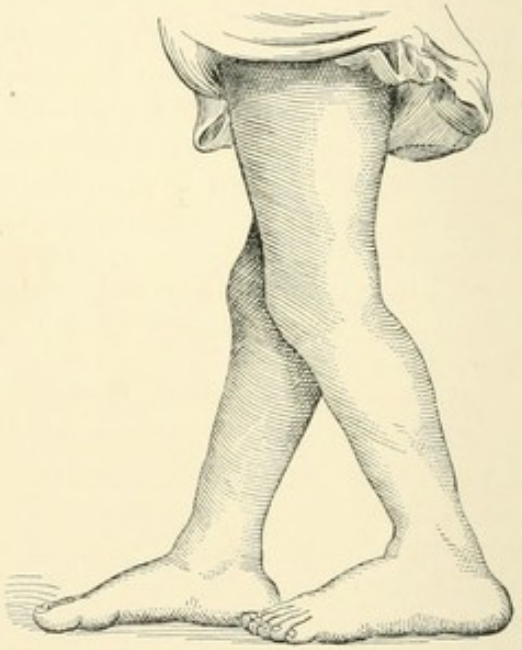


FIG. 34.—Rachitic curvature after operation.

(From photographs in the collection of Dr. T. S. Roberts.)

ventilation is bad and the general surroundings are unhealthful. It begins about the first or second year of life, rarely after the sixth. Its starting-point is the epiphyseal line, where there is found a deficiency of lime salts, and at the same time an increased growth of cartilage. Hence the bone is wider and thicker at this part. The child is loose-jointed, the ligaments being relaxed, and movements of the articulations frequently cause pain (Figs. 33, 34). When the spinal column is the seat of the disease one or other of the various spinal curvatures may result. Rachitic children are often hydrocephalic, and deformities of the brain are not uncommon.

Symptoms.—One of the earliest indications of rachitis is perspiration about the head, particularly during sleep. The child is restless, and rolls his head from side to side on the pillow. There is constipation;

the urine is increased in quantity and loaded with phosphates. Enlargement of the epiphyseal end of the bones will be most likely to occur at the lower end of the radius and the ribs. The forehead and the frontal eminences are enlarged. The changes in the ribs produce the characteristic pigeon's breast. Teething is delayed. The anterior fontanelle fails to unite, and the want of growth results in a dwarfing of stature. Bronchitis, catarrhal affections, and pneumonia are common complications, and, in some instances, causes of death. About 90 per cent. of the cases improve under proper management.

Treatment.—The treatment of this affection may be summed up under two words—nutrition and hygiene. Removal from crowded, ill-ventilated dwellings to the pure air of the country, sea-air, and sea-bathing are invaluable. Of drugs, the best are cod-liver oil, syrup of the iodid of iron, phosphorus, and the lactophosphate of lime.

Osteomalacia.—While rickets is a disease of childhood, osteomalacia, mollities ostium, or malacosteon is a disease of adult life. The most frequent subjects are pregnant women or those who have borne children. In men it is rarely found. Its cause has never been clearly explained. Among the causes assigned are defect of lactic acid, defective nutrition, ovarian and uterine disorders, and changes in the trophic nerves. The leading feature of the disease is a progressive softening of the bones, resulting in all sorts of deformities, going on from bad to worse, and ending in death from exhaustion or from some complication, such as disease of the lungs, bronchi, or pleura.

Symptoms.—Its early history is obscure. Pain is one of the most important symptoms. It occurs at a number of points of the body, and is liable to be mistaken for rheumatism. The sex of the patient and the existence of pregnancy with large deposits of phosphates in the urine should excite suspicion. When osteomalacia has advanced so far as to cause bending and deformities of the bones, no doubt can exist of the terrible character of the malady.

Treatment.—The treatment is by no means satisfactory. Some cases are mild and have a tendency to remain almost stationary; others progress to a fatal termination in spite of every form of treatment. The best hygienic surroundings are indispensable, and deformity should be prevented by the use of protective dressings. Pregnancy should be avoided, as it has an especially injurious effect upon the disease. The medical treatment consists in the administration of cod-liver oil, phosphates, and lime salts, but they produce little if any benefit. Removal of the ovaries and uterus has had some advocates, and a few cases have been reported in which there was decided benefit from the operation.

Actinomycosis.—Until recent years this disease was confounded with sarcoma, owing to the fact that its microscopical structure bears a close resemblance to the round-celled variety of these tumors. It is now known to be a disease due to a specific germ. Infection usually takes place through the mouth, either from a wound or a carious tooth. It may also find a portal of entrance by way of the lungs, where, reaching the pulmonary alveoli, it sets up a broncho-pneumonia. The chief characteristic of the disease is a chronic inflammation which closely resembles that caused by the tubercle bacillus.

Symptoms.—An enlargement of the lower jaw or an ill-defined swelling in the submaxillary region or a nodule of the skin is generally the first symptom. The progress of the disease is slow, but steady. The lymphatics and blood-vessels are not involved until a late period. Pain and swelling are not marked until suppuration begins. Then the local and constitutional symptoms become as marked as they are in acute cellulitis or in diffuse osteomyelitis. As the disease progresses secondary deposits take place with caseous nodules and abscesses, no part of the body being exempt. To the naked eye there is nothing to distinguish the growth from sarcoma or granulation tissue. The special character of the disease must be settled by finding the micro-organisms which produce it.

The granulation tissue and the pus contained in it are filled with round bodies like millet-seeds of a yellow color. The fungus itself is easily recognized by its star-like masses of mycelium.

Treatment.—When recognized early the diseased part should be thoroughly removed, and when this can be done the prognosis is favorable.

Tumors of Bone.—The benign tumors of bone are exostoses, fibromata, and enchondromata; the malignant are sarcomata and carcinomata.

Exostoses are localized overgrowths of bone (Fig. 35), the term

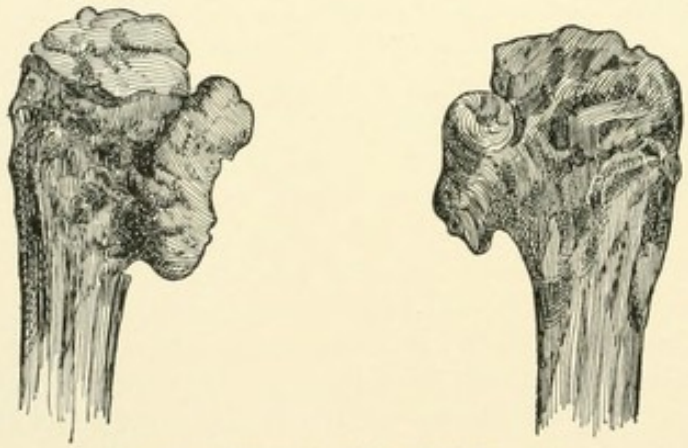


FIG. 35.—Exostosis of head of the tibia.

hypertrophy being applied when the whole extent of the bone is increased in size. Their structure is the same as bone itself, and they are divided into two classes, according to their density, the ivory or eburnated and the cancellous. The ivory variety is commonly found on flat bones, and a favorite position is the frontal sinus, where it may grow to considerable size, resulting in horrible deformity. This form is often associated with syphilis. The cancellous variety affects the long bones. Exostoses are often hereditary, and in that case are generally symmetrical and multiple. They begin to grow in childhood, and their starting-point is the junction of the shaft with its epiphysis. They grow from cartilage, which is gradually converted into cancellous tissue, and generally cease to enlarge when the bone to which they are attached has reached its full development (Fig. 36).

Diagnosis is easy. The tumors are painless, hard, and fixed, closely

connected with bone, and can be readily felt or seen. Exostoses give little trouble, except under the following conditions; when they interfere with the free use of a joint, especially in flexion: when by their pressure they cause atrophy or ulceration of the overlying soft parts; or when they occur in the inner surface of the skull and press upon the brain. Even in the last-mentioned condition no serious cerebral disturbance may result, and the existence of a tumor may be discovered only after death.

Treatment.—Where no inconvenience is caused no treatment is

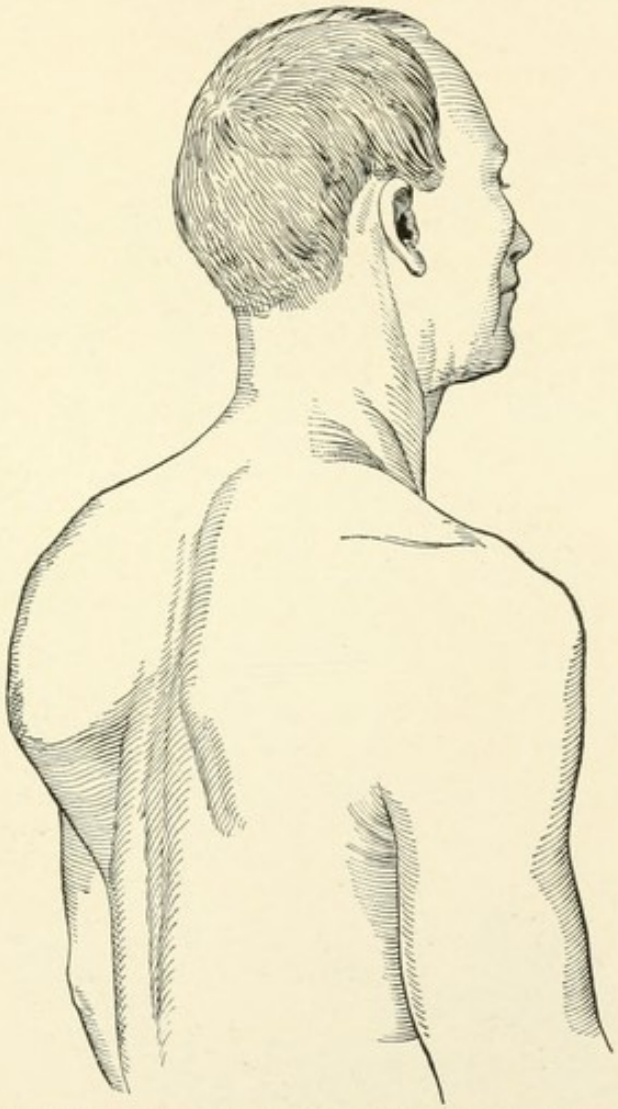


FIG. 36.—Osteoma growing on the under surface of the scapula (from a photograph in the collection of Dr. Graham, Washington, D. C.).

called for. The growth can be broken off if it be attached to the bone by a narrow pedicle, but in most cases it is best to cut down upon and remove the tumor.

Chondromata, or Cartilaginous Tumors.—These growths are found chiefly on the extremities of the long bones and in connection with the small joints of the hands and feet (Fig. 37). If composed of purely cartilaginous tissue, they are benign, but, unfortunately, they often contain a mixture of sarcomatous elements which places them within the category of malignant growths.

Chondromata occur on the surface or in the center of bone, in the former case being very easy of diagnosis, in the latter exceedingly difficult. They have a tendency to become cystic.

Symptoms.—A slowly-growing tumor, elastic and firm, of less density than bone and irregular in shape, situated at the extremity of a long bone or at the small joints of the hands or feet, is suggestive of chondroma. Pain is not present unless a nerve be pressed upon, which does not often occur. When the growth is central it cannot be diag-

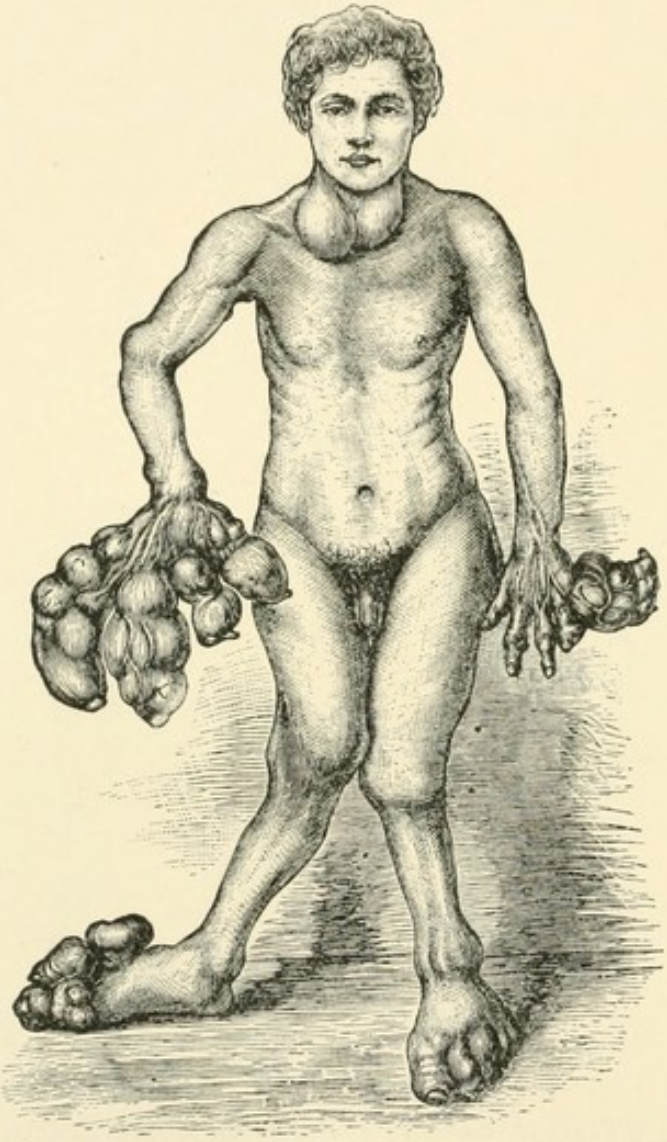


FIG. 37.—Lad twenty years of age with multiple chondromata (after Steudel).

nosed until it has attained considerable size, and even then its nature often remains in doubt until after its removal.

Treatment.—The only effective remedy is extirpation. The growth itself may be removed and the surrounding parts scraped away, or it may be necessary to remove a part or a whole of the bone to which it is attached. In some cases nothing short of amputation will suffice.

Fibromata.—The commonly chosen seats of fibromata are the jaws and the base of the skull. The growth begins, as a rule, in the periosteum and is pedunculated. Rare cases occur in which the starting-

point is the center of the bone. A tumor composed purely of fibrous tissue is rare. With the exception of epulis and naso-pharyngeal polypi, the tumors of a fibroid character are fibro-sarcomata. Fibromata grow slowly, have a tendency to become cystic, and often cease to enlarge when the bony skeleton has arrived at maturity.

Diagnosis.—Fibrous tumors are irregular in shape, firm to the touch, but not so hard as bone, with which they are, as a rule, connected. The so-called naso-pharyngeal polyp commencing on the under surface of the sphenoid bone fills in time the naso-pharynx, the posterior nares, and the antrum. These growths are dangerous on account of their tendency to free hemorrhage. When the patient reaches the age of about twenty-five years the polyp ceases to grow and atrophy com-

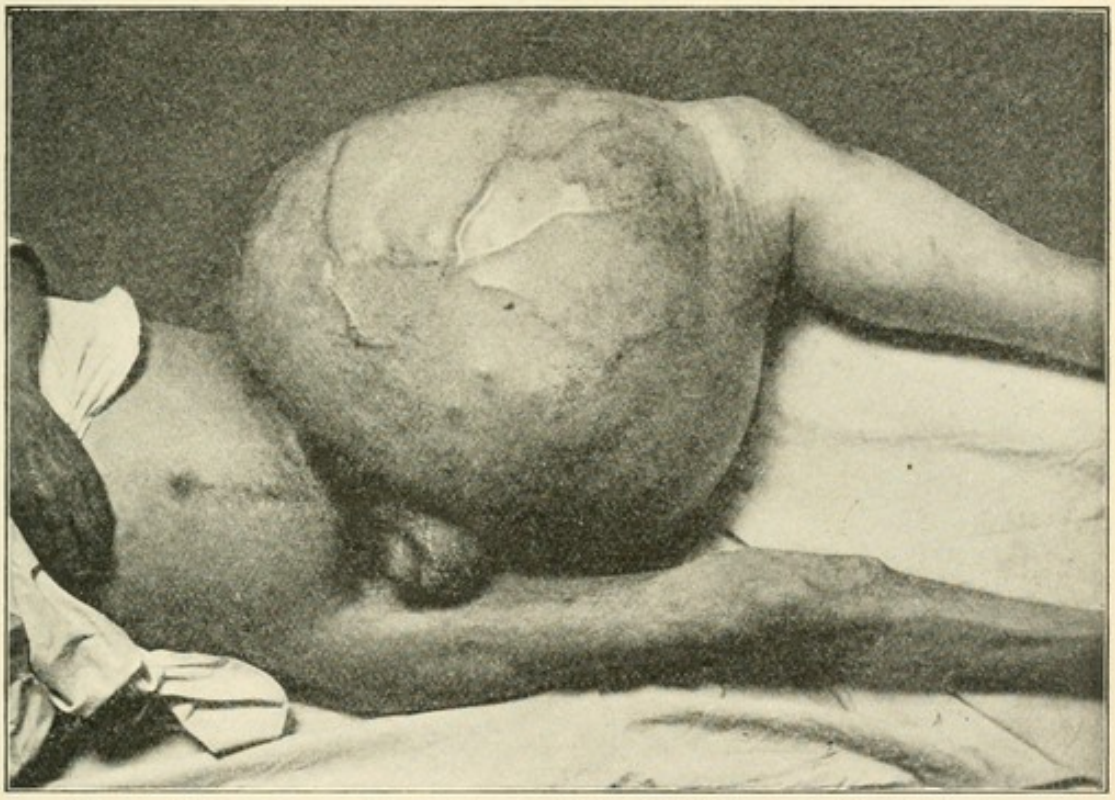


FIG. 38.—Osteosarcoma of femur (from a photograph in the collection of Dr. Jepson, Sioux City, Iowa).

mences. Unless hemorrhage is frequent and copious it is advisable to delay treatment in the hope that this favorable change may take place.

Treatment.—Remove either by extirpation of the tumor alone or by resection of the portion of bone from which the growth has originated.

Malignant Tumors of Bone.—**Carcinoma** of bone is exceedingly rare, and is always secondary or due to simple extension of the disease from neighboring structures.

Sarcomata, on the other hand, are common, and are distinguished from all other tumors of bone by the rapidity of their growth (Fig. 38). No bone in the body is free from liability to this form of malignant disease, but certain bones are especially prone—viz. the lower end of the femur and the upper end of the tibia; that is to say, the bones on each side of the knee-joint. The jaw is also a common situation, and the

disease here constitutes one of the forms of epulis. Injury, such as fracture or bruising of a bone, frequently precedes the growth and must be considered an exciting cause. Sarcomata in bone, as elsewhere, may occur at any age, but the great majority of cases are found in early life. After forty years of age the disease is very rare.

If we classify the tumors according to their histological structure, we have three varieties—round-celled, spindle-celled, and giant-celled. The malignancy exists in about the proportion of the size of the cell. The round cell and spindle cell are found in tumors of the most rapid growth, while the giant-celled neoplasms grow slowly and have fewer malignant characters.



FIG. 39.—Round-celled sarcoma (from a photograph in the collection of Dr. Graham, Washington, D. C.).

A sarcoma is classed among malignant growths for the following reasons:

(1) It infiltrates the surrounding structures.

(2) The lymphatic glands become involved sooner or later.

(3) It occurs in the form of secondary deposits in other parts, the lung being specially liable to this metastasis.

Clinically, sarcomata of bone may be divided into two varieties, periosteal and central.

Periosteal Sarcomata.—These are the most malignant of bone-tumors, being composed, as a rule, of round or spindle cells (Fig. 39). There is a special tendency in this variety to affect different organs, so that, although no sign of the disease is seen in the stump after an amputation, a secondary deposit in the lung may carry off the patient.

The deeper, more vascular layer of the periosteum is the starting-point. While the tumor is small the external layer of the periosteum is stretched over it, but in the course of time this gives way, the growth breaks through, and rapidly infiltrates the surrounding tissues (Fig. 40).

Central sarcomata begin at the articular ends of the long bones or in the cancellous tissue of the short ones. They are not so malignant as the periosteal variety, and in the early stages are not easily recognized. As the tumor increases in size its pressure produces atrophy of the bone, until nothing is left but a thin shell of osseous tissue, which cracks beneath the fingers like an egg-shell. The fracture of this weakened bone from some trivial cause may be the first thing to excite suspicion of the real nature of the disease.

Symptoms.—The early symptoms of sarcoma are frequently obscure. Pain, which may be mistaken for rheumatism, is generally present. It is worse at night, and may be very severe. In many cases there is a history of a traumatism. In a young person a rapidly-growing tumor at the seat of a newly-united fracture or in one of the bones near the knee-joint must be looked upon with suspicion.

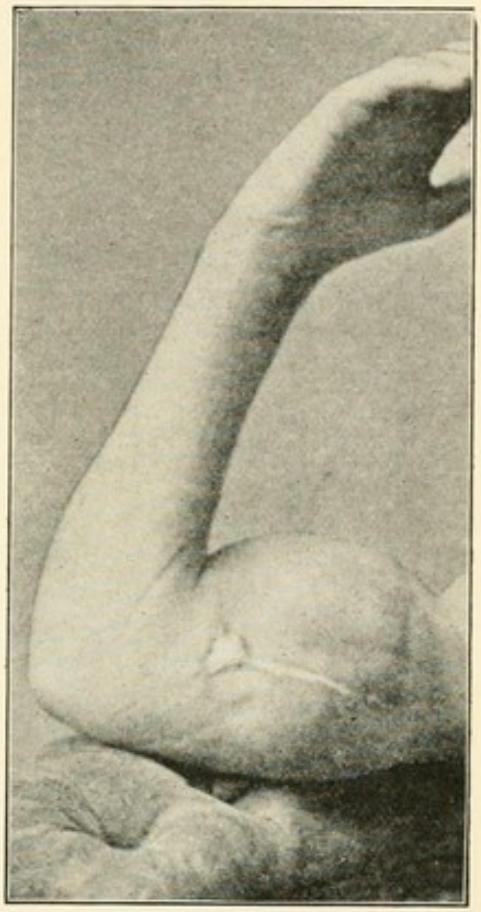


FIG. 40.—Recurring sarcoma of the humerus (from a photograph in the collection of Dr. Strickler, New Ulm, Minn.).

The following questions may be considered:

(*a*) Is there swelling of the bone? If there be a periosteal sarcoma, a distinct swelling will be felt, usually along one side of the bone, fusiform in shape, and avoiding the extremity of the bone. The swelling, in the central variety, appears at a much later period, is more globular in shape, and has egg-shell crackling when pressed upon by the fingers. It is found at the cancellous end of the bone.

(*b*) Does the tumor pulsate? Pulsation is a character of the central variety, and of the periosteal when connected with the flat bones. This pulsation is readily distinguished from the expansile, heaving pulsation of an aneurysm. Even should a thrill and bruit be present, they are only observed over small portions of the tumor. Pressure has little or no effect upon the size of the swelling, and pulsation in the artery below is not impaired, except when the growth compresses the main vessel against the bone.

The consistence of the tumor is subject to great variety. Sometimes it is hard and dense, at other times soft and fluctuating. Should spontaneous fracture occur, followed by a tumor of rapid growth, a diagnosis of central sarcoma could be made with confidence.

In any case of doubt an exploring needle of moderate size can be thrust into the growth. If it be a sarcoma, the needle will be found to penetrate the bone, and through the cannula may escape myeloid cells or other elements which can be examined microscopically.

Diagnosis.—The conditions likely to cause errors in diagnosis are—

1. Chronic inflammation of bone with necrosis. Cases of this kind are exceedingly puzzling, and no amount of care will ensure against a mistaken diagnosis. When the course of ostitis is very slow and free from pain, when there is much inflammatory thickening without the formation of abscess, and the sequestrum has formed in the manner known as "slow necrosis," the nature of the disease can in some instances be settled only by free exploration. I have known two cases in which all treatment was abandoned and a diagnosis of sarcoma made, which afterward proved to be necrosis of the femur near the hip-joint.

2. Inflammation in a neighboring joint may mask the symptoms of a sarcoma which has its seat in the cancellous extremity of a long

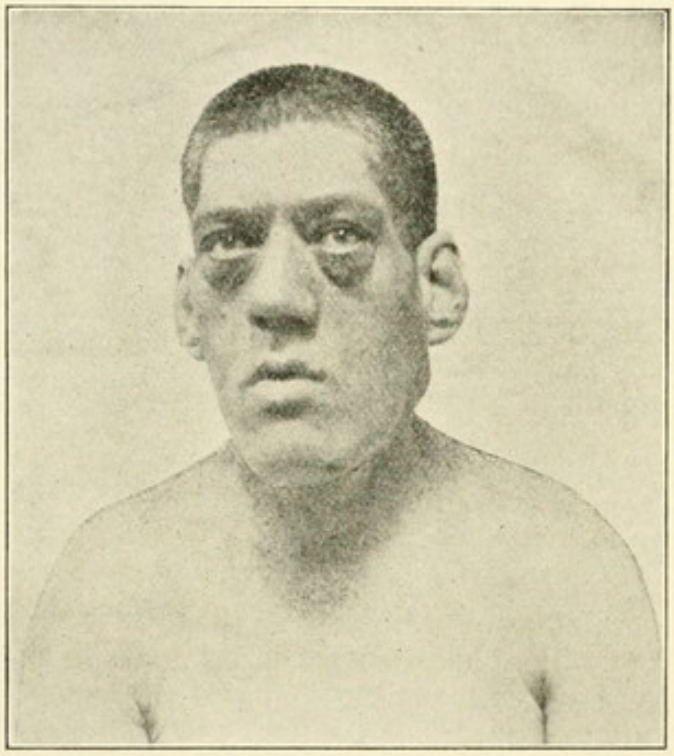


FIG. 41.—Acromegaly (from a photograph in the collection of Dr. T. P. Findley).

bone. If care be taken to look for all the characteristics of joint-disease, mistakes are not likely to happen. The position of the limb, the pain (worse at night), and the effusion of fluid into the joint are very expressive, while the history of a tumor in the bone, beginning not at, but near, the joint, is indicative of sarcoma.

3. Syphilitic gummata. The difficulty in this case can be removed by putting the patient upon iodid of potassium for a few days. If the growth be syphilitic, it will steadily diminish.

4. Aneurysm of bone. This condition, if it ever occur, must be exceedingly rare.

Treatment.—In either form of the disease the only chance of success lies in early and complete removal. If the tumor is situated on an

extremity, amputation affords the only hope. The operation should be at or above the nearest joint.

In periosteal sarcoma of the femur amputation at the hip-joint is justifiable, but when the tumor involves the middle or upper third of the bone the case is practically hopeless. Recurrence of the disease will take place, either in the stump or in some internal organ, notably the lung.

Acromegaly.—This disease, first described by Marie in 1886, is attended with a remarkable enlargement of the bones of the face, head, pelvis, thorax, feet, and hands (Fig. 41). Although the affection is of a nervous origin, the bony enlargement is a true hypertrophy, and first appears in the hands, feet, and lower jaw. The disease is generally symmetrical. There is usually freedom from pain; the joints do not become ankylosed; it follows a very long chronic course, and up to the present time no treatment has been found which has any effect upon the disease.

CHAPTER IV.

INJURIES AND DISEASES OF MUSCLES, TENDONS, AND BURSÆ.

THE injuries to which muscles are liable are bruises, strains, ruptures, and wounds.

A blow, a violent and prolonged contraction, or overuse will result in a condition known as a **strain.** The muscle is tender to pressure; there is more or less swelling, stiffness, weakness, and pain, especially when the muscle is brought into action. The injury is found in groups of muscles, such as the deltoid, the pectorals, biceps, and pronator radii teres (the "lawn-tennis arm"). The adductor muscles of the thigh are affected in prolonged and severe horseback-riding. Any muscular exertion to which the individual is unaccustomed will produce it. A blacksmith can swing his hammer all day and feel no ill effects, but a man unused to such labor will find, after the first day's toil, that his arm is powerless.

Treatment.—Rest and hot bathing or fomentations.

Rupture.—Under a violent muscular effort or as the result of a severe blow the muscular structure may be ruptured. A few fibers may give way or the whole muscle may part in its continuity. The patient experiences a sudden and severe pain, perhaps attended with an audible snap, and immediately finds that the muscle has lost its power in whole or in part. On examination there will be found a depression or gap at the seat of rupture, and swelling due to extravasated blood. Sometimes the quantity of blood is so great as to produce a hematoma. At a later period there is discoloration of the skin. The function of the muscle is, of course, impaired or even lost, and this may result in permanent weakness of the limb. In debilitated conditions of the body, as in convalescence from typhoid fever, the muscles may suffer laceration from trivial causes, owing to their fibers having undergone granular degeneration.

Treatment.—The most important point in treatment is rest in the position which most relaxes the ruptured muscle. The torn ends may be approximated by properly applied compression. In cases of complete separation in healthy muscle sutures should be employed. In diseased muscle this is useless, as the stitches will tear out. Union is effected by the interposition of connective tissue, the length of the band depending upon the degree of separation.

Wounds.—By accident or in the course of an operation wounds of muscle may be made, and are subcutaneous or open. The symptoms are retraction of the divided ends and hemorrhage.

The *treatment* consists in early and accurate approximation by catgut sutures. The union is commonly by fibrous tissue.

Myalgia.—Pain in a muscle or group of muscles is a common ailment depending upon overuse, exposure to cold, and to a variety of causes, such as lead-poisoning or syphilis.

The diagnosis of pain in a muscle or group of muscles is important. If a patient complains of pain over the deltoid, for example, and the pain is increased when he raises the arm from the side of his own volition, while no pain is felt if the surgeon moves the arm and at the same time the muscles are kept relaxed, it will prove that the muscle is the seat of pain. Placing the limb in such a position that the muscles are stretched will also produce pain. Hence we have this rule: When a muscle is affected active movement produces pain, passive movement is painless; over-extension or passive stretching is painful. Ligamentous pain is elicited by any movement, either active or passive, that stretches the ligaments. A certain amount of passive motion can take place in a joint without stretching either muscles or ligaments, and this amount is unattended with pain. If you continue this movement and pain is then felt, it may be set down as having its seat in the ligaments.

The *treatment* is heat, electricity, massage, and sedative applications.

Myositis (inflammation of muscle) follows an injury, but, as a rule, this is unimportant compared to the effect upon other tissues. Muscular rheumatism, so called, is a form of myositis, and is often produced by exposure to cold. Gonorrhea is often attended by muscular pains (one of the forms of gonorrheal rheumatism), and may also be regarded as myositis.

A chronic form of myositis is often observed in syphilis. It gives a wood-like hardness to the parts, and a common situation is the sphincter ani muscle.

Symptoms.—The symptoms of myositis are stiffness of the affected limb and pain, which is worse at night and increased whenever the affected muscles are brought into action. Constitutional symptoms, such as fever, chills, etc., are seldom present.

Suppurative myositis is by no means common, except in the case of the psoas muscle. It has been observed as a localized inflammation, resulting in muscular abscess and due to some local irritation, such as a foreign body or traumatism. Diffuse suppuration in muscles has, in a few instances, been observed. It appears to occur under the same conditions as diffuse osteomyelitis. The entrance of pyogenic organisms is by a wound or through one of the mucous surfaces.

Still more rare is the disease known as **acute progressive myositis,** which involves the whole of the muscular system and ends in death by

asphyxia or pneumonia. It is probably due to bacteria the nature of which has yet to be determined.

Myositis ossificans (Figs. 42, 43) is a peculiar form of muscle-



FIG. 42.—Myositis ossificans, showing the abduction of the arms (Stephen Paget).



FIG. 43.—Myositis ossificans, showing the contraction of the left sterno-mastoid, the masses of bone in the latissimi dorsi, and the extreme amount of abduction of the arms obtainable (Stephen Paget).

inflammation in which bony plates form in the muscular tissues. The most common situation is the dorsal region.

Permanent Shortening of Muscle, or Contracture.—Long-continued inactivity of muscles, as in the bed-ridden, is liable to result in contracture. These cases are generally of a mild character, and the muscles rapidly regain their normal condition under proper exercise. Chronic inflammation of the muscle itself, descending neuritis, and sclerosis following lesions of the cortex produce the most serious forms of permanent shortening.

Treatment.—In the milder forms massage and passive motion usually suffice. In the severer cases tenotomy may be required. If the division of a tendon is likely to result in too wide a gap, the tendon can be lengthened, as recommended by Anderson (Fig. 44), by first splitting it in the middle line, and then sliding the ends to the proper position and suturing them.

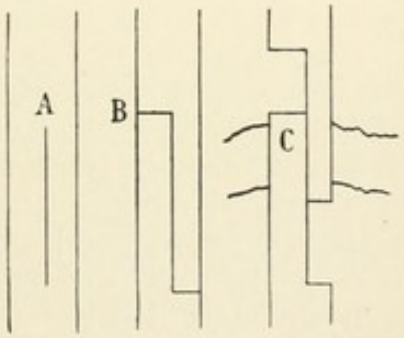


FIG. 44.—Anderson's method of lengthening a tendon.

Tenosynovitis, inflammation of tendon or thecitis, is a common affection. A favorite situation is at the wrist, due to over-exertion of the flexor tendons in workmen, such as stone-cutters and others, who use a hammer or other tool continuously. Any tendon, however, may be affected. The disease occurs in three forms—acute, suppurative, and chronic.

The **acute form** is due, as a rule, to overwork. The course of the tendons is sensitive to pressure, and the overlying skin is hot and in some cases

reddened. Every movement of the muscle is attended with pain. The surfaces of the tendon and its sheath become roughened, and produce a crepitant sound which has been compared to the rustling of silk. In aggravated cases the exudation not only involves the tendon-sheath, but the adjoining cellular tissue, so that the swelling may extend from the wrist down over the dorsum of the hand and up the arm to or beyond the elbow. Instead of simple serous fluid, the exudation may contain blood, and the pain, heat, and tension may be excessive. This variety may run into the chronic or the suppurative form of the disease.

Chronic tenosynovitis is nearly always of tubercular origin. The tendons of the forearm are those most commonly involved. The progress is slow and is attended with the formation of granulation tissue, in which can be found the tubercle bacilli in large numbers. According to the density of this granulation tissue will be observed swelling along the tendons, firm or fluctuating. In some cases small bodies resembling rice or melon-seeds are formed in the sac, either floating in the fluid or attached to the walls.

Besides cases due to tuberculosis, chronic tenosynovitis is frequently a result of the acute form of the disease. This may be due to some constitutional dyscrasia, such as gout or rheumatism, or it may be a consequence of adhesions. Long-continued disease of a limb after fracture or other injury is liable to result in such adhesions, which, if not completely broken up by passive movements, are a constant source of pain and inconvenience.

Suppurative Tenosynovitis.—This is most frequently met with in the form of thecal abscess or whitlow in connection with the flexor tendons of the fingers or thumbs. It was formerly not uncommon as a result of septic infection after amputations, and also as playing a part in pyemia and septicemia. Whitlow begins generally as the result of a slight injury or wound which admits septic organisms. Having once gained an entrance, the germs follow the course of the lymphatics, which in these situations is toward the tendon-sheath, the periosteum, and the bone. The dense, resisting structure of the sheath and its tendon gives no room for expansion, and hence the intolerable pain and throbbing which characterize whitlow. Two varieties of whitlow are recognized—the superficial and the deep. The superficial variety occurs about the nails and affects one or several fingers at the same time. The subjects of the disease are delicate children or debilitated persons. In some instances it runs its course in a few days or even hours, ending in the formation of serous fluid, which is reabsorbed; in others ulceration takes place, and the nail is undermined and eventually cast off. Deep whitlow is a much more serious affair. The palmar aspect of the last phalanx of one of the fingers is the common situation. The finger becomes painful in a day or two after an injury; then it begins to throb, particularly when allowed to hang down; the patient passes sleepless nights; the pulse increases in frequency and the temperature rises. Suppuration is taking place, and nothing but the evacuation of pus and the relief of tension will get rid of the suffering.

Treatment.—At the very commencement of the disease the hand may be placed for an hour or longer in a hot solution of corrosive sub-

limate in the hope of destroying the germs and averting suppuration. If at the end of two or three days the symptoms show no sign of abatement, the only treatment of value is free incision. When the terminal phalanx is affected the tissues should be divided down to the bone. In the case of the first or second phalanx the pus is probably no deeper than the tendon, so that opening the sheath is sufficient, and relief will speedily follow. The rest of the treatment consists in strict antiseptic dressings.

Ganglion—or "weeping sinew," as some of the old surgeons called it—is a collection of fluid in connection with a tendon-sheath. Its favorite situation is the back of the hand or wrist, where it appears as a round, firm tumor of varying density, causing little or no inconvenience, except in such occupations as require constant use of the affected tendon. This little tumor is a cyst containing the synovial fluid, but generally changed to a jelly-like consistence. Sometimes the tendon-sheath is distended for some distance, and the fluid contains melon-seed bodies and is thick and gelatinous. This form, sometimes called compound ganglion, is found in the palm, while the simple cyst is common on the back of the hand and wrist. The causes are strains, overuse, or slight injuries frequently repeated.

Treatment.—Three methods of treatment are in vogue:

1. Subcutaneous rupture. This may be effected by a quick and forcible pressure of the thumb or a smart blow. The contents of the cyst are forced along the sheath or into the surrounding tissues, and are then absorbed. The objections to this method are that the cyst rapidly refills, and it may then be so thick and strong that it cannot thus be ruptured.

2. Subcutaneous division by a small knife or flat needle.

3. Cutting down upon the cyst and excising it is the most effectual of all methods, and when carried out aseptically is perfectly safe.

Compound ganglion is a serious affection, and the results of the most careful treatment are often unsatisfactory. Syme's method of freely laying open the sheath was successful in his hands even before he resorted to antiseptic surgery. The sheath should be opened above and below the annular ligament, the melon-seed bodies removed, and thorough drainage effected. Suppuration is disastrous, for it is almost sure to extend to the joint, and the tendons themselves are liable to slough. This operation should never be undertaken except under the most rigid asepsis, and in any case a guarded prognosis should be made.

Dupuytren's contraction is an affection of the hand found in men (rarely in women) of middle or advanced life. Its characteristics are flexion of the fingers at the metacarpo-phalangeal joint; the palmar fascia is tense and firmly adherent to the skin, while great resistance is felt when an attempt is made to straighten the fingers. In aggravated cases the fingers are tied rigidly down into the palm of the hand. It is generally associated with gout, but engineers, fitters, and other mechanics are liable to suffer from it.

Treatment.—In the early stages massage and passive movements of the affected fingers may arrest the progress of the deformity. A splint may be worn at night, and a variety of complicated appliances have

been invented by instrument-makers. These have not been very satisfactory. When the finger is so far contracted as to form a right angle, operative treatment is necessary. Various procedures have been resorted to. Adam's method consists in subcutaneous section at many points with a fine tenotomy knife. The hand having been carefully disinfected and held in an elevated position for a few minutes to limit the amount of hemorrhage, incisions are made in the palm at those points where the skin is still movable over the fascia. This is continued down the fingers, each resisting point being severed until the digits can be thoroughly extended. The small openings can be sealed by iodoform and collodion, and the hand placed immovably upon a palmar splint for three or four days. Passive motion should then be continuously carried out. In favorable cases two weeks suffice to effect a cure.

Diseases of Bursæ.—Between tendon and bone, over bony prominences, and in fact at any point where there is much friction, bursæ exist, either congenital or acquired. They may communicate with the cavity of a joint, in which case they must be regarded as offsets of the synovial sac. In most cases they are simply cavities in the cellular tissue.

Wounds of bursæ, if not infected, heal rapidly. Punctured and lacerated wounds and contusions are liable to prove troublesome, owing to the friction of the adjacent structures. The treatment of such injuries is by rest, thorough cleansing, drainage, and pressure.

Bursitis, or inflammation of bursæ, is commonly met with in the form of "housemaid's knee," the bursa in front of the patella being the seat of inflammation (Fig. 45). The "student's elbow" is an inflammation of the bursa over the olecranon, due to pressure of the elbow upon a hard table while absorbed in study. The bursa lying between the tendo Achillis and the os calcis is another that is liable to inflammation. It is recognized by a swelling which occupies the space on each side of the tendon, and is distinguished from an effusion into the ankle, which would appear in front of the joint.

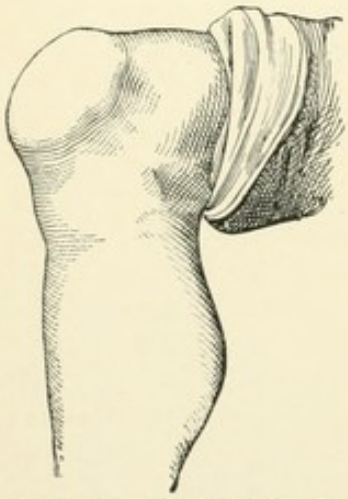


FIG. 45.—Prepatellar bursa, contents aspirated; no return (from a photograph in the collection of Dr. Lincoln, Wabasha, Minn.).

Bursitis may be acute, chronic, or suppurative.

Acute bursitis is nearly always the result of injury. The housemaid upon her knees scrubbing floors bruises the prepatellar bursa and inflammation follows. Syphilis, gout, and tuberculosis are also regarded as causes. The early symptoms of bursitis are swelling, redness, pain, and pyrexia. The bursa being, in its natural state, an unfilled cavity, a certain amount of fluid can collect without producing tension; hence pain is not an early symptom. In superficial bursæ diagnosis is easy, but in the case of deep bursæ it may be difficult. Here we have little or no swelling to guide us, and our reliance must be placed upon our knowledge of the action of the muscles. Inflammation of the bursa under the deltoid is recognized from

the fact that rotation of the arm is free from pain when the limb is in the position of moderate abduction, but excessively painful when by forced adduction or abduction the sac is made tense. In the case of the bursa under the psoas we have freedom from pain when the thigh is rotated in the position of flexion, but intense pain when this movement is carried out with the limb in extension.

Suppuration is recognized by the occurrence of a chill or a marked rise in temperature with increased severity of all the symptoms. Chronic bursitis is a sequel of the acute form or may result from tuberculosis or syphilis.

Treatment.—In the acute form rest, cold applications, and pressure may be tried. If these measures do not give relief, the sac should be aspirated and firm pressure maintained by means of a bandage. When suppuration takes place the cavity should be laid open, irrigated with corrosive sublimate 1 : 2000, drained, and dressed antiseptically.

CHAPTER V.

INJURIES AND DISEASES OF JOINTS.

I. INJURIES OF JOINTS.

In examining any joint we must keep before our minds the following structures, any or all of which may be implicated when an articulation is injured or diseased: viz. the bones, articular cartilages, synovial membrane, ligaments, and muscles. The common injuries of joints are contusions, sprains, wounds, and dislocations.

Contusions.—Direct violence, such as blows, kicks, or falls upon a joint, is important, from the fact that more or less hemorrhage may take place into the articular cavity, causing distention and affording a good culture-soil for septic germs should they chance to gain an entrance. When the bruise is not severe and no hemorrhage results, rest and the application of warm fomentations will soon restore normal conditions.

Sprains are more serious. A forcible twist of a joint, as when a person "turns his ankle," is liable to cause more or less laceration of the tissues. The ligaments may be stretched or torn across, and may detach a thin scale from the bone, the synovial membrane may be rent, the muscles may be lacerated or overstretched, and their tendons thrown out of their grooves. In severe sprains the bones themselves are wrenched asunder, but slip back into place. Between a sprain of this kind and a dislocation the only difference is that in the one case the bones return to their normal position, while in the other they remain dislocated. It is a common saying that a bad sprain is worse than a fracture, and to a certain extent this is true. If much laceration of tissues occur and the most careful treatment be not employed, permanent weakness of the joint may result.

The *symptoms* of sprain are—

(1) Severe pain following a forcible twist or wrench of a joint. Sprains occur, as a rule, when the muscles are, so to speak, taken off their guard, and the same is true of dislocations. If the muscles were prepared for the strain and thrown into strong resisting contraction, it is doubtful whether sprains or dislocations would ever occur. The pain is of a severe and sickening character. The patient becomes deathly pale, nauseated, and perhaps falls fainting to the ground. As the more intense pain passes off a feeling of numbness succeeds, with a dull aching due to pressure on the nerves. Movement of the limb causes unbearable pain. There can usually be felt one or more spots which are intensely tender to pressure. These correspond to the lacerated ligaments.

(2) Swelling sets in almost immediately, particularly if there be rupture of vessels in or about the joint. When the swelling is due to inflammatory exudation, it is longer delayed, and may not be observed until the end of twenty-four or forty-eight hours.

(3) Discoloration of the skin follows the injury, varying in hue from a greenish-yellow to black, and if there be much extravasation of blood, the tissues about the joint may be filled with it.

Errors in Diagnosis.—Sprains may be mistaken for dislocation, for fractures near joints, or in the case of the ankle for talipes valgus.

Differential Diagnosis between Sprain and Dislocation.

SPRAIN.	DISLOCATION.
Deformity.	
Only the result of swelling.	Great deformity, and bones felt in abnormal position.
Pain.	
Pain of a peculiar sickening character, afterward numbness, relieved by pressure and rest.	Severe pain, even when at rest, not relieved until reduced.
Mobility.	
Normal mobility, except as impaired by swelling and pain.	Want of normal mobility, both in direction and degree.

Fracture of the lower end of the fibula is often difficult to distinguish from a severe sprain of the ankle. The diagnosis can be settled by finding the characteristic deformity of this fracture and a particularly tender spot over the fibula by digital pressure.

Spurious talipes valgus (flat-foot) need not cause any difficulty, as in this case there is a history of a gradual and prolonged debility, and not a sudden wrench as in sprain.

Treatment.—In mild cases cold applied immediately after the injury will tend to prevent swelling and effusion into the joint by constricting the blood-vessels. If seen several hours after the accident, hot fomentations generally afford most relief. Perfect rest in the elevated position is of the greatest importance, and will relieve pain better than liniments or lotions. Of all appliances, a flannel or an elastic bandage applied over a thin sheeting of absorbent cotton gives the greatest support and relief to the joint. In the case of the ankle care should be taken to fill in the hollows around the malleoli with cotton before applying the

bandage. When there is much laceration of ligaments the joint should not be used until perfect repair shall have taken place, otherwise there is a risk of permanent weakness. In cases of ordinary severity it is sufficient for the patient to lay up for a few days, and then, with the joint firmly bandaged, he can move about on crutches in the case of a sprained ankle or knee, or with the arm in a sling when the wrist or elbow is the injured joint.

Massage is of great value in protracted cases, or even in the early stages when the acute inflammation has subsided. It can be employed as follows: Raise the limb and relax the muscles. Begin with very light movements, commencing above the joint, where there is still no swelling, and working downward to the articulation. The direction of the movements must always be toward the trunk, using the thumbs, the pulp of the fingers, or the palm of the hand according to the part of the limb that is being manipulated. The tender spots are the last to be touched. Swelling by this means gradually subsides, and as the circulation improves absorption rapidly takes place. Attention is next paid to the parts where extravasation is greatest, and by the thumbs or fingers these spaces are rubbed, moving in small circles upon the skin, and gradually increasing the pressure as the structures can tolerate the operation. Passive motion of the joint can be combined with these movements, for even in the case of ruptured ligaments a considerable degree of motion can be effected without throwing the ligaments into a state of tension.

Wounds of Joints.—Wounds of joints must always be looked upon as serious injuries. They are common among artisans, such as ship-carpenters, who work with edged tools. As gunshot injuries they are common, and they also occur as complications of dislocations and fractures. Even in non-penetrating wounds of joints the injury is a serious one, for if the wound be allowed to suppurate the cavity of the joint may be opened into and become the seat of serious mischief. Large wounds, laying open to view the articulating surfaces of the joint, are self-evident and easily diagnosed. In perforating wounds, however, it is not always easy to prove that the joint has been cut into. The most important sign is the escape of the synovial fluid more or less mixed with blood. It can be readily recognized by its viscidity when a drop of it is examined between the thumb and finger. If the amount of this fluid is large, it may be regarded as pathognomonic of a wound of a joint. It may happen that a small bursa is opened into which does not communicate with the articulation, but in this case the amount of fluid is small, and it ceases to come away after the first gush, while in the case of the true synovia it can be made to ooze out on flexion and extension of the joint. When no synovial fluid escapes, the rapid filling of the joint with blood would be strong evidence of a penetrating wound.

Treatment.—Provided the wound is made by an aseptic instrument and no infection is allowed to gain access to the joint, these wounds are free from danger. An incision in the synovial membrane or in any other of the joint-structures, if kept thoroughly aseptic, will heal as readily as in any other tissues. The danger lies in the ease with which septic germs gain an entrance, and in the difficulty of keeping the

wound thoroughly drained. Asepsis here is everything in treatment.

Before touching the wound itself the skin for a considerable distance around should be thoroughly washed with soap and water, and afterward with either alcohol or turpentine, and lastly with corrosive-sublimate solution. The limb should be wrapped with sterilized towels. After cleansing the wound from all clots and impurities, the finger, scrupulously clean, assisted, if need be, by a probe, should explore the wound. It is often necessary to enlarge the wound in order that pieces of clothing carried in by the bullet or penetrating object and all particles of bone can be effectually removed. After thoroughly irrigating the joint with sterilized water a drainage-tube is inserted, passing through the joint from side to side if necessary. A full antiseptic dressing and immobilization of the limb on a splint complete the operation. Should the joint become septic, the wound and every sinus about it must be opened up, washed out, and drained, and the process repeated as often as necessary. In gunshot wounds, which form a very dangerous class of these cases, the bones are often so destroyed as to require the removal of a considerable part of their articular ends. It is better to make an atypical resection rather than the typical operation, in order to leave the joint as little impaired as possible. Such cases are apt to result in bony ankylosis.

Treves strongly advocates constant irrigation of the joint night and day to avoid the retention within the cavity of septic and decomposing materials, and excellent results have been obtained in very unpromising cases.

When thorough drainage can be maintained there is little likelihood of great tension in the joint. Should this occur, the fluid must be got rid of by free openings and extra drainage-tubes. When there is danger of ankylosis resulting the limb should be kept in the position which will be most useful to the patient in the event of a stiff joint.

Dislocations.—When one of the bones entering into the formation of a joint is permanently displaced from its normal relations with the other bones, it is said to be dislocated. In sprains a temporary displacement may take place, the bones immediately returning to their normal relations.

Dislocations are classified as *traumatic* when the result of violence; *pathological* when the bones have become displaced owing to destructive changes in the joint, as, for instance, in disease of the hip or knee; *congenital* when occurring *in utero* and as a result of non-development; *complete* when the articular surfaces are entirely separated or only touch each other at their edges; *incomplete*, or *subluxations or partial*, when the surfaces are not completely separated. For every ten cases of fractures you meet with, you may expect one of dislocation. Dislocations occur at any time of life, but the most common period is between twenty and thirty years of age.

The *causes* of dislocation are predisposing and immediate. Some people are naturally loose-jointed; their ligaments are lax; the area of contact between the articular surfaces is small; and, altogether, the joints have not the normal power of resistance. A joint distended with fluid is thereby predisposed to dislocation. The immediate causes

may be summed up in a few words—external violence and muscular action.

In examining a patient for dislocation, always strip the suspected joint of all clothing, and also its fellow on the opposite side of the body, which will serve for purposes of comparison. Four features must be kept in mind, and, as a rule, these four will settle the question. They are—Loss of symmetry; want of normal mobility; change in direction of the axis of the dislocated bone; constant pain, relieved only by reduction.

In certain forms of dislocation the end of the displaced bone can be felt in its abnormal position. A systematic manner of making the examination would be the following:

(*a*) *History.*—Falls are common causes of the accident. A fall upon the shoulder is likely to dislocate the upper end of the humerus or fracture the clavicle. A fall upon the outstretched hand will dislocate the elbow of a child, but fracture the humerus of an adult.

(*b*) *Inspection.*—A glance may decide the change in outline and show an unmistakable displacement of the bones. The eye may be assisted by measurements, as in dislocation of the hip, where shortening or lengthening of the limb affords important evidence. The head of the humerus in the axilla may press upon the veins and cause edema of the arm.

(*c*) *Palpation.*—The finger can be placed over the bony prominences and their position determined, as in the case of the condyles of the humerus and the olecranon at the elbow. Motion, both active and passive, must be tested. Voluntary movements are always restricted, and may be entirely lost. Passive motion cannot, as a rule, be tested until the patient has been placed under an anesthetic. When superficial palpation affords no satisfactory evidence deep pressure will frequently do so.

Should these methods fail to satisfy the surgeon, he can gain much additional evidence by placing the patient under an anesthetic. Motion, which was before restricted on account of pain, can now be freely tested, and any want of normal mobility accurately determined. Great care must be taken to exclude fractures in the neighborhood of the joint, severe sprains, and separation of the epiphyses. Crepitus is pathognomonic of fracture, but in some cases it is wanting. It may be present in dislocations, owing to the fact that a dislocation and fracture may exist together. A dull rubbing sound, due to the movement of a dislocated bone on tendons or fascia, must not be mistaken for crepitus.

In obscure cases, and especially when dislocation and fracture are combined, the *x*-rays may settle the diagnosis in a most satisfactory manner (see chapter on "The Röntgen Rays in Diagnosis").

When we consider the structure of a joint, it is not difficult to understand what takes place when dislocation occurs. One or more of the ligaments must be torn: rarely does stretching alone occur. The pain of dislocation is produced by two factors—viz. the violence to the ligaments and the pressure of the head of the bone in its new position. The capsule of the joint also suffers, and it is quite common to have this membrane torn. In joints of the ball-and-socket variety

the bone is pushed through a rent in the capsule, and in some cases affords no little trouble to get it back through the opening which it has made. The muscles also suffer, for they not infrequently are overstretched, lacerated, or torn from their attachments, perhaps bringing away a scale of bone with them. The bones themselves do not always escape. At the shoulder-joint the dislocated head of the humerus often breaks off a piece of the rim of the glenoid cavity; the head of the femur may detach a part of the lip of the acetabulum; the coronoid process of the ulna may be carried away in backward dislocation of the elbow.

Complications may give no end of trouble. Fracture and dislocation combined are found at the shoulder, the elbow, the hip, and in fact may occur at any joint. The displaced bone may compress arteries, veins, nerves, and neighboring organs; the bruising and tearing of soft parts may add to the seriousness of the injury, and the bone may be driven through the skin, thus forming a compound dislocation. In view of these conditions it is most important that a dislocation be reduced at the earliest possible moment. Pain, which continues as long as the part remains overstretched, will cease almost as soon as the bone is replaced; the displacement, when once rectified, has no tendency to return; the rent in the capsule speedily heals and the normal condition of things is restored. The only conditions which warrant delay in reducing a dislocation are great swelling and inflammation in and about the joint, also profound shock from associated injuries. While I mention the existence of swelling and inflammation as a reason for delay, I would also urge that when it is possible reduction is the very best means of getting rid of these conditions. Shock is important as prohibiting the use of anesthetics or painful manipulation.

Treatment.—Two difficulties confront us in reducing a dislocation: The bone may not readily come back through the rent which it has made in the capsule or it may become locked against another bone or be caught in a ligament, tendon, or dense fascia. The other obstacle is the contraction of the muscles which pass over the joint. Immediately after a dislocation the muscles become relaxed, but after a time they regain their contractility and become rigidly contracted. This action tends to push the ends of the bones farther and farther past each other, and greatly increases the difficulty of bringing them back to position. To overcome this, steady traction must be made upon the muscles until by sheer fatigue they become relaxed. Under an anesthetic relaxation is immediate and complete.

Two methods of reduction are in vogue:

1. *Extension and Counter-extension.*—By this method steady traction is made until the muscles relax or perhaps become torn, and the bone by sheer force is freed from its unnatural position, when with a snap the muscles draw it into its proper place. A good example of this method is seen in the case of the shoulder-joint, where, by placing the heel in the axilla to steady the trunk, traction is made upon the arm, and the bone slips back with a dull sound into the glenoid cavity. The older surgeons were in the habit of reducing luxations of the hip by means of pulleys and cords, which, adding immensely to the power, caused something to give way. We seldom see mechanical appliances of this

description now, for in the second method we have something more rational and scientific, and at the same time generally applicable.

2. *Manipulation.*—This is adapted to the ball-and-socket joints, the articulations which are most complicated and likely to give most trouble. The procedure aims to relax the muscles, and then by suitable movements to free the head of the bone from its entanglements, bring it back through the rent in the capsule, and finally into its normal position. These manipulations will be described under Special Dislocations. The after-treatment of dislocations is the same as that of sprains. Little is needed in the way of retentive apparatus, for there is but slight tendency to recurrence. At the same time, the joint should be kept at rest to allow the torn structures to heal and to regain their normal firmness and strength. Inflammation is seldom a source of trouble, but should it take place cold applications or evaporating lotions are generally all that are demanded. Care must be taken not to keep the joint too long at rest, for adhesions may result which will impair its movements. Passive motion, cautiously carried out, may be begun by the end of the first week, and massage, as in the case of sprains, will be found a valuable adjunct.

Old dislocations are difficult to deal with. Changes in the structures take place which, after a time, render reduction a physical impossibility. The muscles become fibrous, and are liable to rupture before they can be stretched to their former length. The head of the bone in its new position becomes surrounded with fibrous tissue, forming a new socket. Over the normal socket, as at the acetabulum or glenoid fossa, the capsule is stretched and may become firmly attached, so that the bone cannot be brought back to position. Still, it sometimes happens that good results are attained even after long periods of luxation. In a boy ten years of age the writer reduced a dislocation of the femur into the obturator foramen after an interval of fifty-six days, in another after twelve weeks, both by manipulation; and in a dislocation of the lower jaw after a period of six months.

In the treatment of old luxations the same methods as are suitable for recent dislocations may be tried. Much greater force will, however, be necessary to break up the adhesions that have formed and to stretch the muscles to their former length. It is difficult to judge of the amount of force that it is safe to employ in cases of this kind. A moderate amount of traction will be of no avail, and too much may lead to serious consequences. The neck of the humerus or of the femur may be broken, vessels may be torn across, and even when every obstacle has given way and the bone is brought to its original position, the last state may be worse than the first. As a guide in the management of such cases the following directions may be useful: Always put the patient under an anesthetic. Break up the adhesions by manipulation and rotation, and avoid any leverage which is apt to fracture the bone. Wrap the limb in a wet towel to prevent injury to the skin. If manipulation fail, try the pulleys. Traction must be slow and steady, and sudden jerks avoided. While this is being done the surgeon, by direct manipulation, follows the head of the bone, and as soon as it is brought down endeavors to force it into its socket.

Compound dislocations must be treated on much the same prin-

ciples as compound fractures. We have here the serious complication of a wound into the joint, and the danger of infection by septic germs, and consequently suppurative arthritis. It will often be a nice point to decide whether the proper course is to amputate or to attempt to save the limb. The amount of laceration and destruction of tissue, the interference with vascular supply, and the probability of securing a useful limb will have to enter into the calculation. At the knee the displaced bone may press upon the popliteal vessels so as to rupture their inner coats, while the outer are left intact. While the absence of hemorrhage would lead us to suppose that the vessels were uninjured, their giving way at a later period will lead to the most serious results.

When the conditions seem favorable for saving the joint the greatest care must be taken in the dressing of the wound. Fragments of bone must be removed, the joint freed from all contamination, such as dirt or clothing, and thoroughly irrigated. Reduction is generally easy. The wound should be dressed in the usual manner and the limb immobilized by a splint. Thorough drainage is of the utmost consequence. When operative interference is demanded the choice will rest between excision of the joint and amputation of the limb.

Diagnosis of Special Dislocations.

The Lower Jaw (Fig. 46).—There is only one direction in which the lower jaw can be dislocated, and that is forward. One side may be displaced (unilateral dislocation), or both sides (bilateral). The injury is easily recognized. The causes are muscular action and indirect violence. The accident always happens when the mouth is open. The patient presents a peculiar appearance when the dislocation is bilateral. The mouth is widely open and speech is difficult. The labials he cannot pronounce at all. He holds his hand against the jaw to prevent further displacement, and saliva dribbles from his mouth. Place your fingers at the angle of the jaw, and you will find in front of the ear a depression instead of the natural prominence caused by the condyle. In front of this there is a prominence due to the new position of the bone and to the contraction of some of the fibers of the masseter muscle. The jaw can be moved downward to a slight degree, but this is all. Pain is severe, owing to stretching of the parts, except it be a case in which the jaw has been repeatedly dislocated. When only one side of the jaw is the seat of luxation, the symptoms, although not so marked, are equally characteristic. The lower jaw appears to be pushed toward the opposite side, and therefore its teeth do not fit normally against those of the upper. The face is not much distorted, and pain is only felt at one side.



FIG. 46.—Dislocation of lower jaw.

In young persons a partial dislocation is sometimes met with in which the condyle is displaced slightly forward when the mouth is widely opened as in yawning. The patient learns to rectify the position by pressing the chin upward.

Errors in Diagnosis.—1. Congenital dislocation of the jaw has been mistaken for traumatic unilateral dislocation. In the congenital form the movements are but slightly impaired or are even normal, which is never the case in the traumatic variety. The upper teeth project beyond the under teeth. There is absence of salivation, and one side of the face is longer than the other.

2. Chronic rheumatoid arthritis is another disease which may be mistaken for dislocation. The history shows that the condition has come on slowly. It is a disease of old age, there is no salivation, and the same condition exists in other joints.

Treatment.—The patient, seated in a chair, has his head supported by an assistant. Protect your thumbs by folds of a clean handkerchief, and, placing one over the molar teeth on each side, press steadily downward, while the fingers at the same time tilt the chin upward. The thumbs should be placed as far back as possible. When great difficulty is experienced, as in old dislocations, one side can be reduced first, and the other afterward, care being taken lest the first be again displaced while the second is being reduced. In very obstinate cases, although these are uncommon, great force has to be employed. A wedge of cork or wood may be placed between the molar teeth and the chin drawn upward with strong force; or a tourniquet may be placed over the head and under the chin, and screwed slowly and steadily up until the jaw is brought into place. A powerful pair of forceps may be introduced between the last molar teeth and their blades separated forcibly. In some cases, direct pressure, made backward upon the coronoid process, will prove successful. It rarely happens that this process becomes entangled in the fibers of the temporal muscle. When this occurs depress the chin before attempting to elevate it.

Examination of Injuries about the Clavicle and Shoulder.—The most convenient position for the examination of injuries about the shoulder is to have the patient seated upon a stool or chair with his back toward you. Place your fore fingers in the suprasternal notch and pass them outward. You can in this way easily decide whether the ends of the clavicle are in position. The clavicles are subcutaneous, and by passing the fingers along their upper borders any irregularity in their shape will decide the existence of fracture. From the outer end of the clavicle the finger can be run along each acromion process and spine of the scapula to the posterior border of this bone. Note any tender spot or any irregularity in the bone. Next take the shoulder, and, placing the hands flat, with a thumb upon each acromion process, note whether the head of the humerus can be plainly felt beneath the hand. Press upon the deltoid muscle and feel for the glenoid fossa of the scapula. If the glenoid fossa can be felt, it is proof of dislocation of the humerus, and then the head of the bone must be sought for. It will be found in one of three locations—under the glenoid fossa, under the clavicle, or under the spine of the scapula. When you have found the head of the humerus rotate the bone

gently by grasping the elbow, and notice whether or not the head moves with the rest of the bone. If there be fracture, crepitus can be felt.

Next examine the coracoid process. There is a groove between the pectoralis major and deltoid which allows you to feel it without much difficulty. Into this groove press the points of your fingers and find the process. Observe whether it is movable or whether pressure upon it causes pain or crepitus. From this point the fingers can be passed around the shoulders to note any difference in contour on the two sides.

To examine the axilla raise the arm gently from the side, and with the fingers in the axilla feel for the head of the humerus and note any undue prominence, always comparing the uninjured with the injured side.

To examine the scapula, place the forearm of the patient behind his back, which throws the lower angle of the scapula out from the chest-wall. The margins of the bone can be followed with the fingers, the inferior angle grasped, and crepitus or mobility noted. Up to this point your examination has been made with the patient's back toward you; now stand in front of him. Have him hold both arms alike, and note any difference in their outlines. Look for any angularity in the arm or forearm which would indicate fracture, or for undue projection of the point of the elbow which would be evidence of dislocation.

We continue the examination by following the shaft of the humerus. Place a thumb on the inner side of the surgical neck of each bone, and with the fingers grasp the outer side; in this way the hand can be run down along the bone to the elbow in search of any projecting fragments or other deformity. Should any such be found, grasp the arm above the suspected spot with one hand and with the other rotate the elbow for crepitus.

To Examine the Elbow.—Still standing in front of the patient, take his elbows into the palms of your hands, with your fore finger resting on the tip of the olecranon, the thumb on the outer epicondyle, and the middle finger on the inner epicondyle of the humerus. In the normal condition of the joint these three bony points are in line. Any deviation from this should be noted. Look for a gap in the olecranon which would indicate fracture, or for the sigmoid notch of the ulna which would point to dislocation. Now move the joint and observe whether its action is free and painless. Place the thumb of your left hand just below the outer condyle, and with the right rotate the patient's wrist; the head of the radius will be felt rolling beneath the thumb. Should this movement be painful, you may suspect fracture; the existence of crepitus will leave no doubt. Grasp each epicondyle in its turn, and attempt to move it upon the rest of the bone, and note the power of the patient to pronate and supinate the forearm. The olecranon is subcutaneous, and the fingers can be run along it in search of fracture. Usually a large gap into which the end of one or more fingers can be placed will be found when this process is fractured. To complete the search follow the tendon of the triceps down to its insertion into the ulna.

Dislocation of the Clavicle.—The dislocations of the clavicle are seven in number—three at the sternal end, three at the acromial

end, and one of both ends simultaneously. At the sternal end the accident is rare, owing to the great mobility of the shoulder, which prevents any severe strain upon the sterno-clavicular joint, except when the force is acting upon the clavicle directly. We have here an illustration of the rule that when it comes to a test between ligaments and bone the bone has to yield. A force acting upon the clavicle will almost surely break the bone before it can be torn from its attachments to the sternum. When dislocation takes place it is in one of three directions—viz. forward, backward, or upward.

Forward dislocation is the most common. The bone can be readily felt as a prominence in front of the sternum, while an examination of the suprasternal notch will show its absence from the normal position. The portion of the sterno-mastoid muscle which is attached to the clavicle is put upon the stretch, and throws the patient's head downward and forward; movement of the shoulders forward is attended with severe pain.

Backward dislocation is also easily recognized by a depression at the normal position of the end of the bone. Very disagreeable symptoms are produced if the bone is sufficiently displaced to cause pressure upon the esophagus or trachea, in the one case causing dysphagia, in the other dyspnea.

Upward dislocation is the rarest of the three forms, and is really a variety of the backward dislocation, for the bone is always displaced backward as well as upward. The bone fills up the suprasternal notch and lies between the sternal portion of the sterno-mastoid and the sterno-hyoid muscles.

The most important of these three is the backward dislocation, for very prompt action may be required to save the patient's life when the trachea is pressed upon by the displaced bone.

Treatment.—One method of reduction serves for all of these forms of dislocation. Seat the patient upon a low stool with his back toward you. Place his elbows close to the sides and a little in front of the median lateral line. Then with your knee against his spine and between his scapulæ grasp the shoulders and bring them backward. If the bone does not slip into position at once, direct manipulation can be employed to aid in the reduction. When these measures fail, place a large pad in the axilla, and, using the arm as a lever, press the elbow in toward the side.

Reduction, however, is the smallest part of the treatment; the difficulty is to keep the bone in position after it has been replaced. This can be readily understood when we recollect that the articular surfaces are flat and smooth, the ligaments are usually ruptured, while even the unavoidable movements of respiration are sufficient to disturb the joint.

In *forward* dislocation a double figure-of-8 bandage is probably the best appliance. A firm pad or a well-padded splint is placed between the shoulders and the bandage passed over each alternately to bring the shoulders back as far as possible. Velpeau's method is the best for dislocation *backward* or *backward* and *upward*. It consists in placing a pad in the axilla and in drawing the elbow forward and upward across the chest, so that the hand of the affected side can be placed upon the opposite shoulder. The elbow, forearm, and hand are

then flexed firmly in position by strips of adhesive plaster. In all cases it is necessary to place over the end of the bone a pad covered with adhesive plaster to keep it from slipping, and hold it in position by a roller bandage. It is absolutely necessary to keep the arm rigidly immobilized for at least three weeks, after which the bandage may be to a certain extent relaxed, but no movement should be allowed for three or four weeks longer.

Dislocation of the Acromial End (Fig. 47).—The cause is usually a fall or a blow upon the shoulder. The direction is commonly upward or upward and outward, so that the end of the clavicle is carried over the end of the acromion process. Reduction is very easily effected by pressing the arm upward and backward, when the end of the clavicle can be replaced by direct manipulation. Should crepitus be felt during this movement, it may be set down as due to a fracture of the edge of the articulation. Should there be any doubt about the outer end of the clavicle itself being broken, measurement of the bone and comparison with its fellow of the sound side will settle the question. It is exceedingly difficult to keep the bone in position after reduction. The best method is probably that recommended by Stimson. Take a piece of strong adhesive plaster three inches wide, and, applying the middle of it to the point of the elbow flexed to a right angle, bring the ends up over the end of the clavicle before and behind the arm, and allow one to overlap the other on the shoulder. The forearm is carried in a sling, and the arm bound to the side by a broad bandage passing round the body.

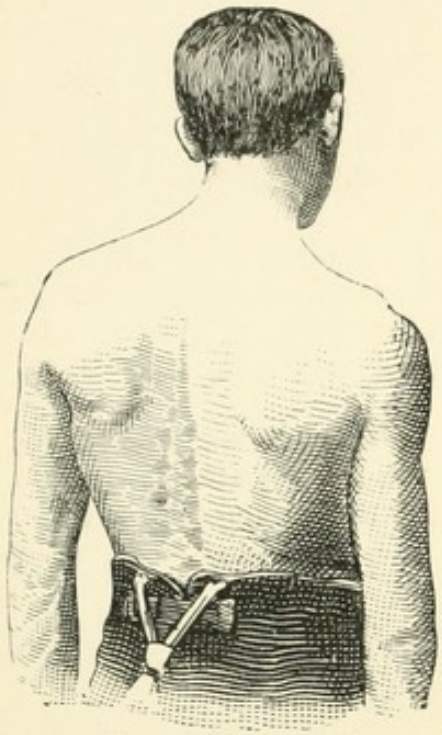


FIG. 47.—Upward dislocation of acromial end of right clavicle (Keen and White).

Dislocation of the Sternum.—It is difficult to distinguish this injury from fracture. It is generally associated with fracture or dislocation of the ribs or the costal cartilages. When uncomplicated dislocation takes place, it is either the manubrium dislocated from the body or the ensiform cartilage from the body.

Diagnosis is not usually difficult. The bone being subcutaneous, a change in its outline can be felt. The junction of the manubrium with the body corresponds with the end of the second costal cartilage. This relation will be found to have been disturbed in dislocation.

Reduction is effected by requiring the patient to draw a deep breath while the fragments are directly pressed into position. Should this fail, forcible flexion of the trunk backward will prove a valuable aid. Many cases have remained unreduced and little or no inconvenience resulted.

The ensiform cartilage may be dislocated, so that its point is directed forward or backward. It causes no great inconvenience as a rule,

although vomiting has been attributed to a backward displacement. When the symptoms are severe enough to warrant interference, reduction can be effected by drawing the cartilage forward by the fingers or by a sharp hook inserted through the skin.

Dislocation at the Shoulder.—In a joint so freely movable and so exposed to violence it is not surprising that dislocations at the shoulder occur as frequently as all other dislocations combined. The glenoid cavity is shallow, and the head of the humerus finds no such deep socket to rest in as the head of the femur finds in the acetabulum. The capsule is weak, loose, and easily torn. The joint is dependent upon muscles and tendons for its support, while the great length of the humerus affords a powerful leverage which can force the joint asunder without difficulty. The aspect of the glenoid fossa is forward and outward. The head of the humerus can be displaced from it in three directions—viz. forward, backward, and downward, very rarely upward.

Forward Dislocations.—Two varieties of this form are recognized:

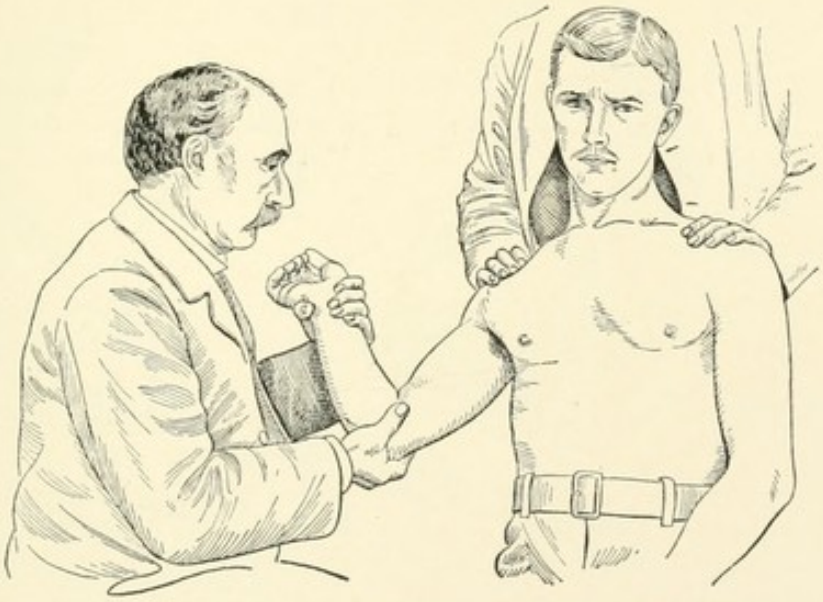


FIG. 48.—Kocher's method of reducing dislocation of shoulder: first movement, abduction and external rotation.

1. Subcoracoid, when the bone has little more than slipped off the glenoid fossa and lies under the coracoid process.

2. Subclavicular, when the head of the humerus has travelled farther forward and lies beneath the clavicle. Some authors give a third variety, when the head of the bone lies a little farther inward than the coracoid, and call it *intracoracoid.*

Of the three varieties the subcoracoid is the most common. The bone lies about a finger's breadth below the coracoid process. The inner and lower portion of the capsule is torn along the edge of the glenoid fossa. Some of the muscles about the joint may be torn, such as the subscapularis, the supraspinatus, the infraspinatus, and the teres minor. Injury to the bones themselves is not uncommon. The greater tuberosity may be torn off, or the head of the humerus may be bruised by forcible contact with the edge of the glenoid fossa.

Symptoms.—Following the method of examination already outlined, we observe—

1. *Change of Contour.*—The deltoid is flattened, and the normal fulness of the shoulder on its anterior and outer aspect is lost. The injured elbow hangs at a little distance from the side. The axis of the humerus passes a little in front of the glenoid fossa. The anterior fold of the axilla is lowered.

2. *Abnormal Position of Bony Prominences.*—Instead of the normal bony resistance below the front and outside of the acromion, a depression is felt, while a well-marked prominence is felt farther forward and below the coracoid process. Press upon this prominence with your fingers and you will find that it rotates with the arm.

3. *Impaired Mobility.*—Active movement is painful and perhaps impossible. Passive movement is greatly limited. The arm can be abducted, but cannot be so far adducted as to allow the hand to be

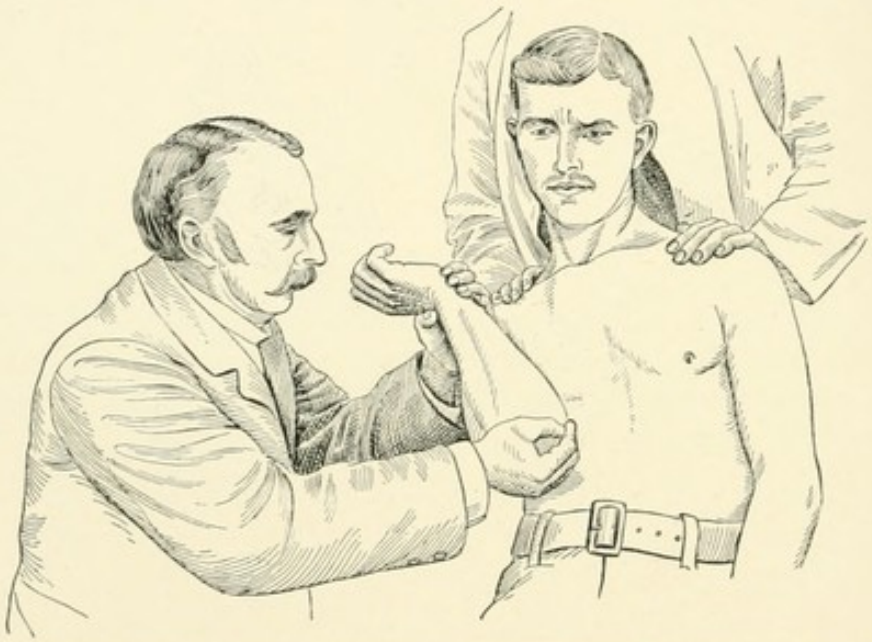


FIG. 49.—Kocher's method: second movement, advancement of elbow forward, upward, and inward, still maintaining external rotation.

placed upon the opposite shoulder or the elbow against the front of the chest. When measurement is desired, both arms should be placed in exactly the same position and the tape stretched from the tip of the acromion process to the olecranon.

When the dislocation is farther forward the symptoms are the same, except that the elbow is farther from the side, and the head of the humerus is felt in its new position—viz. intracoracoid, or subclavicular.

Treatment.—1. *Manipulation.*—Kocher's method (Figs. 48, 49, 50) of manipulation is the best. Flex the elbow to a right angle and press it closely to the side. Make external rotation—*i. e.* turn the forearm as far as possible away from the chest, when the head of the humerus will roll outward in front of and below the acromion. Keep up the external rotation, carry the elbow well forward and upward, rotate the arm inward, and lower the elbow. This movement may be aided by an assistant's directly manipulating the head of the bone in the later

steps, or by the use of a band in the axilla to draw the head of the humerus outward.

2. *Extension and Counter-extension.*—An old method of reducing all forms of dislocation of the shoulder was to have the patient placed on a table, couch, or the floor, when the surgeon, removing his boot

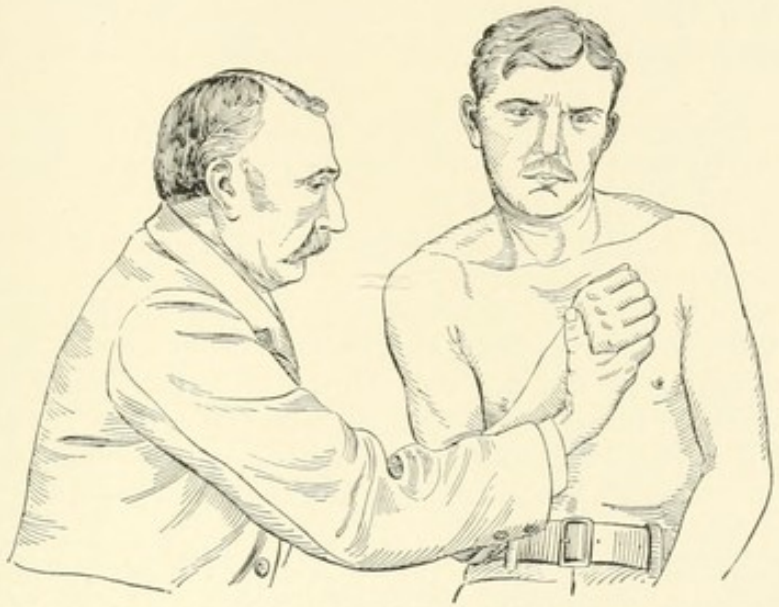


FIG. 50.—Kocher's method : rotation inward, the hand being carried toward the opposite shoulder.

and sitting beside the thigh of the patient, placed his heel in the axilla, to make counter-extension, while, grasping the wrist of the affected limb, he steadily drew upon it until the bone slipped into position. While this method is applicable to all dislocations of the shoulder, it



FIG. 51.—Reduction of dislocation of humerus.

is not without its disadvantages. Rupture of the axillary vessels has more than once occurred. It should never be resorted to in the aged or in those whose arteries are diseased. When traction has to be employed it is better to make it in a direction at right angles to the

body. Place a folded sheet around the chest and have an assistant hold it firmly on the sound side. Then, grasping the injured limb by the forearm and elbow, draw directly outward, while the assistant makes counter-extension by the sheet (Fig. 51). Or, while the patient is lying down, make traction on the arm until the muscles are overcome; then, using the clenched fist of your disengaged hand as a fulcrum, bring the arm forcibly in toward the chest.

Backward Dislocation.—Two dislocations backward are recognized:

1. Subacromial, when the head of the humerus lies below the acromion and its anatomical neck rests against the edge of the glenoid fossa. This is not very common.

2. Subspinous, when the bone goes a little farther, resting below the spine of the scapula.

Symptoms.—The want of symmetry will be shown by a loss of fulness of the shoulder in front and an increase behind. The head of the bone is generally felt without difficulty, lying behind the glenoid fossa. The elbow lies close to the side and the arm is rotated inward. The coracoid and the anterior edge of the acromion stand out with unnatural prominence. Voluntary motion is lost; passive motion is painful and restricted.

Downward Dislocation.—This form is rare, but when it does occur the symptoms are very characteristic (Fig. 52). The accident occurs

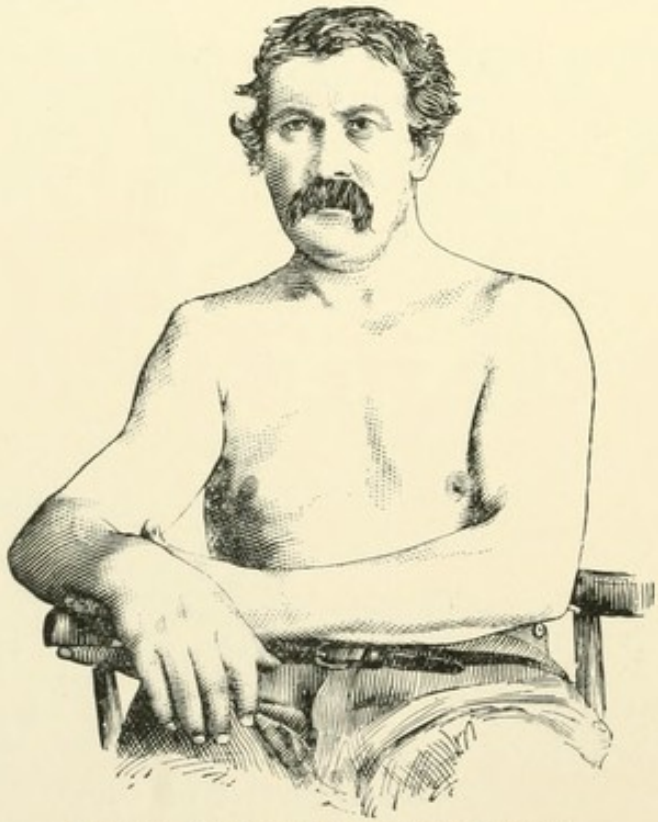


FIG. 52.—Subglenoid dislocation (Stimson).

when the arm is abducted with sufficient force to tear the capsule, with rotation or direct force downward, so that the head of the humerus slips below the glenoid cavity. Sometimes the head of the bone is

directly below the glenoid, but most commonly it is below and a little in front. The name subglenoid is given to both of these varieties. In rare cases the bone has slipped below the glenoid cavity with the arm placed upward and close to the side of the head. This variety has been called *luxatio erecta.*

The *symptoms* of subglenoid dislocation are very similar to those of the subcoracoid, only more pronounced. A striking feature is the marked angularity given to the shoulder by the prominence of the acromion.

Treatment.—As the bone lies upon or close to the axillary vessels, great care must be taken lest these be injured. Complete relaxation of the muscles must be secured under chloroform. Traction can then be made in moderate abduction, while, at the same time, the bone can be helped back into position by direct manipulation.

Upward dislocation is a curiosity. Several cases have been reported. One of these occurred during an epileptic convulsion. Another was produced by a blow upon the acromion while the arm was raised. A fall upon the elbow caused the third. The recognition of the head of the bone in its unnatural position is not difficult. Both active and passive motions are restricted. The elbow is directed backward to a slight degree and the arm lies close to the side.

Errors in diagnosis are liable to occur by mistaking a dislocation for—

1. Fracture of the neck of the scapula;
2. Fracture of the surgical neck of the humerus;
3. Separation of the greater tuberosity of the humerus;
4. Fracture at the anatomical neck.

In all of these the elbow can be made to *touch the side*, while in dislocation it cannot. Crepitus is also an unfailing guide in nearly all. Separation of the greater tuberosity will prove the most puzzling, and the point will be to decide between it and subspinous dislocation. In both cases a tumor will be felt upon the scapula. It is either the detached tuberosity or the head of the humerus. In the one case it rotates with the humerus (dislocation); in the other it is small and is not affected by rotation.

Dislocations at the Elbow.—This joint, being made up of three bones with the two prominences of the ulna, is subject to a great variety of dislocations. To avoid unnecessary complications I shall classify them as follows:

1. *Common Dislocations.*—(*a*) Dislocation of the radius and ulna together backward and diagonally backward and outward; (*b*) Dislocation of the radius separately.

2. *Rare Dislocations.*—(*a*) Dislocation of both bones forward, outward, or inward; (*b*) Dislocation of the ulna alone; (*c*) Dislocation of both bones separately, the one being driven forward, the other backward.

Dislocation of both Radius and Ulna.—*Examination.*—Place the patient upon a chair and stand in front of him. Grasp the two elbows in the palms of your hands, and place your thumbs on the external epicondyles, the middle fingers on the internal epicondyles, and the tips of the fore fingers on the tips of the olecranon processes. When the joint is extended these three points should form a line transversely to

the axis of the arm. When the elbow is bent the tip of the olecranon sinks below the epicondyles. Any disturbance of these relations will indicate that something is wrong with the joint—either dislocation or fracture.

Backward Dislocation of Both Bones (Fig. 53).—In this case the olecranon is carried far back, and the distance between it and the epicondyles is increased. The head of the radius is felt at the back of the outer condyle. The greater sigmoid notch of the ulna can be felt at the back of the joint, and the tendon of the triceps stands out prominently. Passive flexion and extension are greatly restricted. There is usually considerable swelling and pain.



FIG. 53.—Dislocation of the elbow backward (Stimson).

Treatment.—While an assistant holds the lower end of the humerus, and at the same time pushes it slightly backward, make traction upon the forearm in the extended position. This is generally sufficient to overcome the action of the muscles and to bring the coronoid process of the ulna in front of the humerus, where it belongs. A time-honored plan, often spoken of as Sir Astley Cooper's method, is to place your knee on the bend of the elbow, and, grasping the wrist, flex the joint strongly over the knee as a fulcrum. If any difficulty is experienced in either of these methods, the patient should be anesthetized.

After reduction the limb should be immobilized for about three weeks. During this time massage will be found useful, but passive motion is unnecessary, and may even prove harmful. Any stiffness of the joint which remains after removing the splints rapidly disappears under exercise of the limb.

Compound dislocation at the elbow is a serious matter. When there is much injury to the end of one or more of the bones, the destroyed portions must be removed as an atypical resection; otherwise reduction should be effected, thorough drainage established, and the principles carried out which are applicable to wounds of joints.

Forward Dislocation of Both Bones.—This accident is always the result of great violence, and the injury is almost sure to be complicated with fracture of the olecranon. In this variety the olecranon lies in front of the humerus or may find its way into the coronoid fossa. The arm is bent to nearly a right angle, and the forearm is supinated. When the normal position of the olecranon is examined, there will be found a flat, broad surface caused by the lower end of the humerus. When the olecranon is broken off, it is retained on the posterior aspect of the joint, but drawn upward by the triceps. Fortunately, this dislocation is rare.

Treatment.—The obstacle to reduction is the olecranon, which, if

not fractured, must be disengaged from the coronoid fossa and made to slip over the articular end of the humerus to its normal position. After thoroughly relaxing the muscles under an anesthetic, hold the forearm at a right angle, make extension from the wrist and counter-extension from the lower end of the humerus. When the olecranon is disengaged from the coronoid fossa make direct pressure downward upon the anterior aspect of the forearm, close to the elbow. Examine carefully, after reduction, to make sure that the head of the radius is in its proper position.

Inward Dislocation of Both Bones.—This is an incomplete dislocation. The olecranon will be found out of its normal position and toward the inner aspect of the joint. The external condyle will be more prominent, and the internal less prominent, than on the sound side. When there is not much swelling the head of the radius can be detected on the articular surface of the humerus about its middle.

Treatment.—Make extension and counter-extension in the flexed position (combined with direct pressure), gradually bringing the arm into the position of full extension.

Outward Dislocation of Both Bones.—The inner condyle of the humerus is naturally more prominent than the external, but in this accident the prominence is greatly exaggerated, while the external condyle can with difficulty be felt. The hand is pronated, and the elbow bent to an angle of about 120° (Fig. 54).

Treatment. — Extension and counter-extension with direct lateral pressure.

The very rare deformity known as *divergent dislocation*, in which the ulna and radius are dislocated separately, needs no special mention.

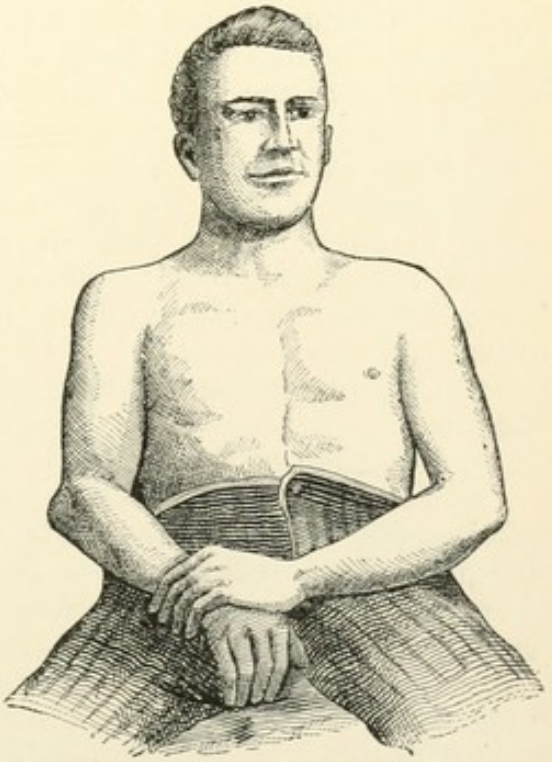


FIG. 54.—Outward (supra-epicondylar) dislocation of the elbow (Keen and White).

Dislocation of the Radius Alone.—This can take place in five directions — forward, backward, outward, inward, and downward.

Forward dislocation is recognized by finding a tumor in front of the humerus which rotates with the elbow, while a depression is found in the normal position of the head of the radius at the external condyle. Supination of the hand causes pain, while pronation is not impaired. The arm can be extended without difficulty, but flexed only to a right angle. A common complication of this injury is fracture of the shaft of the ulna.

Treatment.—In some cases reduction is difficult or even impossible, while in others it proves very simple. Extend the forearm, make

steady adduction to disengage the head of the bone, and then by direct pressure force it into its proper position.

Backward dislocation of the radius is rare. The tumor in this case is felt behind the humerus, and moves with rotation of the radius. When the ulna is fractured the tendency is for the radius to be pushed upward, the forearm at the same time being abducted. Reduction is effected by direct pressure upon the head of the radius.

Outward dislocation is exceedingly rare, and is readily diagnosed by the position of the head of the bone at the outer side of the elbow.

Inward dislocation cannot occur without displacement of the ulna as well.

Downward dislocation, an accident of young, loose-jointed children, is caused by forcibly drawing upon the hand of a child of three years of age or less. After a jerk the child cries with pain and cannot use the arm. The limb hangs by the side with the forearm slightly pronated. On examination there is tenderness over the head of the radius, and the bone may be felt to be displaced downward. It is supposed to be below the orbicular ligament.

Treatment.—Steadily supinate the arm, when a slight click will be felt and no more inconvenience will be experienced.

Dislocation of the Ulna Alone.—This is a rare accident. It cannot be displaced forward without fracture of the olecranon. When dislocated backward the marked prominence of the olecranon behind and the trochlea in front leaves no room for doubt.

Old, unreduced dislocations at the elbow are difficult to treat. If the patient is young and there has been disturbance of the periosteum at the time of the injury, new bone has probably been thrown out which forms an insuperable barrier to the movements of the joint. The displaced olecranon becomes firmly bound down by adhesions to the posterior surfaces of the humerus, and should the limb become fixed in an extended position, it is almost useless to the patient. Three courses are open to the surgeon:

1. Forcible flexion of the joint, with or without fracture of the olecranon.

2. Open arthrotomy, with division of all the tissues which prevent movement.

3. Resection of the joint.

Dislocation at the Wrist-joint.—*Examination of the Wrist and Hand.*—The bones of the wrist and hand being subcutaneous, any irregularity due to displacement or fracture is readily detected by the eye or palpated by the fingers. Run your fingers over the dorsum of the carpal, metacarpal, and phalangeal bones and note any irregularity. Grasp the extremities of each bone, and ascertain whether there be movement or crepitus.

Dislocation of the Lower End of the Ulna.—This can occur backward or forward. In either case the end of the ulna stands out prominently, can be recognized in its new position, and frequently overlaps the end of the radius.

Direct pressure is sufficient to replace the bone.

Dislocation of the carpus from the radius. This may take place in four directions—forward, backward, outward, and inward.

These deformities present no difficulties in their diagnosis. It must be borne in mind that dislocation at the wrist is very rare compared with two other injuries for which it is liable to be mistaken. These are Colles's fracture and sprain. Careful attention to the symptoms of Colles's fracture—the silver-fork appearance, the position of the styloid process of the radius, and its relation to the ulna—will leave no room for doubt. In this fracture the styloid process is below the prominence on the back of the wrist, while in dislocation of the carpus forward the bones form a rounded prominence on the front of the wrist, behind which is a sharply-defined line representing the lower end of the radius.

Of the carpal bones the semilunar is the one which is most frequently dislocated singly. The displacement is forward. Except when swelling is great the deformity is easily recognized.

Treatment consists in replacing the bone by direct pressure.

Dislocation at the Carpo-metacarpal Joints.—The most frequent and the most important of these is found at the base of the metacarpal bone of the thumb. The direction is backward, and the luxation is frequently incomplete. The head of the bone can be felt between the tendons of the extensor primi and secundi internodii pollicis. Reduction is readily effected by extension, counter-extension, and direct pressure. Immobilization should be maintained for one or two weeks, as the displacement is liable to return.

Metacarpo-phalangeal Dislocation.—This is most frequently seen in the thumb. Small and insignificant as this joint appears, the difficulty of reducing a dislocation here is often very great, owing to the interposition of the anterior ligament with the sesamoid bones.

The phalanx is generally displaced backward and overlaps the metacarpal bone. A very troublesome complication of this injury arises when the glenoid ligament is turned upward and lies between the phalanx and the metacarpal bone. This may occur during attempts at reduction.

Treatment.—Make strong extension and press the thumb downward until the anterior edge of the base of the phalanx overlaps the lower end of the metacarpal bone. Then flex the thumb, and the bone slips into its place. Sometimes the glenoid ligament and the heads of the flexor brevis form a sort of button-hole through which the end of the phalanx must be manipulated. This can be done by direct pressure combined with rotation, first to one side and then to the other.

Dislocations of the Phalanges.—These offer no difficulty in diagnosis and seldom prove obstinate in reduction. To obtain a grasp upon them various devices have been resorted to, of which the best and readiest is the clove hitch.

Dislocations at the Hip-joint.—*Examination of the Hip.*—The patient, divested of ordinary clothing, should be placed upon a table or firm mattress. In the case of females a thin night-dress or sheet covering the body need not interfere with the examination and renders the ordeal less embarrassing. See that the body lies perfectly straight, and that a line from one anterior superior spine of the ilium to the other lies at right angles to a line from the ensiform cartilage to the symphysis pubis.

1. *Inspection.*—With the spine resting its whole length upon the

table observe whether one or both knees are flexed. The knee being pressed down upon the table, observe if the spine becomes lordosed (arched forward). If this occur, it is strong evidence of disease of the joint, of psoas abscess, of sacro-iliac disease when complicated with psoas abscess, or of inflamed bursæ beneath the psoas.

Does the suspected limb lie parallel to its fellow? The thighs are normally directed inward in women, slightly so in men. If the thigh is abducted, it is evidence of the early stage of coxitis or of synovitis of the hip.

Adduction of the thigh points to dislocation on the dorsum ilii and to the later stages of joint-disease.

Observe whether the limb is rotated in or out. Eversion occurs in fracture of the neck of the femur or when the synovial cavity is distended, as in synovitis, or when there is tension of the psoas and iliacus muscles as in abscess. Inversion is evidence of dislocation or of the later stages of *morbus coxæ*.

2. *Measurement.*—The limb can be best measured from the anterior superior spine of the ilium to the external malleolus. Shortening indicates at least two of the forms of dislocation—on the dorsum ilii and into the sciatic notch. It is also a sign of fracture of the neck of the femur and of advanced hip-disease. Do not be misled by the apparent lengthening of a limb. This is due to a simple tilting of the pelvis.

3. *Mobility of the Joint.*—Grasp the knee with one hand, place the other upon the outer side of the pelvis, and put the joint through the several movements of flexion, extension, adduction, abduction, and rotation. Observe carefully whether the pelvis moves with the femur; if so, whether this is due to bony ankylosis or to rigidity of muscles, and whether the movements are attended with pain. The patient's attention should be diverted, otherwise it will be difficult to determine how much muscular rigidity is due to his fear of being hurt. When doubt on this point still remains, give an anesthetic, and if rigidity passes off you may know it was due to muscular contraction.

4. *Examination of the Bones.*—Begin with the trochanter; compare the two sides, and then, applying the palm of the hand, press inward firmly and gradually against the neck of the femur. Pain or tenderness under this test is evidence of inflammation of the neck or head of the femur. The head of the bone may be sought for on the dorsum ilii, the buttock, or near the pubis. Grasp the iliac crests and press them toward or apart from each other. Pain felt in these movements should direct attention to inflammation in the sacro-iliac joint.

Dislocations at the hip can never be intelligently studied without first having mastered two small and apparently insignificant structures that enter into the formation of the joint. One of these is the Y-ligament, so called, and the other is the obturator internus muscle. Before Prof. Henry J. Bigelow of Boston revolutionized the treatment of dislocation at the hip the great obstacle to reduction was supposed to be the resistance of the powerful muscles about the joint. Dr. Bigelow cut away all the other muscles, and still found that these two structures, the Y-ligament and the obturator internus muscle, were sufficient to produce all the varieties of luxation of this joint, and also

to constitute the obstacles which prevent the return of the bone to the acetabulum.

What is the Y-ligament? It is a portion of the capsular ligament which is thick and strong, and remains untorn when the head of the bone makes a rent in any other part of the capsule. The capsular ligament is a sort of tube surrounding the joint. It arises from the circumference of the acetabulum and the parts surrounding, and is inserted near the junction of the neck of the femur with the trochanter. The human being walks erect, and naturally a severe jolt transmitted to the joint, as in jumping from a height, is likely to dislocate the bone upward. To prevent this the capsular ligament is much thicker and stronger on that side, and forms a powerful band which helps to keep the joint in position. This part of the capsule, which goes under the various names of the "Y-ligament," the "ilio-femoral ligament," and "Bertin's ligament," arises from the anterior inferior spinous process of the ilium, and from the bone below as far

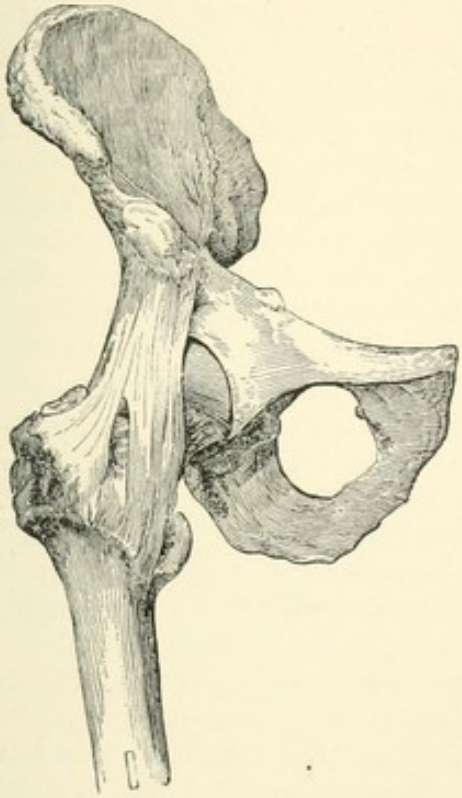


FIG. 55.—The Y-ligament.

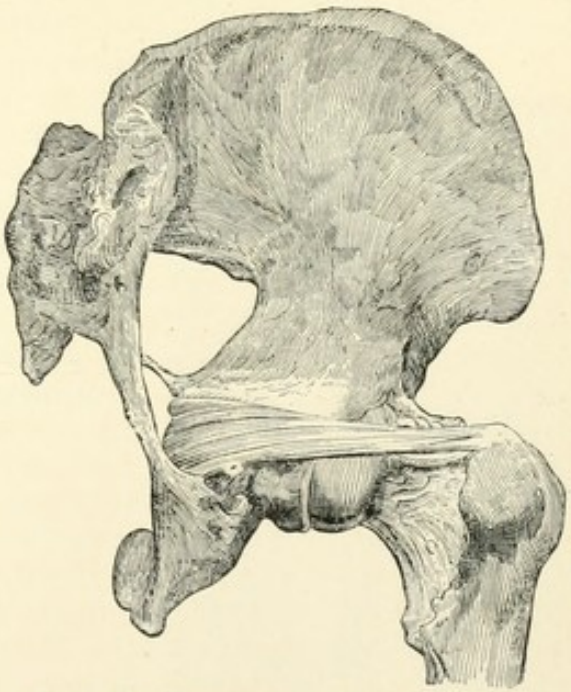


FIG. 56.—The obturator internus muscle.

as the border of the acetabulum. This dense band, sometimes a quarter of an inch in thickness, passes down toward the great trochanter, where it divides into two branches, thus forming an inverted letter Y. One of these branches is inserted into the anterior and superior part of the great trochanter. The other goes farther down, and is inserted into the femur close to the lesser trochanter (Fig. 55).

Bear in mind, that in all dislocations at the hip this ligament remains untorn, while every other structure may be lacerated. By its tension is determined the different positions which characterize the deformity, such as flexion, inversion, eversion, adduction, or abduction of the limb.

The obturator internus muscle, the other structure which plays an important part in some dislocations, arises inside the pelvis from the inner surface of the obturator membrane and from the bony edge of the

foramen. Its fibers converge into a tendon which passes toward the lesser sciatic notch, where it winds around a trochlear surface, and is inserted into the upper border of the great trochanter in front of the pyriformis (Fig. 56).

Dislocations at the hip-joint are four in number—two backward and two forward.

If a dislocation is backward, it is either on the dorsum ilii or into the sciatic notch; if forward, it is either on the obturator foramen or on the pubis.

Dislocation upon the Dorsum Ilii.—Supposing a person to fall from a height, his abducted knee first striking the ground and with the body bent forward, the force will come upon the posterior wall of the capsular ligament and the ligamentum teres, both of which will yield readily. The limb, being abducted, loses the support of the great muscles, and the head of the femur slips out of its socket backward. It must land in one of two places, the sciatic notch or the dorsum ilii. The same accident is liable to occur when a person is bending forward and a heavy body falls upon his back or hips. While the bone is slipping backward the Y-ligament becomes tense, and would prevent the displacement but for one thing. The femur rotates inward, so that, while the Y-ligament holds the trochanter firmly enough, the head of the bone slips outward. This accounts for one of the characteristic signs—viz. inversion of the foot. The head of the femur being thrown backward and the Y-ligament still on the stretch, the knee is of necessity thrown forward; both of these deformities continue until the luxation is reduced. The capsule is torn at its posterior part, and also some of the muscles about the joint, such as the quadratus femoris, the obturator internus and externus, and the pyriformis.

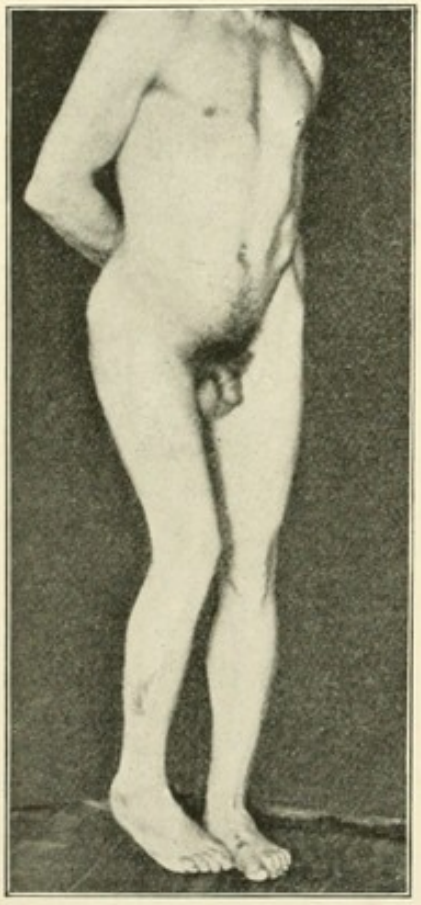


FIG. 57.—Dislocation on dorsum ilii.

Symptoms.—The limb is shortened from one to two inches. The knee is directed to the sound limb, and the toes lie upon the instep of the opposite foot. The head of the bone can, in some cases, be felt in its new position on the dorsum ilii (Fig. 57).

Dislocation into the Sciatic Notch.—This is also a backward dislocation, and presents the same symptoms as the iliac variety, only to a less marked degree. The shortening is not more than three-quarters of an inch to an inch. Inversion of the toes and adduction of the thigh are also present, but less marked than in the former case. The toes of the injured side rest upon the ball of the great toe of the opposite foot. There is little difficulty in diagnosing these two dislocations from one another, nor would a failure to do so result in any serious consequences, as the treatment is the same. The

mistake most likely to be made is to fail to distinguish between sciatic dislocation and fracture of the neck of the femur with inversion of the foot. In most cases of fracture there is eversion of the foot, but with impaction there may be inversion; hence the necessity for careful examination. The following are the important differences:

Sciatic Dislocation.	Fracture of Femur with Inversion.
History.	
Frequent in middle life.	An injury of old age.
Result of violence.	Often slight violence.
Shortening.	
Slight.	Well marked.
Crepitus.	
Absent.	Present unless impacted.
Mobility of Limb.	
Impaired.	Often increased.
Inversion of Foot.	
Inversion is persistent until the dislocation is reduced.	The foot may at any time become everted by relief of the impaction.
Tumor.	
An abnormal tumor may be obscurely felt behind the acetabulum, which moves with the rotation of the thigh.	The upper fragment often fails to move with the rest of the femur.

Dorsal Dislocation with Eversion.—In the rare instances in which this form occurs the outer branch of the Y-ligament ruptures, and allows the head of the femur to slip inward, thus causing eversion of the foot, instead of inversion, as in the ordinary form of the luxation.

Treatment of Backward Dislocations.—Prof. Bigelow's reduction by manipulation is a great improvement on the older methods (Fig. 58). The patient lies on his back upon a low table, completely anesthetized. Grasp the ankle of the dislocated limb with one hand and the leg below the knee with the other. Flex the leg on the thigh, and the thigh upon the abdomen until it forms a right angle with the surface of the table. Adduct the knee until it is carried over the middle of the sound thigh. Next cause the knee to describe a circle outward and downward until the leg is brought to the table and lies extended by the side of its fellow. What has been done in this maneuver? By flexion of the thigh you have relaxed the Y-ligament. When you adducted the thigh with outward rotation the head of the bone was lifted over the edge of the acetabulum and it dropped into its normal position.

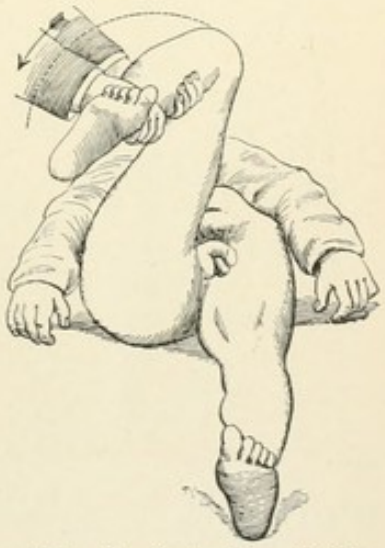


FIG. 58.—Reduction of dislocation on dorsum ilii (after Bigelow).

Backward Dislocations below the Tendon of the Obturator Internus.—If you examine Fig. 56, you will

see the position of the obturator internus muscle. In the ordinary backward dislocations of the femur the head of the bone passes *above* the muscle. In the variety of dorsal dislocation which we now have to consider it passes *below* the muscle; and this is the important part which the obturator internus plays in luxation of the hip. The bone, having slipped out of its socket and passed below the obturator internus tendon, does so while the thigh is in a flexed position. As soon, however, as the thigh is brought down from this to a straight position, the head of the bone, being firmly held at the trochanter by the Y-ligament, slips upward over the tendon, which now winds tightly around the neck of the femur between the head and the acetabulum. No wonder the old surgeons pulled and dragged with pulleys until they either caused something to break or gave up the fight and called the case one of "irreducible dislocation."

Treatment.—The patient lying on his back, proceed as follows:

First movement: Carry the knee across the opposite thigh to a position of extreme adduction.

Second movement: Sweep it upward horizontally toward the abdomen. This will allow the head of the bone to come down below the tendon.

Third movement: Raise the thigh to a vertical position, and the bone, disengaged from its entanglement with the obturator tendon, will lie in the position of an ordinary backward dislocation. From this point reduction can be effected as described under backward dislocation—viz. adduction until the knee is carried over the middle of the sound thigh. Then describe a circle upward, outward, and downward until the leg is brought to the table.

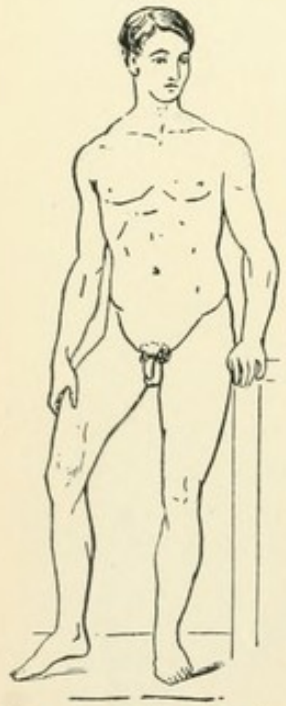


FIG. 59.—Thyroid dislocation.

Forward Dislocations.—These have a direction downward and inward. Two dislocations are found under this heading:

1. *Into the Obturator Foramen.*—This accident occurs while the person, standing with the thigh abducted and flexed, receives a blow upon the back of the pelvis, or it can be caused by forced abduction alone. The Y-ligament remains untorn, and, as the head of the femur is driven forward and inward, the thigh is flexed and abducted. The symptoms are very characteristic. The patient stands with the injured limb a little in advance of its fellow. There is apparent lengthening, but this is due to a tilting of the pelvis. Measurement may even reveal a slight amount of shortening. The hip is flattened, the adductors tense, and the head of the bone in some cases can be felt on deep pressure (Fig. 59).

Treatment.—Place a towel around the upper end of the thigh, and, while an assistant draws outward upon it at right angles to the middle line of the body, make alternate flexion and extension of the thigh upon the body. This is the simplest method, and probably the best. By it the writer succeeded in

two cases—one at the end of eight weeks, and the other after the expiration of three months.

Another method is as follows: Flex the thigh to a right angle, adduct and make traction at the same time, and then rotate inward while lowering the knee (Fig. 60).

2. *On the Perineum.*—The bone has to slip only a little past the obturator foramen to lodge in the perineum. This variety is therefore an exaggerated form of the preceding displacement. Flexion and adduction are now more marked, and there may be a slight degree of shortening.

Pubic Dislocation.—This occurs usually while the limb is in a position of over-extension, or it may be caused by a fall upon the knees or feet. The bone can occupy one of several positions in the neighborhood of the pubis, but the most common is the ilio-pectineal eminence. The head of the femur



FIG. 60.—Reduction of dislocation into the thyroid foramen (after Bigelow).

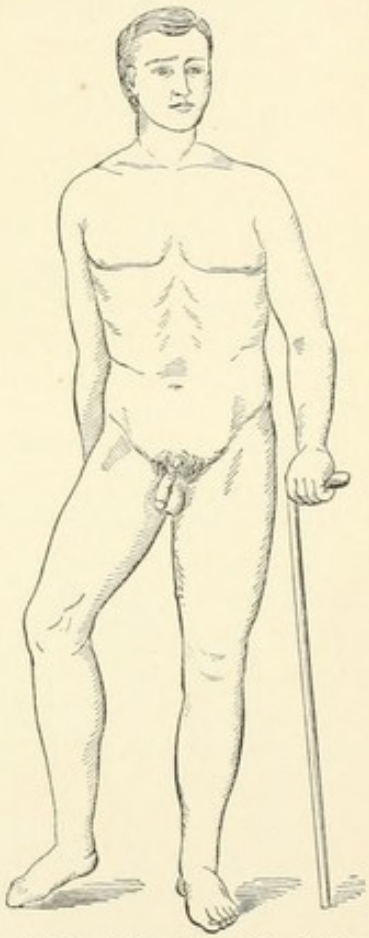


FIG. 61.—Dislocation of head of femur upon the pubes (after Hamilton).

cannot only be felt, but even be distinctly seen, in its unnatural position. The toes point outward. There is flexion of the thigh, and if the knee be pressed down upon the table the spine will be found to arch upward in compensation. In backward dislocation the injured thigh lies across the opposite limb, but here the reverse is true, and it takes a direction outward (Fig. 61).

The injury most liable to be mistaken for this luxation is fracture of the neck of the femur, yet there need be no difficulty in settling the question. If the patient be anesthetized, the outward rotation can be rectified in fracture, but immobility will be found in dislocation. There is shortening in fracture which can be removed by traction. In almost every case the head of the bone can be distinctly felt in dislocation.

Treatment.—First movement: Flex the thigh. Second movement: Abduct the thigh and make traction in the line of the axis of the femur,

while an assistant at the same time presses the head downward and outward toward the acetabulum.

Rare Forms of Dislocation.—Of all cases of dislocation at the hip-joint, the dorsal luxations occur in 50 per cent., the ischiatic in 30 per cent., the obturator in 11 per cent., the pubic in 7 per cent. This leaves 2 per cent. of cases in which the bone is found outside any of these regions. One of these is downward upon the tuberosity of the ischium. It is very rare, and when it does occur the displacement is often changed into one of the more common varieties. Thus the bone can slip upward and backward, becoming a dorsal, or forward by adduction and eversion, forming a dislocation into the obturator foramen.

Treatment.—Flex the thigh and then make traction.

Another rare luxation is directly upward (supracotyloid). Only a few cases of this kind have been reported. The symptoms are eversion with abduction. The trochanter is moved upward and backward, and the head of the bone can be felt on deep pressure.

Diagnosis between Contusion over the Great Trochanter and Dislocation at the Hip-joint.—A person suffering from a fall or a blow upon the great trochanter may present some symptoms which are difficult to distinguish from dislocation. The pain may be so great as to render movement impossible; the limb may be apparently shortened, owing to the patient's trying to find the easiest position. When there is doubt an anesthetic will make diagnosis easy. Motion is then free and normal if the injury is only a bruise, but is restricted in the case of a dislocation. Measurement will show a change in the length of the limb in the case of a dislocation, but none when the injury is a bruise. Palpation will settle the position of the head of the bone.

Congenital Dislocation of the Hip.—This is, in the majority of cases, due to arrested development, and the displacement is most commonly upward upon the dorsum ilii. In some instances the head of the femur is normal, but it is quite common to find the neck shorter and inclined to be horizontal. The ligamentum teres is sometimes thickened and stretched, owing to its having to support the weight of the body. In some cases it is wanting or very much atrophied. The acetabulum, although never entirely absent, shows a want of development. It may be oval and flattened, or it may be small and shallow, with absence of its cartilaginous rim. The muscles around the hip also exhibit a lack of development. As a result of this dislocation the pelvis undergoes certain changes. The crests of the ilii approach each other, while the tuberosities of the ischii become farther separated.

Symptoms.—The dislocation is seldom recognized until the child begins to walk, when a peculiar waddling gait is the first symptom to attract attention, and it is noticed at the same time that the back is very much arched (Fig. 62). The child very easily becomes fatigued, but seldom is there any complaint of pain.

By Nélaton's measurement (from the anterior superior spine of the ilium to the tuberosity of the ischium) a displacement of the trochanter upward will be found varying from half an inch to one or two inches. By gentle traction on the leg the trochanter can be brought down, and measurement will show that the leg has thus been lengthened,

but as soon as the traction is discontinued the trochanter will be found to return to its former position.

The two conditions with which this deformity is likely to be confused are bow-legs and infantile paralysis. The resemblance to bow-legs is marked in double congenital dislocation. A child with extreme bow-legs has a waddling gait and a tilted pelvis, but the position of the trochanter in relation to Nélaton's line will be found sufficient to settle the question. Infantile paralysis of one leg may bear a close resemblance to unilateral dislocation, while the laxity of the joint may

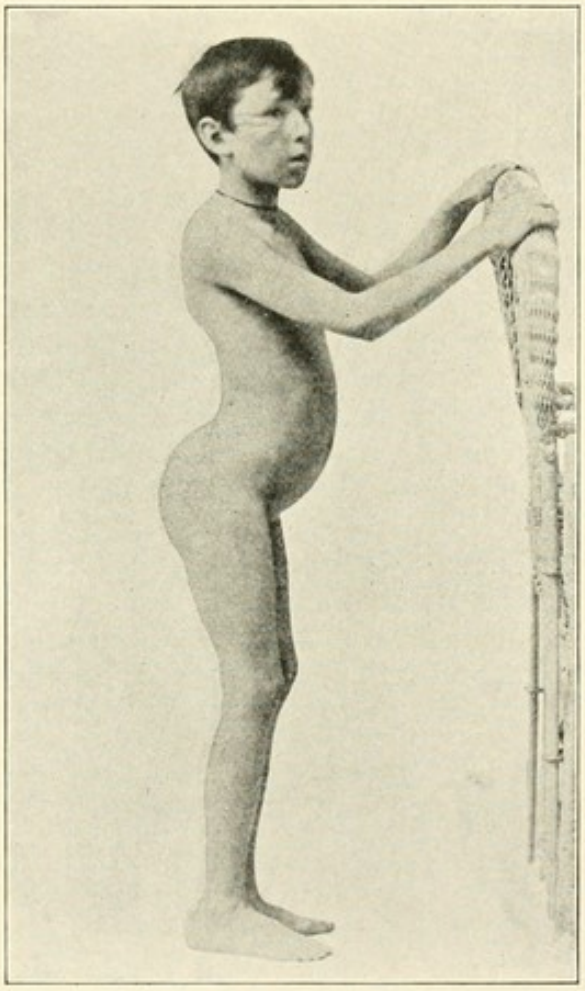


FIG. 62.—Double congenital dislocation of hip (from a photograph in the collection of Dr. J. E. Moore).

closely simulate luxation. But here, again, the position of the trochanter in relation to Nélaton's line will settle the diagnosis.

Dislocation at the Knee-joint.—Two bones may be dislocated at the knee-joint, the tibia and the patella. The tibia can be dislocated in five directions—forward, backward, outward, inward, and rotary.

Forward dislocation is probably the most common. The head of the tibia can be felt projecting in front of the condyles of the femur, while the latter bulge backward into the popliteal space. Numbness is often felt as a result of the stretching of the nerves, and the artery and veins may be seriously injured or even ruptured.

Treatment.—Extension, counter-extension, and direct pressure.

Backward dislocation is generally caused by direct violence in the region of the knee. The head of the tibia may be felt bulging backward into the popliteal space, while in front there is a corresponding depression immediately below the patella. The leg is in a position of extreme extension, and slopes forward so as to form an obtuse angle with the front of the thigh. The dislocation is frequently compound, and the most serious feature of it is the injury of the popliteal vessels, which, though apparently free from harm at the time of the accident may have their coats so stretched that they give way at a later period, followed by gangrene of the leg.

Treatment.—Traction and direct pressure.

Lateral luxations are rare and require no special description.

Rotary Dislocations.—The only case of this kind seen by the writer occurred to a lumberman whose foot was held firmly in a deep track in the frozen snow while his body swung round upon the limb. The displacement was recognized and reduced by his fellow-workmen.

Dislocations of the Patella.—This bone, being freely movable, may be displaced by direct violence, by muscular action, or by both forces combined. The most common displacement is outward. It sometimes happens that the bone is tilted upon its edge (vertical dislocation), and cases are recorded in which the bone was completely turned front backward. The patella being a superficial bone, the diagnosis presents no difficulty. The dislocation can easily be reduced by relaxing the quadriceps and placing the bone in position by direct pressure.

Dislocations of the Fibula.—The upper end of the fibula is rarely dislocated. The most common displacement is outward and forward. It can occur backward and also upward. The displacements are readily recognized, and reduction by direct pressure is easy. At the lower end of the fibula the few dislocations that have been reported were backward.

Dislocation of the Ankle.—*Examination* of the ankle-joint after injury is often a difficult matter. Swelling is likely to be great, and pain so intense that manipulations cannot be borne by the patient. The injuries that must be taken into account are fractures of the lower end of the bones of the leg, fracture of the astragalus, dislocations of the foot from the astragalus, dislocation of the astragalus from the tibia, dislocation of the astragalus alone, sprains of the ankle, and inflammatory disease in the joint.

These injuries will at once divide themselves into two great classes, one being attended with deformity, the other without deformity.

1. **Injuries without Apparent Deformity.**—Carefully note the seat of any pain or tenderness. Grasp each malleolus separately and attempt to move it independently of the foot. If crepitus can be felt and the malleolus be found movable, it will be evidence of fracture of the malleolus. If, besides fracture of the lower end of the fibula, there be found increased lateral mobility of the ankle-joint, you may decide that the internal malleolus is broken as well, or that there is laceration of the internal lateral ligament. The injury is Pott's fracture.

If you have failed to find any fracture, ask the patient to stand upon the injured foot. Should this cause intense pain, you may suspect

fracture of the astragalus. Move the foot and you may find deep crepitus; then your diagnosis may be positive. Should the results of your examination be negative, make careful measurements of the length of the leg, the distance between the heel and the malleoli, also between the malleoli, the tubercles of the scaphoid, and the base of the fifth metatarsal bone. Thus you can detect partial displacement of any of the bones which might not be apparent to the eye.

A severe pain behind either malleolus, with swelling and tenderness, should excite suspicion. Examine carefully for the tendons which pass behind these bony prominences. Possibly there is a depression where the tendon ought to be, or the tendon may be felt like a thick cord over the side of the malleolus. If on the inner side, these symptoms will indicate dislocation of the tendon of the tibialis posticus; on the outer side, that of the peroneus longus.

2. **Injuries with Deformity.**—The foot is displaced outward or inward. If outward, it is evidence of one of three injuries—viz. (*a*) Pott's fracture; (*b*) Dupuytren's fracture; (*c*) Subastragaloid dislocation.

If inward, it is also evidence of three injuries—viz. (*a*) Dislocation of the ankle inward; (*b*) Subastragaloid dislocation inward; (*c*) Dislocation inward of the medio-tarsal joint.

Note carefully the form and position of the heel. If it is elongated or unduly prominent, you are likely to find one of the following: (*a*) Fracture of lower end of tibia; (*b*) Dislocation of ankle backward; (*c*) Subastragaloid dislocation backward.

If the heel is flattened, it may be the result of one of three injuries: (*a*) Dislocation of the foot forward; (*b*) Subastragaloid dislocation forward; (*c*) Fracture of the os calcis.

Is the heel raised? It indicates one of three things: (*a*) Fracture of the posterior part of both bones of the leg; (*b*) Fracture of the os calcis; (*c*) Dislocation of the foot upward.

After completing the examination and finding no deformity, no undue mobility, no alteration in measurements between the bony landmarks, no crepitus or displaced tendons, and yet the joint is painful, hot, and swollen, with a history of a severe twist or strain, the only diagnosis to be made is a sprain; the tender points about the joint will indicate the position of the lacerated ligaments.

Dislocation at the Ankle.—The foot may be dislocated from the tibia and fibula in any of four directions—inward, outward, backward, or forward. A very rare form of dislocation has been met with in which the astragalus has been driven upward, widely separating the tibia from the fibula.

Backward Dislocation.—This variety is the result of extreme plantar flexion of the foot. The astragalus slips behind the tibia, causing marked lengthening of the heel and corresponding shortness of the foot in front. One or both malleoli may be broken in this or any of the luxations at the ankle. Backward dislocation is a common accompaniment of Pott's fracture.

Forward dislocation is the result of forced dorsal flexion (extension), or it may be produced by a blow upon the heel. The symptoms are just the opposite to those found in the preceding: the heel is

shorter, the foot in front longer, and the astragalus can be felt in front of the tibia.

Inward dislocation is not common. Its cause is extreme inversion. It is generally complicated with fracture of the internal malleolus or the lower end of the tibia, rupture of the external lateral ligament, or fracture of the external malleolus.

Outward Dislocation.—This is simply a complication of Pott's fracture.

Subastragaloid Dislocations.—An astragalus may remain articulated with the tibia and fibula while the other bones of the foot are dislocated from it. They can take a direction backward, forward, outward, and inward. These are frequently compound dislocations, and often associated with other serious traumatisms. When simple, the dislocation is usually backward and to one or the other side. The foot is everted or inverted and in the position of plantar flexion. The head of the astragalus can be felt as a rounded tumor on the dorsum under the skin; one malleolus stands out prominently, while the other is obscure.

Treatment.—Draw the foot forward while maintaining it in extreme plantar flexion and pressing upon the heel. Considerable difficulty has been experienced in reducing the dislocation, and it has often been found necessary to divide tendons which interfere with replacement.

Dislocation of the Astragalus.—In this variety the astragalus alone is displaced, severing its connection from the tibia and fibula on the one hand, and from the bones of the foot on the other. It is, as it were, squeezed out from its socket, and this has been known to occur with such violence that the bone has been shot through the skin.

It may be displaced forward or backward, but, as a rule, the direction is a complex one, such as forward and inward or outward and forward.

Dislocation forward is a result of over-distention. The bone can be readily recognized, either partly out of its socket or completely displaced forward, and resting upon the cuboid or on the scaphoid and cuneiform bones. Movement is totally lost. The foot is turned in the direction opposite to the displacement—*i. e.* either inward or outward.

Dislocation Backward.—The astragalus can be felt behind the ankle. The bone is frequently fractured as well.

Treatment.—The incomplete dislocation forward is the variety usually met with. The best manipulation consists in bending the knee and making traction on the foot while in the position of plantar flexion. The bone must also be pushed backward by direct pressure. Sometimes it is necessary to divide the tendo Achillis and other tissues that happen to be in the way. Excision of the bone has been practised in some obstinate cases. Dislocations of the remaining tarsal bones are not common. The most frequent is probably dislocation of the metatarsal bones from the tarsus—sometimes all together, sometimes singly.

Dislocations at the metatarsal and phalangeal articulations of the toes are so similar to those in the corresponding joints in the fingers that they do not require a separate description.

Loose Bodies in Joints.—A person while walking is suddenly

seized with a sickening pain in the knee; the limb gives way beneath him, and he suddenly falls to the ground; or if, during any ordinary movement of the joint, it suddenly becomes locked in the position of flexion, one of two conditions may be diagnosed: (1) A loose body in the joint; (2) A displaced semilunar cartilage.

1. **Loose bodies** occur only in the large joints, and out of every 10 cases 9 are found in the knee. These bodies are sometimes called "loose cartilage," from the fact that their structure resembles that tissue. They are, however, often fibrous and sometimes bony. In size they vary from a small pea to the size of the patella. One, two, three, or more may be found in one joint, either free in the cavity or attached by a pedicle to the synovial membrane. Their most common origin is from villous outgrowths of the articular cartilage or the synovial membrane. Rarer sources are osteophytes, blood-clots, and neoplasms.

Symptoms.—In many cases there is more or less effusion of synovial fluid, giving the characters of a chronic synovitis, and causing more or less discomfort from distention of the joint. It is when the so-called "loose cartilage" slips between the bones and the weight of the patient comes down upon it that the characteristic symptoms appear. Few conditions can compare with the horrible sickening pain then felt by the unfortunate patient. He falls almost fainting to the ground. The articular cartilages are crushed, the ligaments are overstretched, and the bones are forced apart by the intruder. It may happen that the joint becomes locked, and cannot be moved until the body is dislodged by manipulation or slips out unaided. The irritation set up in the joint is soon followed by an acute synovitis, which fills the cavity with fluid. If, after such an occurrence as this, you examine the knee, you will find evidence of the body. It is most likely to be found just below the condyle at the outer side of the joint. Several examinations may be necessary before it is definitely located, and even then it slips away as soon as it is touched. Patients soon get into the way of finding the bodies for themselves, and often become expert in dislodging them from a mischievous position to one in which they give no trouble. Left to themselves, however, these cases are liable to grow serious. Repeated attacks of synovitis lead to degeneration of the membrane, causing thickening and the formation of fringes. The synovitis passes from the acute to the chronic condition, and the joint is permanently impaired.

Treatment.—If seen soon after the body has slipped between the bones, the joint may be found locked, and the first point is then to dislodge the body. This is done by alternately flexing and extending the limb (if necessary, under an anesthetic), after which the joint is immobilized and the synovitis treated until all irritation shall have subsided. Formerly various means were resorted to for the purpose of fixing the movable body in some harmless position without opening the joint, but with the safeguards we now possess in aseptic operations the only treatment worth entertaining is complete removal of the body by an incision. After fixing the body with the fingers or by thrusting a needle through it, an incision is made into the joint and the body pressed out or grasped by forceps and withdrawn. The wound should

be closed with two layers of catgut sutures, one to secure the synovial membrane, the other to close the opening in the skin. A careful aseptic dressing, followed by a plaster-of-Paris cast or splint, completes the operation.

2. **Displacement of a Semilunar Cartilage.**—This is an accident very similar to the preceding, and the symptoms are almost identical. The older authors were in the habit of speaking of it under the vague term "internal derangement of the knee-joint." When the cartilage becomes displaced and slips between the bones, the same symptoms are produced as in the case of loose bodies in the joint. It usually occurs in connection with chronic synovitis or osteo-arthritis—diseases which have a tendency to impair the vitality of the cartilages and dispose them to become easily detached. The cartilage is not so easily felt as is a loose body, but the internal semilunar is the one most commonly affected.

Treatment.—The cartilage is replaced when it causes locking of the joint by flexion, extension, and rotation, under anesthesia if necessary. The joint should then be immobilized until all inflammatory action subsides, after which an elastic knee-cap may prove very useful. When the cartilage cannot be replaced, and when it gives persistent trouble, incision of the joint is advisable. Two courses are then open to the surgeon, one being to replace the cartilage and stitch it to the periosteum, the other to remove it entirely.

II. DISEASES OF JOINTS.

As a rule, there is no difficulty in distinguishing between injuries and diseases of joints. Injuries of joints are associated with traumatism, and it only remains for us to diagnose between the different lesions that could possibly be produced by a given combination of forces. Diseases of joints are more tardy in their development, and, as a rule, have no immediate connection with violence.

In the examination of a joint for disease the first point to be determined is whether there is organic disease of the part, and thus exclude hysteria, which is so common a disturbing element in our estimate of joint-affection. Here the history will afford valuable aid by showing evidence of other developments of hysteria or strong emotional disturbance. If the patient complains of violent pain in a joint in which there is no swelling, no redness, no wasting of muscles, and a marked hyperesthesia of the skin, out of all proportion to the other conditions, a close scrutiny for hysteria is decidedly in order. Notice the position in which the joint is held. It may exactly simulate one of the characteristic positions of disease, but a little further inquiry may reveal the fact that other positions are assumed at times. The pain caused by passive motion may appear to be unbearable, but if the patient's attention be directed to something else, the same movements can be made without difficulty. Anesthesia is an infallible aid in cases of grave doubt. While under an anesthetic the hysterical joint can be freely moved, and rigidity of the muscles returns only with consciousness, but in organic disease rigidity reappears just as soon as deep anesthesia passes off.

Having excluded hysterical joints, the consideration of organic disease will be considered under the following heads: synovitis, arthriits, and osteo-arthritis.

Examination of Joints for Disease.—Having taken a full history of the case as described, you should proceed to make a systematic examination of the joint, gaining at the outset the confidence of your patient, and leaving until the last anything likely to produce pain. Not only the joint, but the whole limb, should be stripped of all clothing, and the opposite member should be similarly dealt with for purposes of comparison.

Inspection.—For the shoulders, elbows, knees, or ankles the patient may be seated in good light; for the hip, it is necessary that he should lie at full length upon a firm table. The skin should first be noted as to its color and the presence of scars, sinuses, or other markings. Is the part enlarged or wasted or deformed, or flexed or distended or otherwise displaced?

Measurement.—Measurement is specially valuable in examination of the hip to show shortening, which is proof of the destructive period of hip-joint disease. It is also important to measure the circumference of the parts to demonstrate the degree of wasting.

Palpation.—Tenderness is a very important sign, and pressure should be employed with gentleness. Swelling about a joint is elastic and fluctuating when the synovial membrane is inflamed and its sac filled with fluid. The ends of the bone may be felt enlarged and swollen from commencing ostitis.

Passive Motion.—With great gentleness the limb above and below the affected joint should be grasped and the range of motion ascertained. The presence of grating may be noticed when the bones are moved against each other. If necessary, this part of the examination should be conducted under anesthesia.

Exploration.—In the case of suppurating sinuses the probe is used to locate the position of diseased bone.

The most common disease of joints is inflammation. We apply various names according to the structure—*e. g. Synovitis*, inflammation of the synovial membrane; *Thecitis*, inflammation of the sheaths of the tendons; *Syndesomitis*, inflammation of the ligaments; *Arthritis*, or *osteo-arthritis* or *pan-arthritis* when all the structures of the joint are involved.

Simple Acute Synovitis.—This is the simplest of the inflammatory diseases of joints. It is seldom that the synovial membrane is alone affected, for the disease is likely to involve the other structures, although to a less degree.

The *causes* of synovitis are local and constitutional. Of the local causes we may name injury, such as wounds or sprains, extension of the disease from bone or other neighboring tissues, and exposure to cold. Of constitutional causes rheumatism, syphilis, and gout are the most important.

Symptoms.—Pain is a prominent symptom. It is usually severe, of a throbbing character, worse at night, and greatly aggravated by pressure or any attempt at movement. Heat is nearly always present, and compared with the sound joint there may be a difference of one or

even two degrees. Redness is not seen except in advanced inflammation.

The position of the limb is characteristic. The patient instinctively places it in the position of greatest ease, and keeps it there. The joint is usually flexed. The part is swollen, and the synovial sac distended with fluid. In the knee the patella will be found floating, as it were, on the effusion, so that it is only when pressed upon that it comes in contact with the other bones. The depressions which normally exist on either side of it and down along the ligamentum patellæ are filled out and rounded by the fluid. By placing a hand upon either side of the patella fluctuation can be readily detected. If the joint is but moderately distended, make pressure above the patella, and you will find that the fluid is driven down to the lower part of the cavity, causing it to bulge outward and pressing the patella farther forward.

In the hip the fulness is most marked beneath Poupart's ligament and behind the great trochanter, especially when the limb is flexed and abducted, and in thin subjects fluctuation can be felt from one to the other of these positions. Another point at which fluctuation or tumefaction can be detected is in the angle between the thigh and the perineum, a little behind the tendon of the adductor longus muscle. Pain is severe and runs down the thigh; in some cases it is referred entirely to the knee.

In the shoulder the fluid causes the deltoid to bulge outward. The shoulder looks fuller and broader than its fellow, and, especially at the upper end, there is a loss of the groove which separates this part from the chest. These changes in contour are best observed by looking down upon the joint while the patient is seated in a low chair. The seat of the greatest tenderness is in front, just below the acromion process.

In the ankle look for this fulness behind the malleoli on either side of the tendo Achillis, and in front where it pushes forward the extensor tendons. In the elbow it fills up the space on either side of the triceps. Another point of bulging is where the radius joins the humerus, and this is also the most painful spot. Fluctuation can be felt between this point and those just mentioned. When the bulging is marked the triceps tendon appears like a broad depression.

At the wrist the tumefaction is at the back of the joint on each side of the extensor tendons of the fingers and between those of the thumb. This swelling must be distinguished from dropsy of the tendinous sheaths, which is longitudinal, while that of synovitis is transverse, resembling a bracelet.

It is not common to find a simple, serous synovitis pass into a suppurative condition, except when by careless aspiration or some other means septic germs find an entrance from without, thus infecting the aseptic fluid in the joint. We should, however, be on the watch for evidence of suppuration, the signs of which are persistent or increased pyrexia, rigors, rapid increase in the swelling, and general depression of the vital powers. The swelling assumes a doughy character, and in the worst cases the skin pits on pressure. In three or four days the muscles begin to contract, causing a flexion of the joint and malposition of the limb.

Treatment.—Place the joint at perfect rest. In the early stages cold applications by means of ice-bags or constant irrigation will check the progress of the disease and relieve pain. Later, heat will afford more relief. Hot fomentations of lead and opium are very soothing and have long enjoyed a good reputation. Over this a thick layer of absorbent cotton should be applied and compression made by a flannel or rubber bandage. Should the fluid continue to increase in spite of all treatment, the cavity should be aspirated, every precaution being taken to guard against sepsis. As soon as the inflammation has subsided passive motion should be commenced, and gentle movement practised each day to prevent adhesions.

Dry Synovitis.—Dry synovitis or croupous synovitis is a variety in which there is a lack of serous fluid or marked swelling. The synovial membrane has a hard, leathery feeling, produced by the coagulation of fibrin in and about the joint-cavity. The fibrinous deposit also takes place in the periarticular spaces and even along the sheaths of the tendons. The disease is confined almost exclusively to the knee, and the subjects are generally rheumatic. It is attended with great suffering, and has a tendency to end in ankylosis; and so rapid is the process that a joint has been known to become truly ankylosed in three weeks. Another termination is suppuration, which is as extensive as the fibrinous deposit, so that not only the joint itself, but the sheaths of the tendons for some distance, may be involved. Fortunately, this termination is rare.

Symptoms.—The most marked symptom of dry synovitis is pain. At the onset it is not very severe, but after the lapse of several days it becomes intense. Naturally, with increase in the severity of the pain and other symptoms indicating synovitis, the surgeon looks for swelling of the joint and the characteristic bulging spoken of under the diagnosis of Sero-synovitis. This swelling, however, is wanting, and instead there is a hard, elastic, and leathery sensation communicated to the finger when the joint is palpated. The muscles in the neighborhood of the articulation rapidly atrophy, thus giving the joint the appearance of enlargement, which on measurement it will be found not to possess. The joint has a peculiar angular or square look; when the finger is passed down the limb from the healthy to the diseased parts an abrupt rounded edge marks the limit of the fibrinous deposit.

Treatment.—The intensity of pain demands a liberal use of sedatives both general and local. Hypodermic injections of morphin are usually indispensable. The action of the skin and the kidneys should be maintained by diaphoretics and diuretics. For local treatment hot applications combined with laudanum or belladonna are soothing, and after the first few days may displace the morphin injections. As soon as the acute symptoms have passed off the splint should be removed, and passive motion gently employed to prevent ankylosis.

Chronic Synovitis.—Chronic synovitis, in a large proportion of cases, is the sequel of an acute attack. This is liable to be the case when there has been want of care in keeping the joint at rest or when any cause of irritation has been allowed to continue. Sometimes the character of the synovitis is chronic from the first. In this case it is rare to have the inflammation confined to the synovial membrane.

Many cases of osteo-arthritis begin as a synovitis. This is particularly the case with adults, while in children joint-disease has its starting-point, as a rule, in an ostitis.

Symptoms.—Instead of the acute throbbing pain which is so marked a character of acute synovitis, we find here an almost painless affection. The local temperature is slightly, if at all, raised above the normal, and there is but little constitutional disturbance. Still, there is the distention of the synovial sac which denotes effusion. The shape of the joint is different from what is found in the acute form. Instead of the pouches on each side of the patella being distended, the greatest bulging will be found beneath the quadriceps. The joint is weak, and gives the patient a feeling of insecurity. A very characteristic sign is a crackling or grating sound, produced by the fringes of the thickened membranes as they are pressed upon by movements of the joint. Flexion is usually permissible, but extension is greatly impaired. The bones appear to stick out with undue prominence, but this is in the main due to the wasted condition of the muscles.

Treatment.—Effusion of fluid in a joint is, like dropsy or jaundice, a symptom rather than a disease. Treatment must therefore be directed, in a great measure, to the condition upon which the synovitis depends, such as tuberculosis or arthritis. In cases of no great duration rest and pressure may be sufficient. The best immobilization is obtained by the use of a plaster-of-Paris bandage. Massage often proves invaluable here, and baths, friction, electricity, and iodin have their advocates. Many of the cases show a disposition to recurrence. The fluid may be nearly absorbed when the slightest disturbing cause starts it up, and soon the joint is distended to its full capacity. For this it has been recommended to aspirate the joint and inject it with some irritating fluid, such as carbolic acid or a weak solution of iodin. The reaction is often severe, and must be taken into account. In tubercular cases injections of iodoform emulsions often prove very satisfactory. These will be spoken of in the treatment of Tubercular Arthritis.

Arthritis.—This signifies inflammation of all the tissues of the joint. It is sometimes spoken of as osteo-arthritis when the bony structure plays a prominent part, or pan-arthritis when destructive changes are apparent in all the articular tissues. The causes may be summed up under the following heads: (*a*) Traumatism; (*b*) Pyogenic organisms; (*c*) Tuberculosis; (*d*) The organisms of acute infections, as typhoid fever; (*e*) Gonorrhea; (*f*) Rheumatism; (*g*) Gout; (*h*) Syphilis.

Simple acute arthritis resembles in many respects acute synovitis. The difference is that here we have all parts of the joint participating in the inflammatory process, and the symptoms, as a rule, are more marked. Pain is more intense; the whole joint is swollen, and not the synovial sac alone. Instead of a fluctuating swelling, there is a more uniform roundness and a feeling of more density and resistance than when the synovial membrane alone is inflamed. If the disease progresses, destructive changes begin to manifest themselves; the ligaments lose their tone, soften, and give way, causing undue mobility of the joint. This may even be followed by changes in the relation of the bones to one another, amounting perhaps to complete disloca-

tion. The cartilages lose their smoothness, and friction is felt when the articular surfaces are moved upon each other. During sleep the involuntary action of the muscles brings these eroded articular surfaces forcibly together, producing those "starting pains" which form so painful an accompaniment of this affection. Perhaps it would be more correct to say that these pains occur just before going to sleep. It is when the patient is losing consciousness and the wearied muscles have ceased their vigilance that a friction of eroded or granulating cartilages sets up a slight irritation. Very slight it may be, yet sufficient to produce a reflex act which throws the muscles into violent contraction and brings together with cruel force those surfaces which are so exquisitely sensitive.

From the joint proper the inflammatory process is likely to spread to the surrounding structures. The muscles atrophy more and more, edema and swelling increase, the skin becomes red, hectic symptoms supervene, the joint is becoming septic, and suppuration is soon fully established.

It may be difficult to decide whether the joint proper is the seat of the disease or the surrounding tissues.

The following points of difference should be sufficient to settle the question:

Acute Arthritis.	Inflammation External to the Joint.
The constitutional symptoms are marked.	No constitutional symptoms, or they may be slight.
Inspection of Joint.	
The swelling is bilateral.	The swelling is unilateral.
Palpation.	
Fluctuation is often found over the synovial pouches.	Fluctuation felt at the seat of the swelling, wherever it may be.
Motion.	
Impaired, owing to destruction of joint in late stages.	Motion only impaired by swelling of the parts.
Disorganization of the Joint.	
Disorganization often complete.	No disorganization.
Termination.	
Destruction of the joint or long-continued disease.	Discharge of abscess and return to normal condition.

Treatment of Acute Arthritis.—The directions given for the treatment of synovitis are in the main applicable here. Rest is of the first importance, and is best secured by the use of a suitable splint. In the case of the hip and the knee extension not only secures rest, but prevents muscular spasm, and is the best means of preventing the "starting pains" already referred to. It prevents the rubbing together of the articular cartilages and serves to keep the limb from being deformed. For either of these joints Buck's extension is a convenient arrangement. Cold applied to the joint by means of ice-bags is valuable in the early stages, and compression by a flannel or rubber bandage is useful.

Constitutional treatment should be directed to any diathesis which may be present, such as syphilis, gout, or rheumatism. When pain is severe and cannot be relieved by rest or local applications, hypodermics of morphin should be employed.

The treatment of many of these cases will prove long and tiresome. The inflammation may subside, fever may pass away, and fluid which has been effused may be absorbed; but a chronic condition exists which falls far short of the normal state and threatens the return of all the acute symptoms on the slightest provocation. Under these circumstances rest, in part at least, must be maintained by allowing the patient to go about on crutches with a plaster cast, or in case of the hip and knee with a Thomas splint. The main object of this line of treatment is to allow the patient to get the benefit of fresh air and light exercise, while the affected joint is at the same time immobilized.

Acute Arthritis with Suppuration.—*Suppurative arthritis* may occur primarily or may invade the joint from the surrounding structures. It may be a sequel of the simple, acute variety or it may be septic from the outset. In any case the presence of the organisms of suppuration is essential. Much will depend upon the number and virulence of the germs and upon the vitality and resistance of the tissues invaded. Wounds of joints made by a non-sterilized instrument or wounds that have not been aseptically treated form a large class of these cases. The next most common cause is an ostitis in one of the bones which enters into the formation of the articulation. At the knee the starting-point may be the lower end of the femur or the head of the tibia; at the hip, the head of the femur. If the surgeon is sufficiently careful, he can long foresee this serious consequence of a simple ostitis. The tenderness on pressure over one particular spot in the bone, with all the other conditions which indicate ostitis, should rouse him to action long before the disease has had time to break down the healthy barriers which lie between it and the joint. If such localized disease in the bone were always treated promptly, the bone opened into, and pus got rid of as we get rid of it in any other locality, a vast number of cases of arthritis would be prevented and an incalculable amount of suffering averted.

Symptoms.—The symptoms are much the same as in simple acute arthritis, but more severe. Suppuration is recognized by a rigor or severe chill, which may be oft repeated. The temperature rises to 104°, 105°, or even 106°. The joint becomes intensely painful, and the swelling not only causes great enlargement of the joint, but spreads up the limb. The skin is red or dusky, and there is subcutaneous edema more or less extensive. The slightest movement aggravates the pain, and the muscles are kept rigid to prevent motion in the joint. When the cartilages have become eroded the ends of the bone grate together, and the "starting pains" already referred to become intolerable. Pus accumulates, distends the joint, and gradually makes its way by the route of least resistance. In most cases this is through the skin, but it sometimes happens that the capsule gives way at its weakest point, allowing the pus to escape along the muscle-tendons. This is particularly the case with the knee, the capsule giving way at its upper portion, the pus burrowing beneath the tendon of the quadriceps along the

femur to form a new abscess higher up the thigh, which if not properly opened and drained will render the last state of the unfortunate patient worse than the first. The intensity of the symptoms, the even swelling, and the well-pronounced chills will readily distinguish suppurative arthritis from synovitis. If there is still doubt, an aspirator can be used to draw off some of the fluid. Should this prove to be thin and non-purulent, the case is one of synovitis. Your drawing off the fluid, if done aseptically, will do good instead of harm. Should the fluid be purulent, but still serous, it would indicate a catarrhal suppuration of the synovial membrane, and aspiration followed by a mild antiseptic washing may be sufficient. Should the contents prove to be thick and curdy, then the most prompt and vigorous measures must be resorted to in order to save the joint.

Treatment.—The joint should be laid freely open, the septic contents washed thoroughly away, and the most thorough drainage established. In the case of the knee the incisions should be made on each side of the patella. In addition an opening should be made behind the joint. The safest way to accomplish this is to pass a pair of dressing-forceps through one of the incisions already made backward through the joint to the popliteal space, a little to the outside of the middle line. When the end of the instrument can be felt beneath the skin, cut down upon it, and, driving the forceps through, grasp a piece of rubber tubing and carry it back as the forceps are withdrawn. A final washing out may be effected through the tubes, first of sublimate solution, 1 to 2000, and lastly of sterilized water. After this the joint is put up in a moist dressing and completely immobilized by a splint. A rise of temperature or soaking of the discharge through the bandages would be an indication for a renewal of the dressings. In all cases immobilization should be as complete as if there were a fracture. The general mode of recovery is by bony ankylosis, but early and careful treatment may result in a perfect joint.

While these local measures are receiving attention constitutional treatment must not be neglected. The patient should be placed in the most favorable hygienic conditions and given nourishing diet and tonics.

If, in spite of all these measures, suppuration continue, further operative measures must be resorted to. Of these the most conservative, and often the most satisfactory, is an atypical resection, by which is meant the removal of only the structures that are actually diseased, leaving the parts that are still healthy. Typical resection, which implies total excision of the joint, is the next radical procedure; and, lastly, when the articulation and all the tissues in its neighborhood are hopelessly destroyed and the patient's condition critical, amputation may have to be performed as the only means of saving life.

Pyemic Arthritis.—One of the most disastrous complications of pyemia is multiple arthritis. Joint after joint becomes the seat of suppuration, and its destruction is often rapid and complete. It always begins in the synovial membrane, not as a simple, but as a suppurating, synovitis. The symptoms are not very uniform. In some cases a large number of joints are affected in rapid succession; in others there may be only one joint invaded or there may be long intervals between the

attacks. The joint first affected is generally the knee, or it may be the right sterno-clavicular articulation. Pain may be slight or almost wanting. The capsule rapidly fills with pus, the joint becomes swollen and distended, and there is generally a rigor. Otherwise the symptoms are the same as in acute suppurative disease.

Tubercular Arthritis.—Of all causes of arthritis, tuberculosis is recognized as the most prevalent. The tubercle bacilli may find a lodgement in any one of the tissues which enter into the formation of the joint, but, in children especially, the bone is the structure first invaded. From the bone the route to the joint-cavity may lie through the articular cartilage, or by a more roundabout way outside the cartilage through the synovial membrane or the periarticular structures.

It must be kept clearly in mind that in tubercular joints the morbid process is not suppurative, but the growth and effects of the tubercle bacilli. The joint may contain fluid, and the old authors were in the habit of speaking of these collections as "cold or chronic abscesses." The fluid has the appearance of pus, but it is only when the joint is opened and the pyogenic organisms are permitted to enter that true suppuration takes place. This is why the opening of a joint before the days of antiseptic surgery was looked upon with dread. The entrance of pus-germs was like setting fire to the prairie, for it became a double infection, and destructive changes went on from that moment with frightful rapidity. In children the tubercular process begins, as a rule, in the bone. In adults it is more liable to make the synovial membrane its starting-point. When the membrane is affected, either primarily or secondarily, it becomes covered with granulation tissue, which spreads to the other structures. Soon the shape of the joint becomes changed, the depressions fill out, and there is a soft gelatinous or lardaceous appearance which is very characteristic. The parts above and below become wasted, while the joint itself increases in size and assumes a spindle shape. The skin is white and often traversed by distended veins. As the tubercular deposits break down and liquefy fluctuation may be felt, and, unless antiseptically treated and got rid of, this fluid will sooner or later find its way to the surface, affording a portal of entrance for pyogenic organisms, and leaving sinuses which may continue to suppurate indefinitely. Deformity is an almost constant result of joint-tuberculosis. It begins by the patient's assuming the position of least discomfort, a position of flexion. It is aggravated by destructive changes in the ligaments, and maintained by reflex action of the muscles.

In the *diagnosis* of tubercular arthritis the first thing to exclude is syphilis. This is not difficult, for, although there are some strong points of similarity between the two, syphilis is much more rare; there is a history of a specific sore, and, as a rule, evidences of the disease can be found in other parts of the body, especially in the glands, and, should there still be a doubt of the disease, put the patient upon a vigorous antisyphilitic treatment for two weeks and note the result.

Tubercular disease of joints, as a rule, develops very slowly; for many weeks or even months there may be only a disinclination on the part of the patient to use the joint, a slight limp, a stiffness or a rigidity of the muscles. Pain may be slight or entirely absent, and much valu-

able information may be gained from its character. When the disease begins in the bone, pain is usually present from the first, and the affected spots are sensitive to pressure. When, on the other hand, the synovial membrane is the starting-point, pain is usually slight, but it becomes a prominent symptom when the disease begins to involve the bone.

In the early stages of the disease, before there is any destruction of tissue or liquefaction of tubercular deposits, the diagnosis may be obscure. A safe rule to follow in such an event is to give the patient the benefit of the doubt by treating him for tuberculosis. In the advanced stage there is little likelihood for error. Destructive changes cause shortening of the limb, and may even produce dislocation of the affected joint. These points can be best brought out under the consideration of tuberculosis of special joints. In all cases evidence of tuberculosis should be sought for apart from the suspected joint, as chronic glandular enlargement, persistent nasal or pulmonary catarrh, and a family history of the disease.

Tuberculosis of Special Joints.—**The Hip-joint.**—This is a disease of childhood, but by no means confined to early life. Children between the ages of five and ten years make up a majority of the cases. The starting-point is generally the under surface of the neck of the femur at the articular side of the diaphysis. There may be two reasons for the selection of this spot: one that it is most subjected to strains and concussions, and the other the fact that the vessels enter the bone in this situation. In the diagnosis of tubercular disease of the hip it is convenient to consider three stages:

First Stage.—The tubercle bacillus is deposited in one of the tissues of the joint—the bones, as a rule, in children, the synovial membrane in adults. The bacillus multiplies and produces new growths of cheesy, gelatinous, or granulation tissue. In this stage little or no irritation may be produced, and the symptoms are often overlooked. For this very reason this is the most important stage of the disease from the points of diagnosis and prognosis. Any one can recognize the second or third stage, but the man who properly appreciates the symptoms of this incipient stage is the one who will save the most joints and effect the greatest number of cures. Take warning from the following danger-signals: The child becomes easily tired and shows a disinclination to play. There is a slight limp, particularly in the morning, which passes off after exercise. The mother says something about pains at the thigh or hip, or more commonly the knee, and wonders if they are "growing pains." In any of these instances the joint should be carefully examined. Movement may be perfect and pain may be absent, but about the hip a slight rigidity of the muscles, especially the adductors, will be found on careful palpation, and there may be also a slight atrophy of the muscles of the thigh.

Second Stage.—This is the stage of *arthritis*. If the symptoms were previously obscure, they now become positive. There is no doubt about a limp, for it gradually advances to lameness. The child is easily fatigued; pain is worse at night and toward the early morning hours. Rigidity of the adductors and atrophy of the muscles of the thigh are now unquestionably present. And yet up to this time attention may be directed to the wrong joint, for the pain may be persistently felt in

the knee. This is a reflex sensibility due to the anatomical fact that the obturator nerve is distributed to both articulations. Over and above these symptoms are conditions due to inflammatory changes in the joint. If effusion be present, there will be distention, most apparent under Poupart's ligament and in Scarpa's triangle, or it may appear before and behind the great trochanter, giving the hip an appearance of increased width. Instinctively the patient throws the weight of the body on the sound side, causing a tilting of the pelvis, and hence the affected limb is advanced and somewhat abducted and everted. The older surgeons spoke of this as apparent lengthening (Fig. 63). Let the patient stand up. The gluteal fold on the affected side is lessened or even obliterated, and in females the line between the vulvæ is inclined. In rare cases the limb will be found to be adducted. Pain as a symptom must not be too implicitly relied upon. Along the obturator nerve is the most likely area in which to find it; that is to say, the anterior and lower aspect of the thigh and the front and inner surface of the knee. Worse at night it is almost sure to be, and in advanced periods of the disease the "starting pains" already mentioned are likely to make their appearance. It occasionally happens that the disease runs its course with a very slight amount of pain.

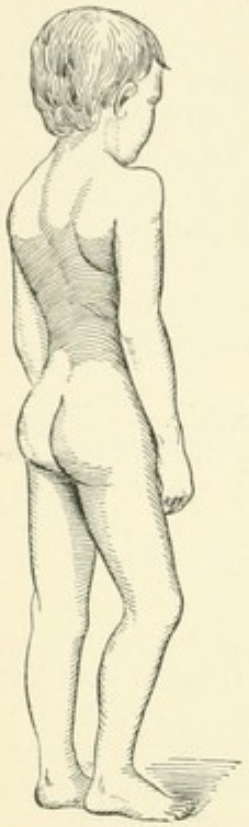


FIG. 63.—Apparent lengthening (after Sayre).

Place the patient at full length upon a firm table. Gently grasp the knee of the affected side and press it downward so as to bring the popliteal space in contact with the table. You will then find that the lumbar portion of the spine is curved upward (Fig. 64). Press the spine back until it comes in contact with the table and the knee is forced to bend upward. The knee and the lumbar spine act recipro-

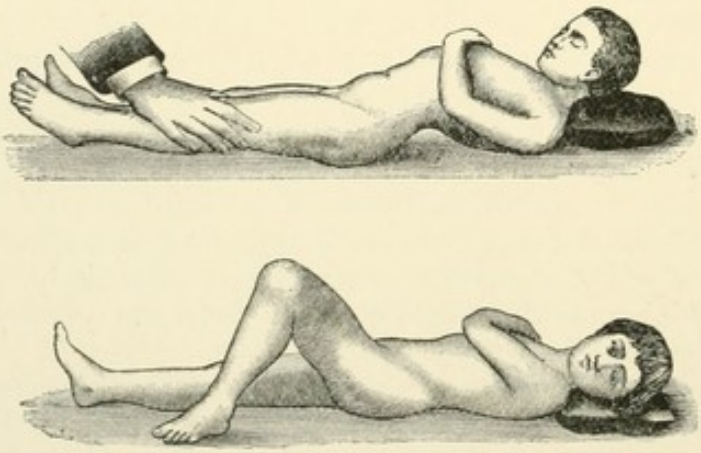


FIG. 64.—Effects on the lumbar spine of flexing and extending the diseased leg in hip-disease (Albert).

cally. This is due to contraction of the psoas iliacus muscle, and is a symptom of the greatest importance. It must not, however, be taken

as a pathognomonic sign of morbus coxæ, for it is found in the following conditions as well—viz. bursitis under the psoas muscle, psoas abscess, and sacro-iliac disease when complicated with psoas abscess.

Effusion, even when considerable in amount, may be reabsorbed, but it is just as likely to go on increasing until it causes the weakened capsule to give way. The fluid pours out into the neighboring tissues, infecting them with myriads of tubercle bacilli. Tension,

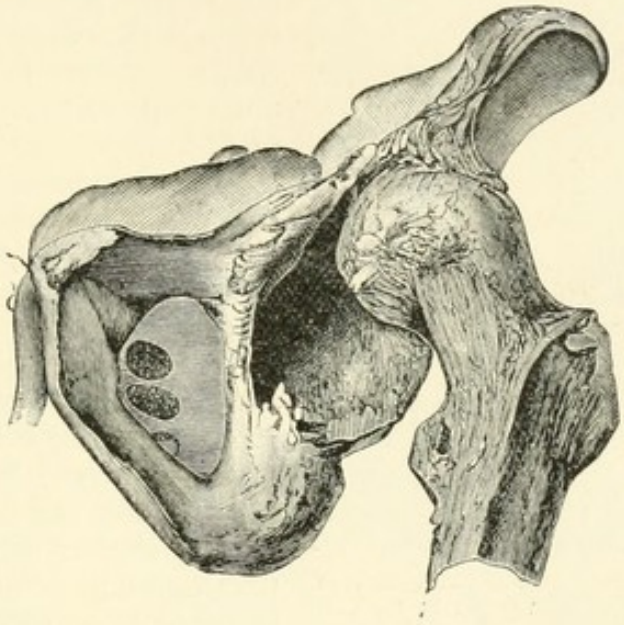


FIG. 65.—Intra-acetabular luxation in coxalgia (Tillmanns).

which has been gradually increasing, now suddenly ceases, affording relief to suffering and an apparent improvement in the patient's condition. This, however, is of short duration. The fluid continues to burrow, and unless properly managed will eventually find an outlet through the skin. The tubercle bacilli are now reinforced by pyogenic germs, abscesses and sinuses are formed, and a long and wasting period of suppuration follows. But the evil effects of rupture of the capsule and escape of the tubercular fluid do not stop here. With the emptying of the synovial sac the articular surfaces of the bones come closer together; reflex muscular contraction increases their friction one upon the other; they begin to break down, and the disease enters upon its last stage.

Third Stage.—This is the period of *destruction.* The acetabulum steadily breaks down at the upper segment of its circumference, the head of the femur following up the erosion, ploughing, as it were, a furrow along the dorsum ilii, changing the acetabulum from a round to an oblong depression (Fig. 65). This is often spoken of as a pathological dislocation, but the term is not appropriate, for it is only the acetabulum that is changed; the head of the femur does not leave the socket, and the capsule forms new attachments as the wasting proceeds. The head and neck of the femur also suffer in the destructive process, so that shortening soon becomes a pronounced symptom in this third stage of the disease. Measurement from the anterior superior spinous process to the outer or inner malleolus will show a shortening of a half inch,

an inch, or more. Bryant's and Nélaton's measurements will demonstrate that the trochanter is higher on the sound side; hence the waste must be at the neck of the bone or in the acetabulum. The ligaments may be destroyed by suppuration or they may lose their hold by erosion of the parts of the bones which afford their attachments. More and more the thigh becomes flexed (Fig. 66), and adduction may take the place of abduction.

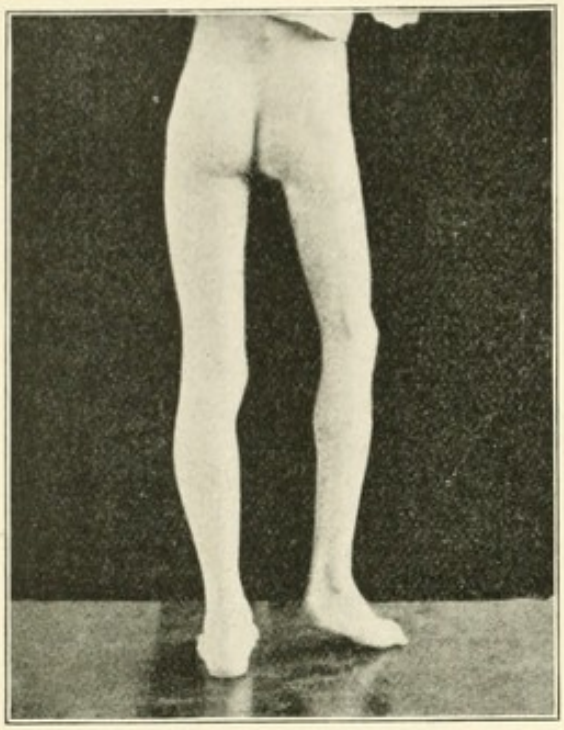


FIG. 66.—Disease of hip, showing flexion and adduction (from a photograph in the collection of Dr. T. S. Roberts).

The constitutional symptoms, which have been more or less marked in the previous stages, now assume the characters of "hectic fever."

From this point the disease may turn in one of two directions. In favorable cases the suppuration gradually abates, bone-destruction ceases, and repair begins. All dead tissues are thrown off by molecular wasting, and the joint is left in a condition of bony ankylosis. Unfavorable cases go on from bad to worse, new abscesses and sinuses forming until exhausted nature gives way and death brings relief. More frequently it happens, however, that the tubercular infection spreads to some of the internal organs, generally to the lungs, and the journey is completed by a shorter and more merciful route.

Treatment.—Bear in mind that the tubercular process may at the outset be a local affection, a pure culture of the bacillus in a rather unfavorable medium struggling for a mastery over the tissues which it has invaded. In the very early part of the first stage, when the bacilli are multiplying, everything which gives strength to the normal tissues will retard or cut short the deposit. Good hygienic surroundings, nourishing food, perfect digestion, and life in the open air constitute the main safeguards. When possible, a change to the air of the seaside, mountains, or pine woods should be made.

Unfortunately, we do not often see a case in this early stage, and if we did we perhaps should fail to recognize it. The bacilli have effected a secure lodgement before they produce the irritation which gives us even the early symptoms. To allay this irritation *rest* of the affected part, complete and absolute, must be relied upon and faithfully employed. It is beyond question that early immobilization with prolonged rest in the recumbent posture is sufficient to check the disease in a majority of cases. As soon, then, as the diagnosis is made the limb should be put up in a Buck's extension appliance and the patient kept in bed until inflammatory symptoms subside. Almost immediate relief from pain will follow the adoption of this plan. A child, no

matter how young and active, soon becomes perfectly reconciled to the restraint; pain ceases and the night-cries and starting pains are prevented. When it is possible, however, the benefits of out-door air and exercise should be secured, while at the same time the joint is kept at perfect rest. The child can be taken out on a cot or in a carriage, or, if the acute symptoms are well under control, a plaster-of-Paris cast so applied as to control the limb and pelvis will answer all purposes. The sole of the shoe on the sound side should be thickened in order to take all weight off the diseased limb, and the patient should move about on crutches. Many forms of traction splints have been devised having for their object the immobilization of the joint and prevention of destruction of the acetabulum from muscular contraction. The splints in most favor are Thomas's (Fig. 67), Phelps's (Fig. 68), Taylor's (Fig. 69), and Lovett's (Fig. 70).

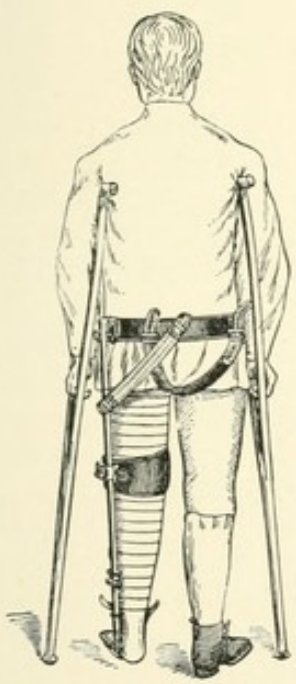


FIG. 67.—Thomas's posterior splint.

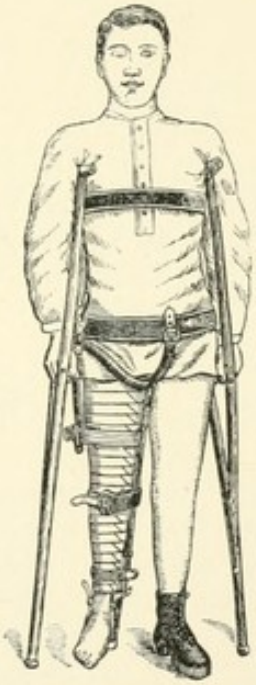


FIG. 68.—Phelps's splint.



FIG. 69.—Taylor's splint.

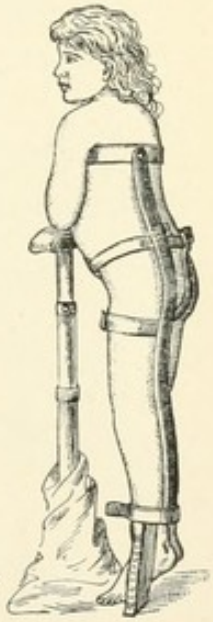


FIG. 70.—Lovett's splint.

Operative treatment has to be resorted to in many cases. When the joint is distended with fluid it may be aspirated to relieve tension. If the accumulation is large and spontaneous evacuation is threatened, an incision should be made with the strictest asepsis, so that a double infection may be averted. Injections of iodoform have proved of very great value. The most suitable form is a 10 per cent. emulsion in glycerin, care being taken that the emulsion is itself sterilized.

Bruns recommends the following:

Iodoform,	10 parts;
Glycerin,	50 "
Distilled water,	50 "

The first injection should not contain more than half a dram of iodoform, and in children even a smaller amount. The injection should be

made about every two weeks. In fungous joints the emulsion should not only be thrown into the cavity, but also into the thickened capsule. When tubercular abscesses exist, they should first be evacuated, and the softened tissue scraped out.

When the disease progresses far enough to cause extensive destruction of bone, the question of resection may have to be considered. The operation, as practised of late years, is not attended with serious danger, but it must be admitted that the results are often disappointing. It does not prevent the recurrence of the disease in other parts of the body, and it may happen that the deformity will not prove much less

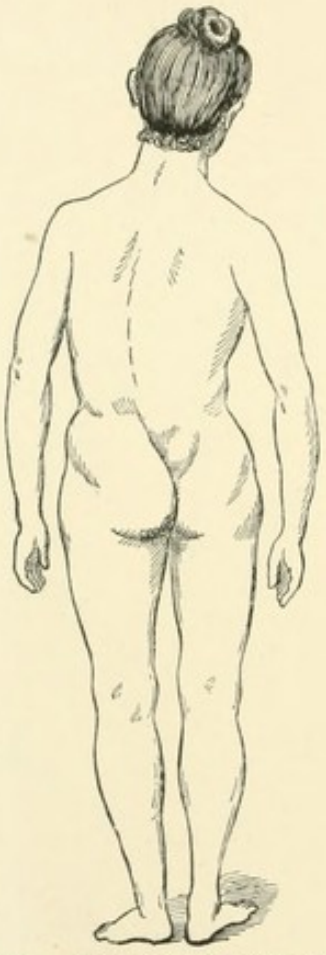


FIG. 71.—Sacro-iliac disease: abduction (Jones).

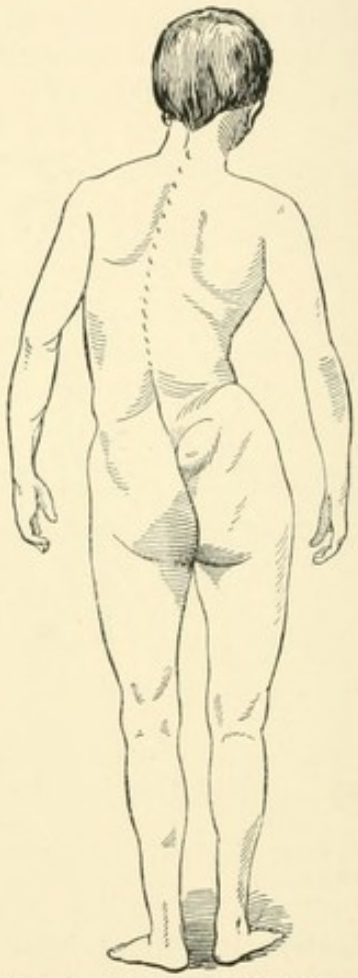


FIG. 72.—Sacro-iliac disease: adduction (Jones).

than after spontaneous cure with ankylosis. Yet resection is advisable, as it shortens the period of suppuration and holds out the best prospect of eradication of the tubercular deposits.

The incision should be treated by the open method, packed with iodoform gauze, and irrigated with corrosive-sublimate solution (1 : 3000) as often as necessary. The joint should be immobilized by extension, as in the treatment of the second stage, and this restraint persisted in for six or eight weeks after the operation.

The Sacro-iliac Joint.—A very serious, but fortunately rare, disease is tuberculosis of the sacro-iliac joint. Adults below the age of thirty-five form the majority of cases met with. The progress of the

disease is slow and insidious, and has to be carefully diagnosed from hip-disease, rheumatism, and sciatica.

Symptoms.—The first symptom to make its appearance is, according to Robert Jones of Liverpool, a peculiar attitude, a "listing" of the trunk toward the unaffected side, and this causes the spine in due time to assume a long, sweeping curve, with its convexity toward the sound side (Figs. 71, 72). Before the development of this deformity the patient finds that he easily becomes fatigued, and the motions of bending forward and returning to the perpendicular are difficult for him. Tenderness on pressure over the synchondrosis is generally present, and continued effort in standing or walking produces great discomfort and fatigue; some patients complain of a sensation as if the body were falling asunder. Lying upon the affected side increases the pain, and it is generally aggravated while the patient is at stool. The thigh may become flexed as in hip-disease, but this is most likely to be the case when psoas abscess is a complication. The most characteristic sign is the pain which is felt when the ilia are pressed together by grasping their crests and moving them toward or apart from each other. Movement of the thigh is attended with severe pain; but if the pelvis be steadied, the patient lying upon his back, the thigh can be moved without causing suffering. This is a symptom of great significance, and is a valuable diagnostic point between hip- and sacro-iliac-disease. There is usually tenderness over the gluteal region, and if the fingers be passed outward toward the sacro-iliac articulation, a spot will be found which is excessively tender and represents the seat of local changes. The first change in the contour of the part is an elongated swelling near the affected joint. When pus collects it may travel in one of the following directions:

1. Through the anterior ligament, keeping outside the pelvic fascia—(*a*) following the course of sacral nerves and pyriformis, out through the great sacro-sciatic foramen, and forming an abscess under the gluteus maximus; (*b*) following the curve of the sacrum behind the rectum to a point in the ischio-rectal fossa, causing inflammation and adhesion of the rectum, and ultimately bursting into it; (*c*) coursing under the lumbo-sacral ligament into the psoas muscle, and thence into the thigh; (*d*) or into the iliacus muscle, and thence into the groin.

2. Through the back part of the joint into the multifidus spinæ, creeping along it and pointing in the lumbar region (Fig. 73), or directly over the joint itself (Jones).

The lameness attending sacro-iliac disease is characteristic. It comes on at an early period; the patient leans forward and favors the limb on the affected side; he walks insecurely and realizes a want of proper support. He cannot stand on the affected limb or twist himself suddenly around. In the course of time it becomes impossible for him to stand erect.

The limb on the affected side seems longer, and the foot may extend half an inch beyond its fellow, but measurement from the anterior superior spinous process to the external malleolus shows that the limbs are of equal length. Nor is this lengthening due to tilting of the pelvis as in coxalgia. It is caused by a tilting forward and

rotation downward of the whole side of the pelvis, due to inflammatory swelling in the sacro-iliac joint.

The *diagnosis* is often obscure, and must rest upon tenderness over the joint, pain on separation, or crowding of the ilia together, and upon the painless movement at the hip when the pelvis is firmly steadied.

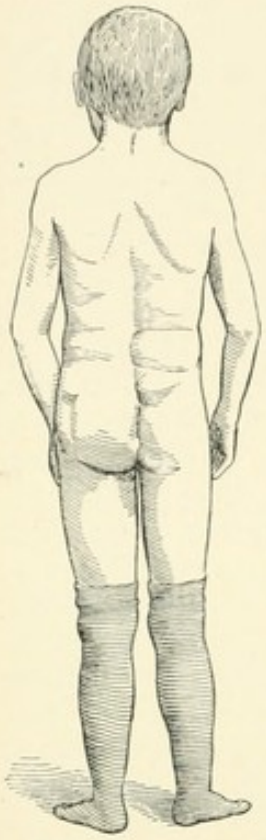


FIG. 73. — Abscess in sacro-iliac disease (Jones).

Sacro-iliac disease must be distinguished from the following: Hip-disease is likely to simulate it, particularly when the symptoms begin in the acetabulum. The early signs may be identical, such as fatigue, pain felt at the knee, etc. The diagnosis must rest upon tenderness on pressure and puffiness over the sacro-iliac joint, which are never present in hip-disease. The seat of pain should be carefully noted. In sacro-iliac disease it is at the sacro-iliac junction behind and away from the hip. Pressure made deeply in the hollow behind and above the great trochanter or against the anterior part of the hip-joint gives no pain. Movement at the hip is painful, but when the pelvis is steadied these movements are free from pain.

The alteration in the shape of the limb affords valuable evidence. In advanced stages of hip-disease there is marked shortening, never in sacro-iliac disease.

(2) **Neuralgia of the Hip.**—This is common in young females, and is often complicated with hysteria. The pain extends over a wide area, is superficial in character, and no special tenderness can be found at the sacro-iliac junction.

(3) **Sciatica.**—Every obstinate case of sciatica should be most searchingly examined for evidence of sacro-iliac disease. The subjects of sciatica are usually more advanced in years than those who suffer from the joint affection. The pain is below the joint; the nerve can be traced down the thigh by its sensitiveness to pressure, and the special symptoms of sacro-iliac disease are wanting. In sciatica pain is not relieved by the recumbent position.

(4) **Spinal Disease.**—If too much stress be laid upon the situation of the abscess, sacro-iliac disease may be confounded with spinal disease. In the latter there is usually a history of disease in the vertebræ and evidence of characteristic change in the curvature of the spine.

The most puzzling cases are those in which the lumbo-sacral vertebræ are involved.

(5) **Disease of the Pelvic Bones.**—When the crest of the ilium or the tuberosity of the ischium is the seat of localized ostitis, a probe can be passed down to the diseased bone, and then there is no change in the length of the limb or the size of the pelvis. The greatest difficulty arises when the acetabulum is the seat of disease. Pain on movement is felt in this case, even though the pelvis be steadied, and the limb will be found shortened by measurement from the anterior superior spine to the external malleolus. Inflammation of the sacro-

iliac joint sometimes occurs in gonorrheal rheumatism and pyemia, but in those cases the course of the disease is rapid, and not insidious as in tuberculosis.

Treatment.—In the early stages rest and counter-irritation are indicated. An apparatus such as that shown in Fig. 74 may be employed. When there is pus, free openings and drainage must be secured. Injections of iodoform emulsion should have a thorough trial; cheesy and broken-down tissues should be carefully removed; pus-cavities should be scraped out and necrosed or carious bone got rid of by chisel and Volkmann's spoon. As a retentive apparatus a plaster cast controlling the pelvis and both thighs down to the knees is very suitable. The patient should be constantly kept in the recumbent position.

The *prognosis* of this disease is, as a rule, very unfavorable.

The Knee-joint.—Tuberculosis of the knee has many characteristics in common with hip-joint disease. The bone is the starting-point, as a rule, in children, while the synovial membrane is the first structure to suffer in adults. The lower end of the femur is most frequently the seat of the infection, next in order comes the head of the tibia, and lastly the patella.

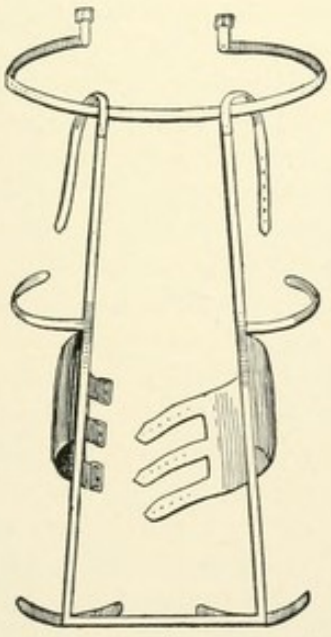


FIG. 74.—Apparatus for treatment of sacro-iliac disease (Jones).

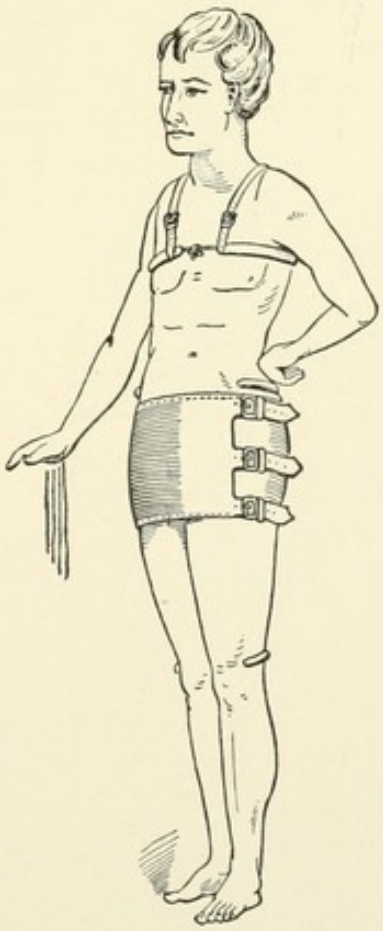


FIG. 75.—Patient in apparatus (Jones).

Symptoms.—Slight pain, or disinclination to use the joint, or a limp may be the first indication of the disease. The pain is localized, and tenderness on pressure over the affected portion of bone can often be elicited. As the arthritis advances the condyles appear to be swollen—a condition which has given rise to a great deal of discussion. This swelling is not in the bone itself, but in the tissues covering it. Rigidity

and atrophy of muscles define the character of the disease here, just as at the hip. Swelling of the whole joint comes sooner or later, and so characteristic is it of disease of the knee that the whole disease is often spoken of as "white swelling." Effusion of fluid is most noticeable on either side of the patella. Flexion is a symptom of great importance, and should be controlled by early treatment, as it rapidly increases and is sure to result in deformity (Fig. 76). Pain is not a trustworthy symptom. It may be but slight, even when extensive ostitis is present, and it may be felt at the hip or acetabulum and throw the surgeon off his guard.

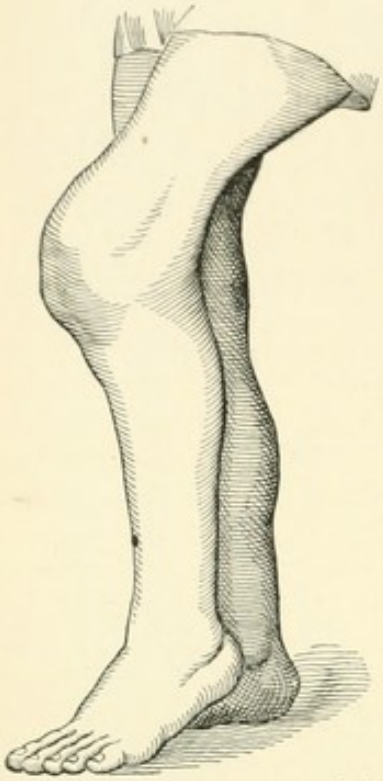


FIG. 76.—Tuberculosis of the knee-joint (from a photograph in the collection of Dr. Gillette).

Treatment.—The principles of treatment are practically the same as already stated in speaking of the hip. Rest can be very effectually maintained by extension and the recumbent posture. Plaster of Paris and the use of crutches can be resorted to when the acute symptoms are well under control and the patient can move about without increasing the pain. When the fluid distends the joint or threatens to open spontaneously, aspiration or incision should be resorted to with the view of avoiding septic infection. Injections of iodoform should have a fair trial; and lastly, when every other means fail and the joint is doomed to destruction, resection or amputation will have to be considered. Nor should operative interference be too long delayed: when there is clear evidence of a localized ostitis at the lower end of the femur or head of the tibia the removal of the diseased focus cannot be too early effected.

A grating sound when the bones are rubbed together would indicate an extensive destruction of bone-tissue, and would probably call for typical resection, while old standing cases with long-continued suppuration, numerous sinuses, and low vitality will necessitate amputation.

The Ankle-joint.—Tuberculosis in the ankle begins, in the majority of cases, as a synovial affection. When the bone is the primary seat of disease, it may be looked for in the parts of the articulation which have to bear the weight of the body, especially in the astragalus, the upper part of the malleoli, the os calcis, and the tarsal bones. In some cases the disease starts in the sheaths of the tendons crossing the joint.

Symptoms.—When the disease begins in the synovial membrane the early symptoms are stiffness, slight pain, and later a fulness of the joint, particularly in front outside the flexor tendons and at the sides behind the malleoli. In the osseous variety pain is likely to be a marked symptom, and a localized ostitis may be recognized at an early period as manifested by tenderness on pressure. Swelling comes later, and gives the idea of an increase in the thickness of the bones. The

joint gradually takes on the globular shape, the skin becomes glossy and white or red from congestion, and the foot assumes the position of plantar flexion.

Treatment.—Immobilization should be resorted to as soon as a diagnosis can be made. Plaster of Paris is a suitable appliance, care being taken to place the foot at a right angle to overcome the tendency to plantar flexion just mentioned. When the starting-point is a localized ostitis, an incision should be made, the diseased focus removed by gouge, chisel, and Volkmann's spoon, the cavity packed with iodoform gauze and allowed to heal by the open method. Injections of iodoform emulsion are indicated especially when the synovial membrane is prominently affected. When there is extensive destruction of the articulation resection is the proper course.

The Shoulder-joint.—The synovial membrane is the first structure to suffer. When the affection begins in bone it is the upper epiphysis of the humerus. Pain is not so prominent a symptom as in other joints, and the disease may terminate in bony ankylosis with comparatively little suffering. Impaired movement, especially that which requires elevation of the arm, muscular wasting, especially of the deltoid and supraspinatus, are the early symptoms, with localized tenderness on pressure when the bone is affected. Suppuration is not so common as in other joints.

Treatment.—The joints of the upper extremity are more amenable to treatment than those of the lower, for the following reasons: They do not have to sustain the weight of the body; they are smaller articulations; and they can be more easily immobilized without confining the patient to bed. The treatment is immobilization by plaster of Paris to control all movements, even to the fingers. When abscesses form they are likely to point in the axilla and should be treated by incision and drainage. When the head of the bone is destroyed resection of the joint becomes necessary—an operation which has afforded encouraging results.

The Elbow-joint.—The characters of tuberculosis in this joint are so well marked that diagnosis is not difficult. Children and young adults form the majority of the patients, and the synovial membrane is the structure first affected. The early symptoms are—a fulness on either side of the triceps tendon, wasting of the muscles, and gradually increasing flexion of the joint. As the disease progresses the elongated spindle-shaped swelling involves the elbow; pronation and supination of the forearm are lost, the patient making awkward attempts to replace these movements by rotation at the shoulder. While the swelling is at first firm and gelatinous, it eventually breaks down and liquefies; the skin becomes thin and sinuses form, followed by long-continued suppuration.

Treatment.—Perfect and long-continued rest in a position of flexion gives good results. When possible the joint should be maintained at a right angle from the first or gradually brought to that position as the patient can bear it. When suppuration takes place, a plaster-of-Paris cast with fenestra for dressing, irrigation, and drainage should be employed. In far-advanced disorganization of the joint resection should be practised, as the results in this articulation are more satisfactory

than in any other, almost perfect movement being acquired in favorable cases.

The Wrist-joint.—The diagnosis of tuberculosis of the wrist seldom presents any difficulty. It commonly is an extension of disease from the carpal bones or a sequel of teno-synovitis. Its progress is, as a rule, more rapid than is the case with other joints. It is found in children and adults, and frequently in persons beyond middle life. The motions of the joint are restricted and painful at an early period; atrophy of the muscles and swelling of the joints are marked, giving the hand an elongated appearance.

Treatment.—The general principles of tuberculosis as described in other joints.

The Phalangeal Joints.—These are not often affected. From a diagnostic point of view disease here is important, owing to its resemblance to syphilitic dactylitis. The history of the case is generally sufficient to decide the question, and should any doubt exist a few weeks of antisyphilitic treatment will settle it.

Rheumatic Arthritis.—**Acute rheumatic arthritis** is a medical rather than a surgical disease, and is fully dealt with in works on the practice of medicine. The symptoms are very characteristic when a number of joints are simultaneously affected, but when only one joint is the seat of disease it may be a serious question to decide between rheumatism and osteo-arthritis. This monoarticular form, however, is very rare. The attack may begin with a single joint, but others soon become involved, while perhaps the symptoms subside in those primarily affected.

The *symptoms* are those of acute synovitis. Pain is unbearable on the slightest movement. Swelling is marked, but suppuration rarely takes place. The arthritis subsides with the termination of the general disease.

Chronic rheumatic arthritis may be a sequel of the acute form or may come on insidiously as a result of cold or exposure. It has many of the characters of chronic synovitis due to other causes, but there is, in addition, a tendency to tissue-changes which are peculiar to this variety. The synovial membrane is thickened and produces a creaking sound. Plastic exudation takes place, producing a thickening of all the periarticular tissues and leaving the joint permanently enlarged.

Treatment.—According to the stage of the affection the joint should be treated on the principles already laid down. In chronic cases constitutional treatment may with advantage be supplemented by baths, friction, and massage.

Gonorrheal Arthritis (**Gonorrheal Rheumatism**).—What has been long considered as rheumatism in connection with gonorrhea is more properly regarded as arthritis. It occurs in different forms—as simple intermittent arthralgia, as a chronic inflammation with copious effusion into the synovial sac (hydrops articuli or hydrarthrosis), as a sero-plastic arthritis, and as a suppurative disease of the joint. Whichever of these forms is manifested, the knee is, in a large majority of cases, the articulation to suffer. Although many authors state that this affection is often connected with any irritation of the urethra, such as might be caused by the simple passing of a catheter, it is doubtful if it

ever really exists without the presence of the gonococcus of Neisser. The persistence with which these germs lie dormant in the urethra renders it probable that when an arthritis is set up by the passage of a catheter it is an auto-infection from latent gonococci or their ptomains.

Apart from the symptoms common to arthritis due to any other cause, some special characters are to be noted:

1. In the acute form the pain is intense, worse at night, and especially on movement. Atrophy of the muscles takes place rapidly; the febrile symptoms run high, causing loss of strength and weight at an early period. Fibrous ankylosis is a common result.

2. In the chronic form pain may be absent almost throughout, while at the same time the joint may be greatly distended. Suppuration is rare.

Neuropathic Arthritis, or Charcot's Disease.—This is an osteo-arthritis observed in patients suffering from locomotor ataxia, and first described by Charcot in 1868. The disease is due to changes in the spinal cord, probably the anterior cornua. The following are its special features: (1) Pain and constitutional disturbance are frequently wanting. (2) The destruction of the joint-tissue is fearfully rapid. Not only is the articular end of the bone destroyed, but a considerable portion of the shaft may come away in fragments. The ligaments break down and favor pathological dislocation. Grating of the eroded bones may be easily elicited at an early period. (3) The knee and other large joints are those most frequently affected.

Gouty Arthritis.—Gouty arthritis has very characteristic symptoms and is easily diagnosed. No period of life can be strictly said to be exempt, but the rule is that it occurs in patients about middle life or after. It is essentially hereditary, but the frequency of attacks and their severity depend very much upon the patient's manner of living. The smaller joints are those most frequently affected, and especially the ball of the great toe, the metatarso-phalangeal. The disease may be acute or chronic.

1. **Acute.**—The type of inflammation is a synovitis attended with a turbid effusion of serum containing urate of soda.

Symptoms.—The patient may or may not have warning of an impending attack by a feeling of malaise lasting for several days. The first local symptoms come on suddenly at night, with intense pain in the affected joint, generally the great toe. The part is exquisitely sensitive, the weight of the bed-clothes becomes intolerable, and the pain is described as that caused by a red-hot iron. The skin is red or dusky red, congested, and hot; the parts at and about the joint are swollen and edematous. The constitutional disturbance is generally slight. In cases of moderate severity the pain subsides toward morning, the swelling disappears, and the joint is probably as well as before. In severe forms the attack returns night after night for perhaps a week or more.

2. **Chronic.**—The symptoms here not so marked, but the structural changes are greater. Mobility is impaired, and deformity exists to a greater or less extent. The deposits of urate of soda give the disease its special feature. They are called chalk-stones or, more learnedly, tophi, and you may look for them beneath the skin at the smaller

joints. The hands are often affected, giving the knuckles an enlarged appearance. The gouty old whistplayers of England were in the habit of utilizing their chalky knuckles to mark the score of the games on the card-table. The urine is usually loaded with uric acid, the skin is predisposed to eczema, and the throat, tongue, and pillars of the fauces are smooth and glossy.

Treatment.—In the acute form rest, with a local application for the relief of pain. The following has been extensively used:

℞.	Atropin,	gr. j;
	Morphin,	gr. viij;
	Aqua,	℥j.

A piece of lint soaked in this lotion is laid over the inflamed joint, covered with oiled silk and absorbent cotton. The constitutional treatment for gout must also be carried out.

CHAPTER VI.

INJURIES AND DISEASES OF THE DIGESTIVE SYSTEM.

I. THE LIPS, PALATE, JAWS AND GUMS, TONSILS, PHARYNX, AND ESOPHAGUS.

The Lips.

THE surgery of the lips embraces a consideration of malformations, inflammations, morbid growths, and wounds.

Hare-lip is by far the most frequent of the malformations of the face, and depends upon a congenital failure of union of the mesial nasal process with that of the superior maxilla. It derives its name from the resemblance to the cleft which exists in the upper lip of the hare, rabbit, and other allied animals; but the analogy between this defect in the human lip and the normal conformation is not strictly correct, the cleft in the latter being *exactly* in the median line, while in the child it is *to one side of the center.* It is often associated with club-foot and other congenital malformations.

The face is developed partly from a central process, the *fronto-nasal plate*, descending from the front of the cranium between the ocular vesicles. From this are developed the prominent part of the nose, the septum nasi, the columna, the central part of the upper lip, and the intermaxillary bone with the incisor teeth. The remainder of the face above the line of the lower jaw is developed from a lateral process on each side, the *superior maxillary plate*, which gradually grows forward till it coalesces with the vertical process just mentioned. From these processes are developed the cheeks and the whole of the superior maxillary bone, except the part of the palate corresponding to the incisor teeth, which, as already stated, is formed from the fronto-nasal

plate. The lower jaw and the soft parts covering it are formed from similar processes, the inferior maxillary plates advancing from each side and coalescing in the middle line. The superior and inferior maxillary plates coalesce at each side, leaving the open space of the mouth in the middle line. The mode of origin of the various deformities of the face is therefore evident. If one maxillary plate fails to unite



FIG. 77.—Double hare-lip before operation (Graham).

FIG. 78.—Single hare-lip before operation (Graham).

with the naso-frontal in front, a cleft will be left through the upper lip on one side of the middle, forming a single or simple hare-lip (Fig. 78); if both plates fail to unite, a double hare-lip results (Fig. 77), and the intermaxillary bone may be left adherent to the tip of the nose and septum nasi (Fig. 81).

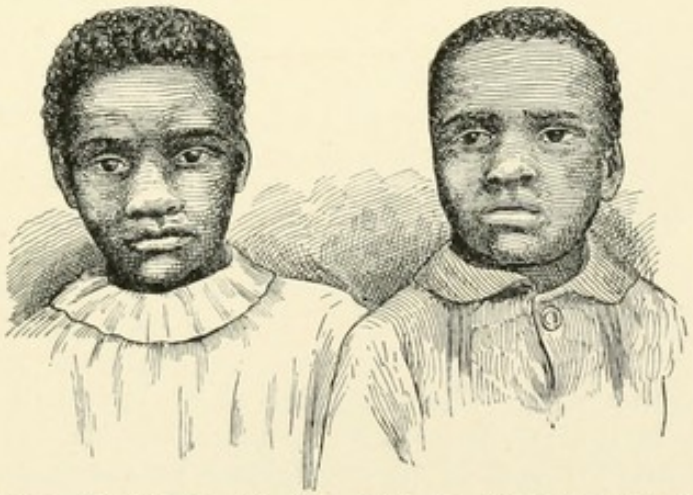


FIG. 79.—Double hare-lip after operation (Graham).

FIG. 80.—Single hare-lip after operation (Graham).

If at the same time the development of the naso-frontal process is arrested, we get the rare condition of a wide gap in the middle line, with absence of the incisor portion of the upper maxilla. If the anterior parts unite, but development is arrested posteriorly, cleft-palate results, the fissure being single, and in the middle line as far as the posterior part of the premaxillary bone.

If both sides fail to unite completely, the fissure is single behind and double in front, passing on each side of the intermaxillary bone. In exceedingly rare cases the fissure of the hare-lip has been seen

extending upward on one side of the nose toward the eye. The cleft in the lip may be single or double. The proportion of single is about nine for one that is double.

The *diagnosis* of hare-lip is simple. In the examination of a case note whether the cleft is single or double, whether it is confined to the soft parts or involves the bony structures. When single, the fissure is to one or the other side of the middle line, and more frequently to the left. In the cleft itself the mesial side of the gap is usually rounded; the outer edge is flattened and the frenum at the angle is long and subcutaneous.

The cleft generally extends upward into the corresponding nares, the inner side of the chasm being continuous with the septum narium; the other with the alæ nasi, making an uninterrupted communication between the oral fissure and cavity of the nose. The mucous membrane of the jaw covers both sides of the gap. When double hare-lip exists it is likely to be complicated with cleft-palate (Fig. 81).

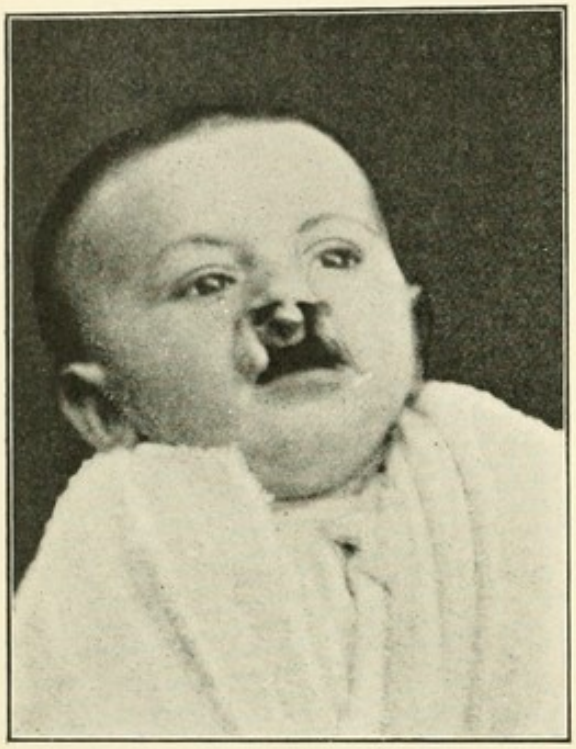


FIG. 81.—Double hare-lip with cleft of hard palate and cleft of intermaxillary bone (from a photograph in the collection of Dr. C. H. Mayo, Rochester, Minn.).

Treatment.—The only treatment is operative. This should be resorted to at an early period. The time chosen must depend upon the strength of the child and the severity of the necessary operation. In a vigorous infant with a single hare-lip it can be done in a few days after birth. As a general rule, however, from the sixth to the twelfth week will be the most suitable time.

In complicated cases of simple cleft it is better to wait for four or five months.

An endless variety of operations has been invented. The principles which have to be kept in view are to remove by a clean incision the edges of the cleft; to separate the lip, and if necessary a part of the cheek from its attachment to the jaw; to bring the edges into close apposition; to unite them by means of sutures or hare-lip needles without tension. The most important point is to guard against a notch at the vermillion border of the lip, and this is accomplished by leaving a redundancy of tissue at the lower end of the fissure, as seen in Fig. 82.

Operation.—The patient, having been anesthetized, is wrapped in a sheet to restrain the arms, and held on the lap with the child's head resting against the assistant's chest. The lip is then freely separated from the gums and from the deeper parts of the cheek, so that the cleft can be closed without the slightest tension. This is best done with scissors curved on the flat, care being taken to keep close to the

bone. One side of the cleft is next transfixed with a sharp, narrow-bladed knife, beginning well up in the angle and cutting downward in the arc of a circle the concavity of which is directed toward the middle line. The strip may be left attached at its lower end, and afterward

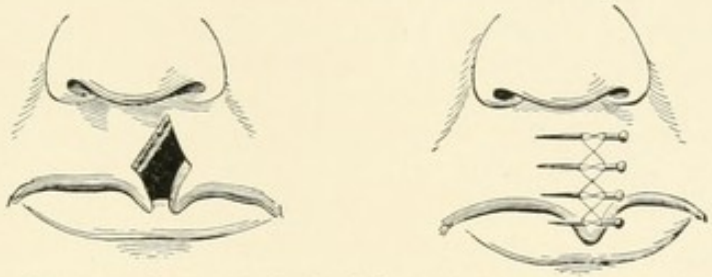


FIG. 82.—Operation for single hare-lip (after Malgaigne).

made use of to fill the notch which may be left when the parts are brought together. Both sides of the cleft having been pared alike, the raw surfaces are brought together, care being taken that a little projection is left at the lower end of the united fissure. This projection contracts during the process of healing and guards against the formation of an unseemly notch. Bleeding, if severe, is arrested by the pressure of hemostatic forceps gently applied to the whole thickness of the lip or by the gentle pressure of the lip between the thumb and fore finger of an assistant. The blood-supply will be considerably lessened by the assistant's making pressure upon the facial arteries as they wind around the lower jaw. The parts accurately fitted are next held together by silkworm-gut sutures. The upper stitch is inserted first to close the angle, and the two or three others to close the remainder of the cleft. The vermillion border will generally require a fine catgut suture. Hare-lip pins are still employed by many surgeons, but silkworm gut fulfils every indication.

The simplest dressing is a coating of iodoformized collodion. To lessen the strain on the stitches a piece of adhesive plaster can be stretched from cheek to cheek. In ordinary cases the sutures can be removed about the fifth day.

Double hare-lip requires practically the same treatment. The central portion must be pared in the same manner as the borders of the cleft. When this central portion is too narrow to be of any use in filling up the gap, it is best to remove it and treat the case as one of single hare-lip. In some cases the central portion is short and only helps to fill the upper part of the cleft, while the sections removed from the sides of the fissure are made to meet in the middle line below (Fig. 83).

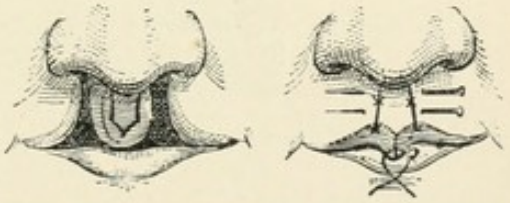


FIG. 83.—Operation for double hare-lip (Keen and White).

Protrusion of the intermaxillary bone is a complication of double hare-lip that requires special attention. The projecting bone should be preserved if possible—not that the bone does much good or that the incisor teeth which grow from it are likely to be fully developed, but its removal leaves the lip without support and causes an unsightly appearance. In many cases the pro-

jection can be pressed back into position either by the finger and thumb of the operator or by the aid of forceps covered with rubber. When replaced the bone should be fixed in position by chromicized catgut, as the least pressure forward will interfere with the healing of the lip. There may be cases in which it will be found advisable to correct this deformity and then wait a week or two before operating on the lip. When the deformity is such that the projecting portion cannot be returned, the bony structure should be removed, saving the periosteum and soft parts to help in maintaining the shape of the lip.

Fissures of the lower lip are very rare, only three or four cases being on record. The fissure is in the mesial line, and the treatment is the same as that required in simple cleft in the upper lip.

Macrostoma is a deformity in which the opening between the lips is abnormally large. It is either congenital, resulting from non-union of the superior and inferior maxillary plates, or the result of a wound which has imperfectly healed. In either case the treatment consists in freshening the edges and uniting them by sutures.

Microstoma is the opposite condition, in which the opening to the mouth is abnormally small. In some cases the opening of the lips is so much contracted as to interfere with the introduction of food into the mouth. It may be caused by the cicatricial contraction which follows burns and ulcers or it may be congenital. The treatment consists in extending the opening to a sufficient length toward the cheeks



FIG. 84.—Deformity resulting from a burn five years unhealed (from a photograph in the collection of Dr. Lincoln).

and attaching skin and mucous membrane by fine sutures. When the tissues are very much consolidated by cicatricial contraction there will be difficulty in maintaining the opening, and it will be necessary to stretch the parts mechanically and maintain the dilatation for a long period. A still greater congenital defect is total closure of the anterior buccal orifice (atresia oris).

The *treatment* consists in making an artificial opening by a longitudinal incision and suturing the mucous membrane to the skin, so as to give the normal vermillion border to the lips. The cicatrices resulting from burns about the face and neck often produce unsightly deformities, drawing down the corners of the mouth or causing eversion of the lips (Fig. 84). A preternatural length of frenum labii will also give rise to eversion.

Cases of this kind require for treatment the removal of the cicatrix and the substitution of healthy integument from an adjacent part.

If the defect be due to a long frenum, the removal of a V-shaped piece from this fold and permitting it to heal by granulation, in order to obtain the benefit of some cicatricial shortening, is indicated.

Nevi of the lips are usually congenital. The minute vessels of the mucous membrane or of the skin, or of both structures combined, may be involved, and when limited to the cutaneous surface of the lip the growth appears as a small red or purple spot. When located in the mucous surface it is recognized as a soft, spongy, vascular mass appearing on the inner surface of the lip, having a bluish or purplish color, which, in cases affecting the whole thickness of the lip, is visible through its cutaneous surface. The tumor enlarges during excitement, as in laughing or crying, and can be deprived of most of its blood by compression, leaving an apparently empty sac. These vascular tumors increase with the growth of the child, and the earlier they are removed the better; they may extend to the cheeks.

In many cases the disease is very limited in extent, and then should be excised and the edges of the wound united with fine catgut or horse-hair sutures. When more extensive the growth may be transfixed by two needles placed at right angles and surrounded by a ligature drawn sufficiently tight to arrest circulation, or the growth may be strangulated by multiple ligatures placed at right angles to each other.

Electrolysis is another method employed when the nevus is large. Two or three needles are passed into its interior and connected with the negative pole of a battery. Another needle is introduced into the growth and attached to the positive pole. In a short time the tissue-destruction which is in progress within the tumor will be indicated by little bubbles of gas which make their way by the side of the needles. Coincident with this the blood in the growth undergoes coagulation, and the mass is absorbed and gradually disappears.

Other tumors found in the lips are the following:

(*a*) **Cysts** are caused by the distention of the labial follicles due to the destruction of the excretory ducts. Small cysts are treated by laying open the sac, turning out the contents, and cauterizing the cavity with nitrate of silver. If large they should be excised.

(*b*) **Lipomata,** or fatty tumors, are exceptionally rare.

(*c*) **Myxomata** are quite uncommon, and are found in the submucosa, and are filled with a yellow, gelatinous fluid. Excision is the proper treatment.

(*d*) **Adenomata,** a new formation of the glandular elements of the lip, forming a tumor, are very rare. Excision is the remedy.

(*e*) **Sarcomata.**

(*f*) **Fibromata,** occurring as hard, florid, pedunculated enlargements, slow of growth and insensible to pressure.

Treatment.—Excision, except perhaps papillomata, which may be destroyed by caustics if of the soft or mucous kind, but if of the corneous variety they should be excised.

Furuncle and **carbuncle** are sometimes found on the lips. They are specially important from the clinical fact that they are often attended with septic symptoms, believed to be due to absorption by the facial vein. They are exceedingly painful, and often produce cerebral symptoms which have been known to prove fatal.

The *treatment* consists in early free incision through the free border of the lip, followed by antiseptic dressing.

Hypertrophy of the lips is quite common in a moderate degree, and requires no attention, but cases are occasionally met with in which the overgrowth is a very trying deformity. One or both lips may be affected and the hypertrophy may be partial or general. The partial form of "double lip," as it is sometimes called, consists in a redundancy of the mucous membrane and submucous tissue, and usually more prominent on either side than at the middle line. It is sometimes so marked as to interfere with the function of the lips, and is always unsightly.

The *treatment* consists in the removal of a longitudinal wedge-shaped piece of the redundant tissue and the closing of the wound with sutures.

Wounds of the lips bleed freely, but hemorrhage is readily checked by grasping the thickness of the lip between the finger and thumb or by applying forceps to the bleeding vessel. Sutures which approximate the edges of the wound will also arrest the hemorrhage. In suturing a wound of the lip the greatest care should be taken to ensure accurate approximation, and thus avoid uneven surfaces after healing has taken place.

Inflammation.—Chapped or cracked lips are troublesome affections, particularly during the winter months. In a diagnostic sense they are of little importance, except that a fissure which continues for a long time should excite suspicion of commencing epithelioma. Simple fissures or chapped lips as a rule heal readily when protected by court-plaster, collodion, or ointment. In children fissures often appear on the upper lip, and are frequently attended with an unhealthy discharge from the nose which excoriates the skin below, with tarsal ophthalmia, enlarged glands in the neck, and signs of tuberculosis. Constitutional treatment is here indicated. The neglected fissures are apt to leave clefts which cause deformity, and should be remedied by paring the edges and bring them accurately together by horsehair sutures.

When cracks are observed in the corners of the mouth, a careful inquiry should be made into the case, as it is not uncommon to find such lesions in persons suffering from constitutional syphilis. A neglected chap or crack or one which has been irritated by smoking is liable to degenerate into a sore or ulcer of considerable depth, with irregular edges, and with unhealthy granulations which bleed at the slightest provocation, as in wiping the mouth or in chewing food.

Touching the sore with silver-nitrate stick and protecting with collodion dressing will serve to ensure its repair. Excision and closing with sutures may have to be resorted to.

Destructive caustics tend to leave an unsightly depression.

Epithelioma.—This is a very common disease of the lower lip occurring in males beyond middle life. In its early stages it is a small persistent ulceration covered with a scab, and supposed by the patient himself to be an ordinary chapped lip, or the growth may begin as a raised papillomatous surface covered with epithelium, or as a crack or fissure, sometimes as a small shot-like tubercle; but, whatever its initial appearance, it is always surrounded by a discoverable degree of submucous induration, By degrees the ulcer enlarges and deepens (Fig. 85) and is surrounded by a hardened ring. When long neglected

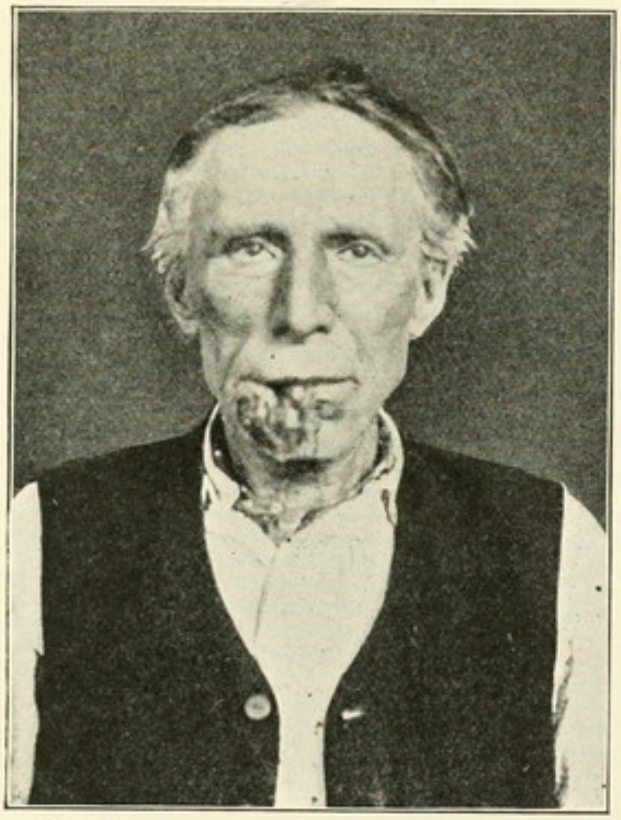


FIG. 85.—Epithelioma of lip (from a photograph in the collection of Dr. Strickler, New Ulm, Minn.).

the glands beneath the jaw become enlarged, the ulceration becomes wider and deeper, its edges hard, irregular, ragged, and covered with fungous granulations which bleed on being handled. The sore pours out an offensive discharge, and the patient is harassed with sharp burning, lancinating pains. The lip is destroyed, nutrition fails, the sufferer is unable to rest without the aid of opiates; he becomes cachectic, and death at last comes mercifully to his relief.

The only disease with which epithelioma is likely to be confounded is chancre. The points of difference are the following: Cancer of the lip occurs in males, and nearly always it is the lower lip. The lymphatics are not affected until late in the disease, and its progress is slow. Chancre, on the other hand, is more common in females and in

young persons. The lymphatics are involved at an early period. There are sore throat, skin-eruptions, and other manifestations of syphilis, and constitutional treatment is readily responded to. An ulceration in a man past middle age which has lasted several months and refuses to heal should be excised.

Treatment.—Operation for the complete removal of the cancerous portion is the only treatment to be thought of, and if resorted to before glandular involvement has occurred, the results are very satisfactory. In ordinary cases the V-shaped incision is best, care being taken to cut wide of the disease. In advanced cases the whole lip, and even a part of the jaw, must be removed, and a new lip formed by transplantation of flaps from healthy skin.

The Palate.

Cleft-palate is a malformation very frequently met with in conjunction with double hare-lip (Fig. 86). The cleft may be confined to the soft palate or may extend through the bony palate as well. It more rarely forms a complication of single hare-lip, and may even occur in children whose lips are perfectly formed. The signs of cleft-palate in combination with hare-lip are too obvious to be overlooked, but when it occurs alone it may escape observation for some time. The first intimation is usually given when the infant attempts to take milk from the breast or from a spoon, with the result that the milk escapes by the nostrils instead of being swallowed. In some cases the nasal character of the infant's cry is sufficient to attract attention to the deformity.



FIG. 86.—Hare-lip and cleft-palate (from a photograph in the collection of Dr. C. H. Mayo, Rochester, Minn.).

The perforations in the palate produced by syphilis cannot readily be mistaken for a cleft. When due to syphilis the openings in the soft palate are not symmetrical; there are usually other signs of the specific disease, and there is a large amount of scar-tissue.

Treatment.—The researches of Dr. Haughton of Dublin have proved that the closure of the hard palate is greatly influenced by the character of the food. A mother who shows any hereditary tendency or who has borne children with this deformity should, during pregnancy, keep her health up to the

best possible condition, and should partake largely of foods which tend to bone-formation. When the cleft is in the palate alone, the nourishment of the infant is a matter of great importance, as the danger is that the child will waste away for want of nutrition. A flap attached to the nipple of a feeding-bottle which closes the cleft while the child sucks is a simple and useful expedient. A long nipple with a hole in its lower side is often satisfactory, as also feeding the child by means of a long-necked bottle, so that the fluid is poured at the back of the throat.

Operative treatment affords the best chance of repair, and has taken the place of silver plates formerly in vogue. Much difference of opinion has existed as to the time when operation should be resorted to, but the following points may be taken as practically settled:

1. When there is hare-lip complicating cleft-palate operate as early as possible upon the lip. Several objects will be gained by this course: The closure of the lip will help the child to suck; it will remove a hideous deformity, and thereby lessen the burden of the parents; and it will be found that the cleft in the hard palate will gradually close to a considerable extent. The tendency of the two sides of the hard palate to approach each other continues for several years after birth, and is greatly favored by the closure of the cleft in the lip.

2. Closure of the palate should not be undertaken until after the first dentition or about the end of the second year. Most children make earnest efforts to talk about this period. Should the operation be delayed, that peculiar nasal twang will have been acquired which is so difficult to unlearn in riper years. Some surgeons would limit operations at the end of the second year to cleft of the soft palate only, while those of the bony palate are left to the twelfth year.

In estimating the probable result of an operation much depends upon the shape of the palate. Persons with highly arched but healthy palates are observed to speak with a nasal twang. Sir William Fergusson pointed out that in cases of highly arched palates (resembling a Norman arch in section) it is not difficult to make the flaps approximate, but these cases are often disappointing as regards the power of speech which the patient afterward enjoys, while in palates with a slight arch (Gothic arch) the flaps are brought together with much greater difficulty, but when the operation is successful speech is much better. Another point upon which success largely depends is the *length* of the palate, for if it does not go back far enough to shut off the mouth from the nose, the person will speak with a nasal intonation. This point is decided in this manner: Grasp the patient's chin and hold his mouth open while you ask him to swallow. If in the act of swallowing the edges of the cleft in the soft palate come in contact throughout their whole length, while at the same time the superior constrictor and palato-pharyngeal muscles closely approximate the palate and pharynx, the case is one favorable for operation. Union may with certainty be expected, and phonation will probably be satisfactory (Heath).

Operation.—Staphylorrhaphy is the name applied to the operation for closure of the cleft in the soft palate. It is an old operation, having been first performed by a Parisian dentist, Le Monier, in 1764. As performed at the present day it is done as follows: The patient, well

under the influence of chloroform, is placed upon a high table with the head turned toward the right side, and so held that any blood which flows will not gravitate into the pharynx. A Whitehead or other suitable gag is inserted and the mouth forced open.

First Step.—The end of one side of the cleft is seized by a tenaculum forceps and held tense, while a thin-bladed knife cuts a narrow strip along the side of the cleft and up into the angle (Fig. 87). The other side of the cleft is dealt with in a similar manner, care being taken to go well up into the angle and leave a clean-cut surface throughout.

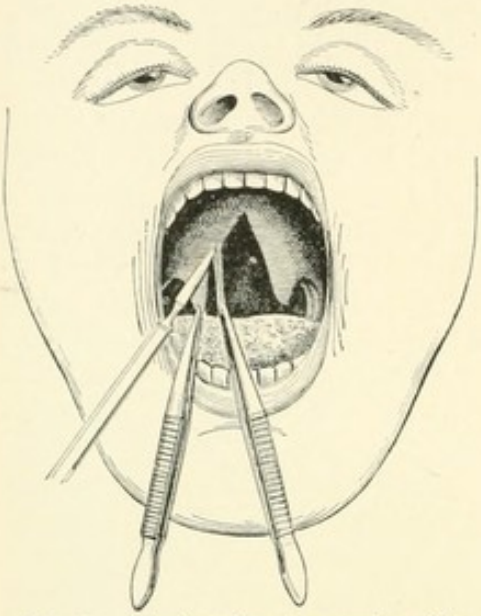


FIG. 87.—Freshening the margin of the cleft in the operation of staphylorrhaphy (after Malgaigne).

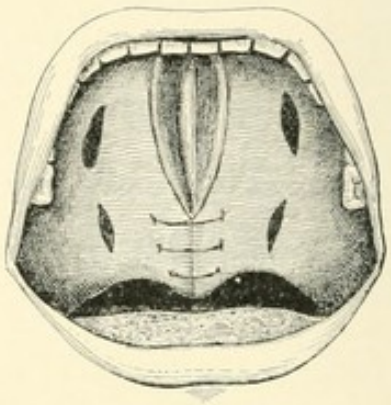


FIG. 88.—Soft palate sutured, with lateral incisions for the relief of tension.

Second Step.—The placing of sutures. Silver wire, chromicized catgut, and silk have been used, but the most suitable material of all is probably silkworm gut. Needles, too, of various kinds have been invented, but a half-curve Hagedorn in a needle-holder is as good as any. The needle should be inserted about three lines from the margin and about half an inch from the angle of the cleft. Other sutures are passed in a similar manner at distances of half an inch until the ends of the cleft are reached.

Third Step.—If the sutures can be tied without producing undue tension, this is done at once, and the operation is finished; but if the strain is too great to allow the parts to come easily together, the tensor palati muscles must be divided. This is done by making an incision in the soft palate just internal to the hamular process, and cutting upward until the muscles are severed. The position of this incision is seen in Fig. 88. The stitches should be removed about the eighth day.

Uranoplasty is the name of the operation for closure of the hard palate, and the method of Sir William Fergusson is generally followed. The edges of the cleft should be pared as in staphylorrhaphy, and sutures inserted, but left untied. Midway between the cleft and the alveolus an incision is made through the soft parts down to the bone.

By means of a chisel the bone itself is next cut through, and, using the chisel as a lever, the bone on each side is forced toward the middle line and the cleft thus obliterated. The sutures are now tied and the lateral incisions packed with iodoform gauze.

Closure of the hard palate may be effected without cutting the bone as just described. Dr. Mason Warren of Boston was the first to operate by detaching flaps consisting of periosteum and mucous membrane. The edges of the cleft are pared as in the preceding. By means of a periosteal elevator all the soft parts are raised from the hard palate, care being taken not to tear the arteries passing through the anterior and posterior palatine canals. The soft palate is cut away from the horizontal plate of the palate-bone, as tearing is apt to produce sloughing. Sutures are now placed in position, but not tied. If, as usually happens, the tension on the stitches is too great, this is remedied by making an incision on each side midway between the sutures and the alveolar border.

The after-treatment in all these operations consists in thoroughly irrigating the mouth with mild antiseptic solutions, such as boracic acid, and in painting the incision with iodoformized collodion. Liquid food should be given for three or four days, and the stitches removed at about the end of a week. Should one or more spots have failed to unite, they can be touched with a stick of nitrate of silver or by the point of a thermo-cautery.

So much for operations as they are generally performed. It must be granted that they leave a great deal to be desired. Waiting for the end of the second year to close a soft palate and for twelve years to close a cleft in the bony palate is tedious and unsatisfactory. Muscles are allowed to remain inactive and to atrophy which can never afterward be properly developed, and as a consequence it is rare to find one of these patients who has perfect phonation. The crying demand is, then, for an operation that will close the cleft in early infancy and allow the patient to exercise these muscles from the first. Such a procedure will prevent the acquiring of nasal intonation and allow the child to speak naturally from the beginning. For the attainment of this object the operation devised and practised by Dr. Brophy of Chicago deserves attention. In cases of cleft-palate with hare-lip he advocates operating on the palate first, as it gives better access to the mouth, and the closure of the cleft in the alveolar process is better accomplished when fully exposed to view through the diseased lip. The operation is thus described by Dr. Brophy:

"First, place the patient on the table with the face toward the light. Introduce the oral speculum and vivify the edges of the fissure; do it thoroughly and with a bold hand. A mere scraping of the mucous membrane will never suffice to bring about union which will be permanent and satisfactory. On the hard palate trim the opposing surfaces of the bone as well. If this is well done, it will secure a sufficient exudate to make the operation a successful one, in this respect at least. The knife will easily cut through the soft bone of the hard palate and the alveolar process of young patients. Then raise the cheek, and well back toward the posterior extremity of the hard palate, just back of the malar process, and high enough to escape all danger of not being above

the palatal plate of the bone, insert a large braided silk suture, carrying it through the substance of the bone, so that it will come out at a corresponding position upon the opposite side. The silk suture is more easily introduced by the needle, but a wire suture of silver should be substituted for it and drawn through in its place, and this wire may be doubled in case the condition of the parts and the tension upon the tissues necessary to approximate them seem to require it.

"Nearer the front portion of the palate insert another wire, carrying it through the substance of the bone above the palatal plates, and out through the other side in a position corresponding to the place of entrance. Thus we shall have one wire passing over the palate in front of the malar process of the bone and another behind it.

"The next step is to take a lead button, moulded to fit the convexity of the part, and long enough to pass beyond the exit of the wire sutures, so that they will pass through it. Have it provided with eye-holes, through which are passed the protruded ends of the wire upon each side; twist them together—that is, the right end of the anterior wire, and the same on the left. It is good practice always to twist wires in one way, either from right to left or from left to right. These are heavy-tensioned sutures, and once approximated the parts cannot be separated by the patient. If from lack of tissue or from firm resistance of the parts the fissure cannot be closed with these wires, there is a further method to be employed which will obviate these difficulties. With your knife, after the cheek is well raised, divide the mucous membrane just over the malar process. Here insert a knife in a horizontal direction, and when well inserted sweep the handle around from one side to the other, as from behind forward. In this way a maximum amount of bone is divided and a minimum amount of the mucous membrane. This being done on each side, the bone can very readily be moved toward the middle line. Having thus divided the bones on either side, the wire sutures passing through the lead buttons may again be twisted, and the cleft of the hard palate will be easily closed by approximation of the two sides. The incision in the mucous membrane in making the separation of the bones is as small as possible, for the reason that this membrane must serve to retain the bones in proximity or to hold them nearly together. If, after the parts are approximated, they are kept antiseptically clean, the bones will kindly unite and the palate will be restored, so that its full function will be performed. Separation of the bones is attended with little hemorrhage, and the parts do not usually cause more inconvenience to the patient than the ordinary operation of lifting the hard palate according to the practice of Fergusson.

"The germs of the teeth are sometimes disturbed, for I have found later, when they are erupted, that certain teeth are imperfectly formed. This applies only to the molars of the temporary set, but it is not unlikely that the germs of the permanent teeth may also be disturbed and the teeth made imperfect by this procedure. The palate, too, may be contracted to an abnormal extent; and yet it is a well-known fact that the alveolar process develops with the eruption of the teeth, and experience has convinced me that in mouths thus treated the teeth of the upper antagonize in a normal way with those of the lower jaw.

If, however, the upper superior arch should be abnormally contracted, and when the teeth erupt fail properly to antagonize with their fellows of the lower jaw, means well known to the modern dentist may be employed by which the arch can be expanded and the slight abnormality removed.

" After the approximation of the edges in the manner described the parts should be thoroughly dried, the edges of the wound carefully examined, and, if need be, some fine sutures inserted here and there to ensure perfect coaptation of the parts."

Tumors of the palate are not common. Sarcoma has been observed in a few instances. The tumor is likely to be mistaken for an abscess, and is readily lanced by the unwary. Epithelioma rarely occurs as a primary affection, but may extend to the palate from the gums or tonsils. Fibrous growths resembling epulis are sometimes found upon the hard palate and require removal.

Syphilis.—The manifestations of syphilis as found in the palate are the following :

(*a*) Mucous patches, oval or circular in shape, raised above the surrounding surface, pale blue in color and covered with moisture.

(*b*) Perforating ulcers extending through the hard or soft palate may always be regarded as syphilitic, except when the result of traumatism.

(*c*) Gummata occur as firm, sharply-defined swellings showing a tendency to soften. These must be distinguished from abscess of the palate. An abscess arises near the alveolus, and usually near the incisor teeth, which are painful and may be loosened. This distribution is very important in view of treatment, for an incision is needed in the case of abscess to prevent necrosis of the palate, but in the case of syphilis it is just what is likely to cause necrosis.

(*d*) A serpiginous syphilitic ulcer begins behind the last molar tooth and spreads upward over the palate, healing by one edge and leaving a hard, depressed scar.

(*e*) Extensive ulcerations extending over palate, tonsils, and pharynx, covered with foul gray sloughs and producing great destruction of tissue, are syphilitic, and must not be confounded with diphtheria or malignant scarlatina, the latter of which runs a rapid course.

(*f*) A narrow, highly-arched palate is one of the effects of inherited syphilis (Gould).

The Mouth.

In examining the mouth a good light is necessary. The inner surfaces of the cheeks may show mucous patches or the ulceration of syphilis. Epithelioma is usually an extension from the tongue.

Salivary calculus is felt as a hard, even tumor, tender to the touch, and between the sides of the tongue and the jaw. It may produce but little inconvenience, such as stiffness of the jaw and swelling of the submaxillary gland, but at times the inflammatory symptoms are marked and cause swelling of a great part of the mouth. One finger in the mouth and another under the chin will readily detect the stone, or it can be sounded by passing a probe down the duct.

Treatment.—Make a free incision in the mucous membrane and remove the calculus, taking care not to break it, as it is difficult to get

rid of a number of fragments. The stones vary in size from that of a pea to that of a pigeon's egg.

Ranula is a name given to a cyst beneath the tongue on one or other side of the frenum. It is generally of a bluish color and contains a clear mucus. It is painless, and only causes trouble by its bulk. As a rule the cyst-wall is thin and semi-transparent, but its character is subject to considerable variation. The cause of ranula has been much discussed, but it is generally agreed that it is obstruction and dilatation of one of the mucous follicles.

Treatment.—The old method of treating these cysts was by passing a seton through them, and some surgeons still adhere to this plan. It is better to cut a piece out of the cyst-wall by means of scissors, and then destroy the remainder of the cyst by the application of solid nitrate of silver, or the edges of the incision in the cyst-wall can be held back by stitches.

The Tongue.

Malformations.—The malformations of the tongue are three in number—viz. tongue-tie, hypertrophy of the tongue or macroglossia, and atrophy.

Tongue-tie is very easily recognized. The child is unable to protrude the tongue beyond the gums, and there may be difficulty in sucking. If allowed to go untreated, articulation is affected. The condition depends upon a shortness of the frænum linguæ. All the treatment necessary is division of this band. Place the child on its back on the nurse's lap with the head toward you, place two fingers beneath the tongue, and divide the frenum with scissors, taking care to point the instrument toward the floor of the mouth in order to avoid the ranine artery. A small nick in the membrane is sufficient, after which the division is completed by tearing with the fingers.

Hypertrophy of the Tongue (Macroglossia).—This is a congenital disease, and many of the subjects of it are also epileptics. The tongue is large to begin with, and its growth is greatly increased by repeated attacks of glossitis. As the organ enlarges it produces great discomfort and becomes a hideous deformity. Gradually and slowly enlarging, the tongue passes beyond the cavity of the mouth, distorting the teeth by its pressure and changing the shape of the jaws. Cases have been reported in which the tongue protruded over the chin and down to the sternum. Saliva constantly dribbles from the mouth. Speech is indistinct, and the tongue is hard, purplish in color, and occasionally ulcerated.

Treatment.—Some cases have been reported in which the use of styptics, such as sulphate of copper (Syme), has been successful, combined with pressure. The most satisfactory results, however, will be obtained by the removal of a V-shaped portion of the organ. This is best done by passing stout threads through the end of the tongue, drawing it well forward, and then by knife, galvano-cautery, or écraseur removing the necessary amount of tissue.

Atrophy of the tongue is always confined to one side, and is not congenital. It is found in connection with brain-disease or injury, especially when the hypoglossal nerve is involved.

Injuries of the Tongue.—Common injuries of the tongue are wounds, caused by accidental biting of the organ, due to falls, incision by sharp instruments, the bite of insects, and scalds. The treatment can generally be left to nature. Wounds, when extensive, should be treated by suture, care being taken to use deep sutures. If healing should be retarded by an acrid condition of the saliva, this can be remedied by the use of alkaline washes.

Diseases of the Tongue.—**Inflammation of the tongue (glossitis)** is usually the result of some local irritation or injury, but apart from any local cause an idiopathic acute glossitis is recognized, which is by some regarded as catarrhal, by others as a parenchymatous inflammation. It is a rare affection, and is almost confined to adult males. The first indication of the disease is tenderness of the tongue felt in the mastication of food or in the drinking of hot liquids. Swelling progresses rapidly, until the organ fills the mouth and protrudes beyond the lips. Saliva is secreted in excessive quantities and dribbles from the mouth. At first dry and shining, the tongue becomes ulcerated, and in rare cases deep suppuration takes place. Difficulty of breathing may become so urgent a symptom as to require tracheotomy for its relief. The disease generally runs a course of five or six days, and then subsides.

The ordinary *treatment* consists in giving a saline cathartic and employing a wash of chlorate of potash or a solution of Seiler's antiseptic tablets. When the symptoms are urgent surgical interference is called for. An incision along each side of the raphé near the base of the tongue, deep enough to cause free bleeding, will be promptly followed by relief of swelling and subsidence of the inflammatory symptoms. If suffocation appears to be imminent, tracheotomy is required.

Tuberculosis of the Tongue.—This disease is usually secondary to a manifestation in some other organ, as the lungs or the larynx, and is then recognized without great difficulty. When it occurs as a primary affection its diagnosis is difficult, and more than one tongue has been excised with the idea that it was the seat of cancer. The disease appears as fissures on the sides and tip of the tongue, but more frequently as ulcers, singly or in numbers. The ulcer is frequently stellate in shape, and may attain considerable depth. The edges are sharply cut, but there is no induration around its base.

The *diagnosis* can sometimes be settled by finding tubercle bacilli in scrapings from the ulcer. It is often excessively painful, and runs a course varying from a few months to two years.

Syphilis of the Tongue.—Of all diseases of the tongue, this is probably most common. Fissures are the most common manifestation of the disease, and are very suggestive of the tertiary stage. They may be single or multiple. They are irritable and sensitive to touch, but the surrounding tissue is not inflamed. When situated on the side of the tongue they indicate the secondary stage, and are best treated with mercury, while the tertiary variety yields more readily to iodid of potassium.

Ulceration is superficial in the secondary stage and appears above the edges of the tongue. When deep and covered with a dirty grayish secretion, they are tertiary and follow the breaking down of gummata.

They commonly occur in the dorsum of the tongue. Their edges are sharply defined and their bases indurated.

Chancre on the tongue is exceedingly rare. It is a single ulcer near the tip of the tongue. Its edges and base are indurated, and the glands beneath the jaw are swollen and hard.

Carcinoma of the Tongue.—Perhaps there is no disease which the general practitioner so reluctantly decides upon as cancer of the tongue. An ulcer of the tongue may continue for many months, apparently neither healing nor spreading, giving little or no pain and producing but slight inconvenience. To pronounce such a case cancer would be to strike terror into the hearts of the patient and his friends, and the fear of being in error after all deters the practitioner from making such a diagnosis. These, however, are the very cases suitable for operation, the ones in which an early diagnosis is of value. Another common error is to treat the ulceration by the application of nitrate of silver and other caustics. This can do no possible good, and if frequently repeated the irritation may cause a cancerous development in an ulcer which might remain benign.

In no situation is carcinoma more common, except it be the lower lip; the form it assumes is epithelioma. Scirrhus is exceedingly rare. Men suffer more frequently than women, the ratio being more than five to one. The earliest sign of the disease is a crack or ulcer more or less hard, having a puckered appearance and causing a characteristic pain from the first. Sometimes, instead of a single ulcer, there are several small nodules, which sooner or later coalesce and form a foul and ragged sore covered with granulations.

In the *diagnosis* of this disease the following points require attention:

1. *Age.*—There is one decade which claims the majority of cases of cancer: it is from forty-five to fifty-five. An ulcer on the tongue of a person over forty years of age should excite suspicion and will bear watching. Should it refuse to heal, it ought to be excised.

2. *Habits of the Patient.*—While cancer of the tongue may arise without any apparent cause, there is no doubt that local irritation plays a part in its causation. Smoking, a badly-adjusted dental plate, a sharp tooth, sharp, ragged, irregular roots, or local injury may cause ulceration which later takes on the characteristics of cancer.

3. *Situation of the Ulcer.*—The sides of the anterior half of the tongue and the under side of the tip are the favorable starting points. A sharp or abnormally placed tooth by its constant irritation may determine the position of the ulcer.

Cancer may follow as a sequel of two other diseases—viz. syphilis and leukoma.

4. *Microscopic examination* of a small portion of the ulcerated tissue should be resorted to in case of doubt.

5. *Progress of the Disease.*—From the slight ulceration appearing on the side or under the tip of the tongue infiltration passes with more or less rapidity to the floor of the mouth, to the gums, the tonsils, and pillars of the fauces. Glandular involvement is first found about the submaxillary region or in the glands about the angle of the jaw. The tongue loses its power of motion to a considerable extent, and cannot be protruded. Salivation is profuse and distressing; the fetor becomes

offensive, and deglutition difficult. The tissues break down, and, should the large vessels suffer, death by hemorrhage may occur suddenly. Constant pain, starvation, loss of sleep, combine to wear out the unfortunate patient, till at the end of a period varying from one to two years the long agony is ended by merciful death.

Carcinoma of the tongue must be distinguished from the following:

(*a*) *Simple Ulcer.*—Simple ulceration may occur at any age or on any part of the tongue, and is generally the result of a local irritant. The teeth should be carefully examined for sharp projections. Traumatisms and glossitis must be taken into account. In simple ulcer there is little or no hardness about the base, while in carcinoma the surrounding parts are deeply infiltrated. After removal of the cause a simple ulcer tends to heal, while carcinoma shows no such tendency. In a person over forty a chronic ulcer of the tongue should be set down as cancerous and freely removed.

(*b*) *Syphilitic Ulcer.*—There is usually a history of syphilis in other parts of the body, and an initial sore. The position of the ulcer is on the dorsum of the tongue, and not on the sides or under the tip, as in cancer. The posterior cervical glands are enlarged in syphilis, while the submaxillary are affected in cancer.

Differential Diagnosis between Syphilitic and Carcinomatous Ulcers of the Tongue.

	Syphilitic.	Carcinomatous.
Age.	Any time after puberty.	Forty-five, and especially between forty-five and fifty-five.
History.	Previous manifestations of syphilis.	Probably none. Perhaps irritation as from a sharp tooth or short pipe.
Situation.	Dorsum or sides.	Sides or under tip.
Character.	Edges well defined, but not indurated.	Edges everted, hard surface covered with characteristic granulations.
Pain.	Slight soreness.	Burning, darting, or cutting.
Glands.	Posterior cervical enlarged.	Submaxillary and sublingual are affected.
Effect of Treatment.	Responds to antisyphilitics.	No tendency to heal under any treatment.

(*c*) *Tuberculous Ulcer.*—When there are other manifestations of tuberculosis, such as phthisis, there is no difficulty, but when the ulcer occurs primarily on the tongue the question is very obscure. The ulcer should be scraped with a knife, and the material removed examined for tubercle bacilli. This form of ulcer is rare.

Treatment.—One method of treatment, and one only, is of any avail, and that is complete removal of the disease by surgical operation. There is always a temptation to treat a cancerous ulcer by means of caustics, but this is a dangerous procedure and should never be followed. Two points should never be lost sight of—viz. *early diagnosis* and *complete removal.*

Removal of a Portion of the Tongue.—In cases which have been diagnosticated at an early period of the disease, when a small ulcer exists on one side or under the tip of the tongue, without any glandular involvement, the whole of the cancerous portion can be removed by taking away only a part of the tongue. The best instrument for this operation is the knife or scissors, although the wire and galvanic

écraseur are often employed. The mouth being held open with a suitable gag, two strong sutures are passed through the tip of the tongue, one on either side of the raphé, and the organ drawn well out of the mouth. With the scissors the tongue is split down the middle and separated from the floor of the mouth. If the écraseur is employed, two stout needles are passed through the detached half of the tongue, and the wide loop passed round behind the needles, or the division can be completed with scissors.

Removal of the Whole Tongue.—Strange as it may appear, total removal of the tongue does not necessarily interfere with speech, taste, or deglutition. Mr. Syme operated upon a case, dividing the lower jaw at its symphysis and removing the whole tongue. The patient not only recovered from the disease, but his speech was wonderfully clear and distinct, and he could sing without difficulty. Taste, though impaired, enabled him to detect bitter from sweet, grouse from partridge, good beer from bad. He also swallowed with ease when the food was liquid or finely divided.

Two special dangers are recognized in total removal of the tongue:

1. *Hemorrhage.*—To guard against this the écraseur has been a favorite instrument, but a serious objection to its use is the extensive sloughing which always results. A very simple method of temporarily controlling hemorrhage from the tongue was devised by Heath. He passed the fore finger well down to the epiglottis, and hooked forward the os hyoides, dragging it upward as far as possible toward the symphysis of the lower jaw. In this way the two lingual arteries are stretched to such a degree that circulation in them ceases, rendering the anterior part of the tongue almost bloodless. In some operations preliminary ligation of the lingual and facial arteries effectually controls hemorrhage.

2. *Sepsis* from the mouth and throat, leading to pneumonia and general septicemia. To guard against this danger operations have been devised by which the incision is made beneath the jaw, or a preliminary tracheotomy is made and a tube inserted through which the patient breathes during the whole period of healing.

Of a large number of different operations which have been devised, two seem to be in general favor—Kocher's and Whitehead's.

1. *Kocher's Operation.*—The attractive part of this operation is that it aims at asepsis throughout.

First Step.—Tracheotomy is performed as a preliminary, and an accurately fitting tube inserted.

Second Step.—An incision is made beginning a little below the lobule of the ear, along the anterior border of the sterno-mastoid to the middle of that muscle, then forward to the hyoid bone, along the upper edge of the greater cornu, and upward along the anterior belly of the digastric muscle to the chin (Fig. 89). This forms a flap which is dissected off and turned up over the cheek. The facial artery and veins are ligated, and the lingual artery tied in Lesser's triangle. All the glands of the submaxillary fossa are removed, also the submaxillary and sublingual glands. If only one side of the tongue is to be removed, this is sufficient, but when our purpose is to remove the whole organ the opposite lingual artery must be ligated in a special incision.

Third Step.—A sponge large enough to prevent blood flowing into the throat is attached to a strong silk thread and pushed well down into the pharynx. By means of scissors the mucous membrane along the jaw, and also the mylo-hyoid muscle, are divided. Through this opening the tongue is drawn out below the jaw, and, having been freed beyond the utmost limits of the disease, it is divided with scissors.

Fourth Step.—The cut surfaces are now thoroughly rubbed with crystals of permanganate of potash. This forms a hard, firm incrustation, which not only serves to arrest oozing of blood, but is an excellent antiseptic. It is better than packing the mouth and fauces with iodoform, which always adds to the distress and suffering of the patient, increasing the tendency to vomit.



FIG. 89.—Kocher's incision for removal of the tongue (Esmarch and Kowalzig).

The after-treatment consists in keeping the tracheal tube thoroughly clear and washing the mouth frequently with such antiseptic fluids as peroxid of hydrogen, boracic acid, and Condy's fluid. For the first two or three days alimentation must be by the rectum entirely. After that the food can be introduced into the stomach by a tube passed into the throat well beyond the raw surfaces.

2. *Whitehead's Operation.*—The patient is placed in a good light, a needle introduced, and the tongue drawn well out of the mouth by a strong silk ligature through its tip. The dissection is made with scissors, beginning at the frenum, and by short rapid snips dividing the organ from its attachment and giving the disease a wide berth, until not only the cancerous portion, but a good part of the apparently healthy tissue, is removed. As soon as the lingual arteries are cut they should be seized with hemostatic forceps and ligated. Should hemorrhage prove troublesome, a strong silk ligature should be passed through the remains of the glosso-epiglottidean fold and left in position twenty-four hours.

Tumors of the Tongue.—Tumors of the tongue are not common, but the following varieties are occasionally met with: viz. papillomata, nevi, fatty tumors, and erectile tumors.

Papillomata, or *warty tumors*, are found on the dorsum of the tongue or on the sides well toward the root. They resemble ordinary seed-warts, and are of little consequence except when they are very vascular.

The *treatment* consists in drying the part and applying London paste (Garretson), or the growth may be transfixed with a needle and ligated. When small the growth can be snipped off with scissors.

Nevi are met with about the tip of the tongue, and are treated on the general principles which govern the removal of these growths elsewhere. If ligature is employed, it must be placed in healthy tissue well away from the growth and tightly tied. The écraseur, if employed, must take away ample material, and is best suited for cases in which

the growth is large and diffuse. Simple cases may be treated with puncture of thermo-cautery needles or the application of nitric acid.

Fatty tumors are rare in this locality, and need no special mention.

Erectile Tumors.—Garretson reports five cases. The most important of these occurred in a child nine months of age. The tumor was congenital and occupied the anterior half of the tongue. It was of a dark-red or purple color, and enlarged to a marked degree every time the infant cried. Manipulation, on the other hand, almost caused the tumor to disappear. It was successfully removed by operation.

Cartilaginous tumors have been found on the tongue, but they are exceedingly rare. Their treatment is removal.

The Jaws and Gums.

Deformities.—Cleft-palate, the most common of all deformities of the jaw, has been already considered. Other deformities are rare, but we must recognize (*a*) failure of union between the two halves of the lower jaw; (*b*) arrest of development on one side of the lower jaw; (*c*) congenital dislocation.

In cases of marked hypertrophy of the tongue constant pressure may produce displacement of the teeth and even dislocation of the jaw. Burns and scalds, followed by extensive cicatricial contraction, may draw the chin or lower lip down to the sternum. Sucking the thumb may cause deformity of the jaw.

In the diagnosis of diseases of the jaw it is convenient to divide them into two classes—*acute* and *chronic*.

The acute forms are inflammatory, and the most common are abscess of the gums or alveoli and periostitis.

When Burns characterized toothache as the "hell of all diseases," he no doubt drew his inspiration from an attack of periodontitis ending in abscess, vulgarly called "gum-boil." The cause of this common affection is suppurating pulp. The diagnosis is easy. There is a history of the characteristic pain of toothache; tenderness and swelling are felt by passing the finger along the gums. The tooth is elongated and tender on tapping. The face on the affected side is swollen, and finally a collection of pus takes place. If the suppuration is near the surface, it readily finds exit or can be released by simple puncture; it may find its way through the skin and open about the lower margin of the jaw. Necrosis in that case is a common result.

Treatment.—In the early stage the gum may be painted with iodin. Fomentations by means of a small compress of lint or absorbent cotton dipped in hot water and repeatedly applied relieve the pain and hasten suppuration. When the pus is near the surface of the gum, simple puncture will suffice; when deeper a free opening should be made. The tooth causing the trouble should receive the attentions of a dentist and be either saved or extracted.

Periostitis or osteo-periostitis is to be diagnosticated when the inflammation spreads over a considerable portion of jaw, attended with high fever, the loosening of several teeth, and excessive tenderness.

Chronic Affections of the Jaw.—A chronic affection of the jaw must be necrosis, periostitis, or a tumor.

Necrosis results from tuberculosis, syphilis, a decayed tooth, or a traumatism. It may follow one of the zymotic diseases, and it is common among those who have to breathe the fumes of phosphorus. It is always preceded by severe pain and inflammation. Suppuration takes place, and one or more sinuses result. Through one other of these openings a probe can be made to touch the necrosed bone. If only one sinus exists and the probe is felt to touch a smooth surface, it is likely to prove the root of the tooth. It must be remembered that here, as elsewhere, the external opening may be no indication of the position of the diseased portion of bone. The opening may be on the face, the neck, or even in the nose.

Treatment.—While the treatment is the same as for necrosis in other parts of the body, one or two special points must be kept in mind. The sequestrum should be removed, if possible, from the inside of the mouth, and no attempt at detachment should be made until the sequestrum is perfectly loose; otherwise the soft parts, especially the vessels, may be injured.

Chronic periostitis is, as a rule, syphilitic. The common situations are the outer side of the lower jaw and the hard palate. There are generally other indications of specific disease, and, should the surgeon be still in doubt, he can settle the point by putting the patient upon antisyphilitic treatment.

Phosphorus Necrosis.—With better attention to the sanitary conditions of factories phosphorus-poisoning is much less common than formerly. The disease is usually extensive and its course rapid, so that a patient may apply for advice whose jaw is necrosed to a considerable extent without his being aware of it. Diagnosis will depend upon the history and the ordinary signs of necrosis.

Tumors of the Jaws.—Epulis (ἐπί, upon, and οὐλα, gums) is a morbid growth improperly named. Instead of being connected with the gums, it is a tumor growing from the periosteum of the alveolar process and sockets of the teeth. When first recognized it appears to be making its way from about the neck of some particular tooth (Garretson).

Simple, Benign Epulis.—The most common form of epulis is that which is connected with the pulp of a tooth, the epulo-pulp-fungoid tumor. It originates in the exposed tooth-pulp, and by gradual increase covers the gum adjacent to the affected tooth. After a time it ulcerates and discharges a sero-purulent fluid, or it may undergo ossification. Another variety of epulis is the erectile or nevoid. Both of the foregoing are simple and benign in character.

Malignant Epulis.—Malignant epulis begins like the benign forms, but its rapid growth, its vascular character, its purplish color, and its tendency to form a fungous mass protruding between the teeth and bleeding on the slightest provocation reveal its serious nature and demand its radical removal.

Treatment.—The benign forms require the removal of the involved tooth and the portion of the alveolar process which forms its socket. The malignant epulides must be dealt with as cancerous tumors. Not only the socket, but a portion of the jaw, must be removed. The doomed section of the maxilla should be sawn through by two vertical cuts, and the intervening portion removed by strong forceps.

In the diagnosis of tumors of the jaws the first question to settle is whether a given tumor is cystic or solid. Cystic tumors are not uncommon in this situation. A cystic tumor is smooth, and rises above the surrounding bone by gradual elevation. Fluctuation may be detected in the growth, or the bony cyst-wall may crackle like an egg-shell under the pressure of the fingers. When these conditions are found, examine the teeth at that part and in all probability you will find one tooth missing. Or it may be that the deciduous tooth at that point has never been cast off. These tumors are liable to be mistaken for malignant disease of the bone, but the surface is perfectly smooth, the patient is generally young, and the growth is painless; all of which argue against malignancy. When this smooth tumor is cut down upon, the thin bone readily gives away and a cavity is opened up. Explore this cavity, and out will pop a tooth which lay loose in a thick mucilage-like fluid or perhaps turned upside down. Even when crackling is absent the smoothness of the tumor should arouse suspicion, and this will be confirmed by finding that one of the permanent teeth has never been cut. It is a good rule never to remove a tumor of the jaw without first cutting into it. While these dentigerous cysts are mostly confined to young persons, too much stress must not be laid upon that point. In a case upon which I operated a short time ago the tumor was smooth and apparently as hard as ivory; there was no crackling, and the patient was fifty years of age. The tumor contained a large molar tooth.

The cyst can be reached by an external incision, but when practicable an opening from the inside of the mouth will prove just as satisfactory, and has the advantage of leaving no disfiguring scar.

Another form of cystic tumor common in the lower jaw is irregular and lobulated. This is *multilocular cyst*, which in the majority of cases is a cystic degeneration of a sarcoma or carcinoma. Total extirpation is the only treatment.

Solid Tumors of the Jaws.—These are naturally classified as *benign* and *malignant*.

In the diagnosis of solid tumors of the jaw begin by examining the face, mouth, and nose. The consistence of the tumor should be felt by first placing the fingers outside the cheek and rolling the skin over the growth; then the fingers should be placed in the mouth and a bimanual examination made. Having satisfied yourself of the consistency of the tumor, pass the fingers over the hard palate and backward over the soft palate to the posterior nares. The nostril will require careful examination, and this can be carried out by throwing a strong light into it and testing any suspicious growth with a probe. If in this examination a growth is found attached to the turbinated bones, it is a polypus. A tumor in the antrum will also show itself in the nostril, but at the same time there will be expansion below the eyelid and perhaps protrusion of the eyeball.

The non-malignant tumors are the following:

1. *Fibromata.*—The growth of these tumors is slow, and they are generally painless. They start from the periosteum, and especially from the periosteum of an alveolus, which renders these growths liable to be mistaken for epulis. When they arise from the periosteum the

growth is smooth or lobulated, firmly attached to the bone, and freely movable over the surrounding parts. When the endosteum is the starting-point the tumor gradually expands the jaw, and if allowed to grow attains an enormous size. If the growth is in the upper jaw, the antrum or nasal fossæ are apt to be encroached upon. We recognize pressure upon the antrum by observing the following points: The outer wall of the antrum below the orbit bulges forward. If the floor of the orbit is pressed upon, the eyeball protrudes. Examination by the mouth will show that the roof of the mouth is flattened or depressed.

2. *Enchondromata*, or cartilaginous tumors, are not common. They are more rapid in their growth than fibromata, are much harder, and



FIG. 90.—Recurrent ossifying enchondroma (Heath).

are more nodular (Fig. 90). The lower jaw and the antrum are favorite situations.

3. *Osteomata*, or osseous tumors, are still more rare. They are harder even than the cartilaginous tumors, and may take the form of exostoses or may present the appearance of a general thickening of the whole bone.

Treatment.—Fibromata, enchondromata, and osteomata should all be treated by thorough removal of the growths. The enchondromata are apt to recur after removal.

Malignant tumors are—

1. *Carcinomata.*—Primary cancer of the jaw is rare. The majority of cases are those in which the disease spreads from the nasal mucous membrane or from the palate (Fig. 91). In either case great destruction of tissue may take place without any marked tumor being developed. A probe passed through a small external opening may reveal a large cavity, while there is no evidence of a cancerous mass by external appearances. Three characters of malignant tumors must be kept in mind—viz. *rapid growth, destruction of bone,* and *fungation into the*

mouth. Fibrous, cartilaginous, and osseous tumors are slow in growing; they are hard to the touch, they do not affect the general health, and are painless, and, except when they exert pressure upon neighboring parts, they do not involve the surrounding structures. Carcinoma is soft and has a tendency to fungate. It is painful, soon telling on the general health of the patient, and involving adjacent structures, especially the lymphatic glands. Fungation is strongly characteristic of cancer. It must be borne in mind, however, that benign tumors, particularly of the lower jaw, may in the course of time break through the skin and form a fungating mass. This, however, is slow of growth,

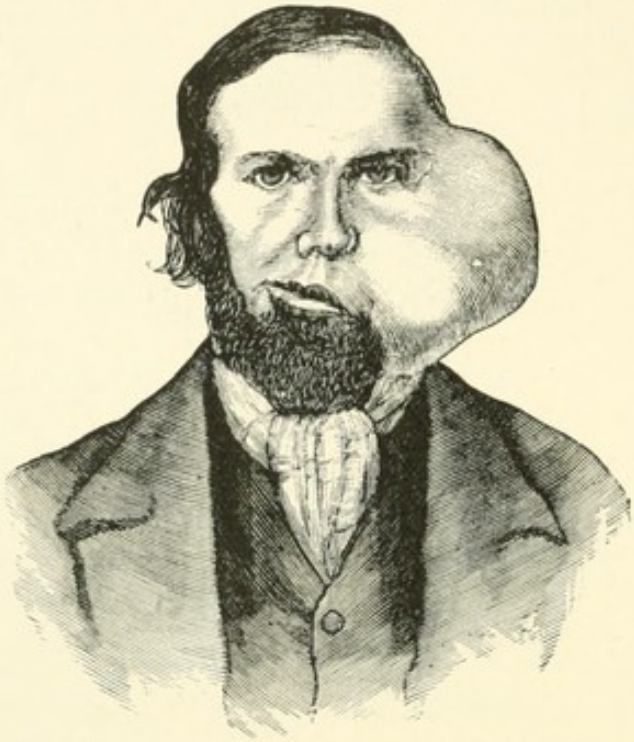


FIG. 91.—Epithelioma of the left malar and superior maxillary (Heath).

as was also the tumor which gave rise to it, and it is more healthy in appearance than a cancerous fungus.

2. *Sarcomata.*—The round-celled or medullary sarcoma is found most frequently in the upper jaw, and bears a close resemblance to medullary cancer. Its leading characteristics are rapidity of growth, softness, and tendency to fungate. In the majority of cases the disease begins in the antrum. As the tumor increases in size it produces symptoms which vary according to the direction taken by the growth. The projecting mass may show on the cheek, causing closure of the nasal duct, producing epiphora and edema of the eyelids. In other cases the growth takes a direction inward, and forms fungous masses in the nose or mouth. Sometimes the disease starts in the hard palate, the alveolus, or the nose. The difficulty here is to diagnosticate between cancer, nasal polypus, and the results produced by decayed teeth. Practically, the diagnosis between carcinoma and sarcoma is of slight importance, as the treatment is the same for both. For purposes of treatment it is sufficient to decide that the tumor is malignant, leaving the histological characters to be decided after removal of the growth. Yet there are

certain clear distinctions to be noted. Sarcoma involves the neighboring parts, but not the glands, while carcinoma readily spreads to the glands. The spindle-celled variety of sarcoma has a tendency to spread along the periosteum, and becomes softer and softer with each recurrence. Probably the greatest difficulty lies in distinguishing between malignant tumors and inflammatory processes. A sarcoma is so similar to an abscess as to puzzle the most experienced. Yet there is an absence of the inflammation and pain which always precede an abscess. A collection of pus due to the carious root of a tooth would show a history of toothache with evidence of dental caries. The probe is not always a sure guide. If roughened bone be felt, it is not necessarily necrosis, for the bone can be laid bare in the same manner by the ravages of carcinoma or sarcoma.

Treatment.—Malignant tumors of the jaw can only be dealt with in one way—complete removal. Within the last few years reports of cases alleged to have been cured by injections of the toxins of erysipelas with bacillus prodigiosus have appeared in the medical journals. In several cases I have given this method of treatment a most patient and careful trial, but in every instance with disappointing results. For the present, at least, our hope must lie in the direction of early and complete removal. Recurrence is the rule, even where the whole of the lower jaw is taken away.

Operation on the Upper Jaw.—Small tumors confined to the alveolus can readily be removed by strong cutting bone-forceps, without any external incision. Tumors of considerable size have also been extirpated in this manner, although the difficulty of delivering the tumors through the mouth has sometimes been so great as to necessitate an incision of the angle. Large tumors involving a considerable portion of the bone require resection of the entire jaw. The method is as follows:

First Step.—An incision is made along the infraorbital ridge from the malar bone to a point just below the inner canthus, thence along the side of the nose around the ala to the middle line, and lastly through the middle line of the upper lip. The flap formed by these incisions is dissected from the bone and turned outward, divided vessels are ligated, and hemorrhage arrested by pressure with hot sponges.

Second Step.—The incisor teeth on the affected side are next removed, a narrow-bladed saw passed into the nostril, and the hard palate and alveolus divided. With a Hey's or other suitable saw section is made of the malar bone in a line with the spheno-maxillary fissure and also of the nasal process of the upper jaw. The saw can be supplemented, if necessary, with bone-forceps. Powerful forceps, preferably Fergusson's lion-forceps, are next made to grasp the jaws, and by a powerful wrench the bone is separated from its connections, and when quite loose the infraorbital nerve and soft palate are severed with a knife. Should any diseased tissue still remain, it can be removed with gouge and chisel. After ligating any spurting vessels the cavity can be filled with hot sponges for a few minutes and all hemorrhage arrested. The flap is now replaced, and the incision accurately closed through its whole extent with sutures of catgut, except the lip, where silkworm gut is perhaps more reliable. The

cavity of the cheek is filled with iodoform gauze, and an external aseptic dressing, retained by a light flannel or gauze bandage, completes the operation. Even before the advent of antiseptic surgery wounds of the face healed readily by first intention, and these operations were wonderfully free from mortality. With careful asepsis and the use of disinfectant mouth-washes the progress of recovery is rapid, and the sufferings of the patient are reduced to a minimum. When the disease is not so extensive as to require removal of the whole jaw a shorter incision is demanded. Division in the middle line of the lip and down to the ala of the nose may be sufficient. When the orbital plate is not involved, the saw can be made to cut horizontally below it, and the palate when healthy may be spared by making the saw-cut immediately above it.

Both upper jaws have occasionally been removed. Probably the best of the methods adapted for this formidable operation is that employed by Mr. Dobson of Bristol,[1] who in 1872, in a woman of fifty-two, divided the lip in the middle line and carried the incision up each side of the nose.

Operations on the Lower Jaw.—When the tumor is small and involves only the alveolus, it can be removed with bone-forceps. If the mucous membrane covering the lower jaw be freely divided, a great portion of the bone can be removed without any external incision. In extensive disease it may be necessary to remove one-half or the whole of the bone. When an external incision is necessary, it can be made just below the lower border of the bone with a division of the lower lip in the middle line; but this later incision is not always necessary. After separating the bone from the soft parts the jaw is divided in the middle line and strongly drawn outward, while the soft parts are separated back to the articulation, and the bone disconnected at the jaw by dividing the ligaments with knife or scissors.

The question of saving the periosteum cannot be entertained if the disease is malignant, but in non-malignant tumors and in necrosis this membrane should be carefully preserved. All bleeding points being secured by ligature, cautery, or pressure, the incision is accurately closed and an external dressing applied. The after-treatment consists in giving fluid nourishment by a tube, and keeping the mouth thoroughly disinfected by detergent washes, of which the glycerinum acidi carbolici applied with a camel's-hair brush, as recommended by Heath, is one of the best.

Diseases of the Temporo-maxillary Articulation.—This is one of the few joints which escape tuberculosis, but it is liable to rheumatic arthritis, and one or both sides may be the seat of the disease. It is chronic in character, and may result in absorption of the interarticular cartilage and in outgrowths from the bone. True ankylosis does not take place. This disease is readily diagnosed from its painful and chronic character, and from the protrusion of the chin either directly forward or to one side according as the disease affects one or both articulations.

Acute inflammation is the result of injury, or it may be the extension of the inflammatory process from the ear or some neighboring

[1] *Brit. Med. Journ.*, 1873.

part. It then follows the course of arthritis in other parts, and should suppuration take place ankylosis is not an unlikely result.

Closure of the jaws may be temporary or permanent. The temporary closure is usually reflex in origin, due to the irritation produced by the cutting of a wisdom tooth or the failure of a tooth to appear, owing to want of room or to an abnormal position. Some of the cases are hysterical. Permanent closure may be due to ankylosis following suppurative arthritis. Another frequent cause is cicatrization following ulceration or injuries of the mucous membrane of the cheek; and often through profuse salivation the lower jaw becomes closely bound to the upper, so that the teeth cannot be separated sufficiently to admit solid food. Sometimes the gums are adherent, especially if there is necrosis of the alveolar process.

Treatment.—When there is complete ankylosis or intractable closure the operation of Esmarch is probably the best. It consists in the formation of an artificial joint in front of the contraction, and admits of at least limited motion of the jaw. It simply consists in the removal of a piece of bone of a wedge shape in front of the masseter muscle.

Diseases of the Tonsils.

The tonsils are subject to the following diseases: tonsillitis, hypertrophy, calcareous and cheesy concretions, sarcoma, and carcinoma.

Tonsillitis, popularly called quinsy, is readily distinguished from other diseases. It is an acute, local, inflammatory affection, generally following exposure to cold, but depending upon a more remote cause, such as a tubercular or rheumatic diathesis. The onset of the attack is marked by pains in the limbs, difficulty of swallowing, chills, and general malaise. The temperature rises quickly, and may reach 104° or 105° F. If the throat be examined at this stage, one or the other tonsil will appear swollen and violently inflamed; the redness extends to the fauces, and the glands beneath the angle of the jaw are swollen and tender. By degrees swallowing becomes more and more painful. To add to the patient's discomfort, large quantities of mucus and saliva are constantly being secreted and must be expectorated. Speech is at first changed to a nasal twang, and later may be almost lost, and when the patient attempts to swallow fluids they run out of the nose. If resolution does not take place (which it happily does in many cases about the third or fourth day), suppuration occurs, and about the ninth day the abscess ruptures, and the patient, experiencing immediate relief, speedily recovers.

Sometimes the second tonsil becomes affected, and then the swelling is so great as almost to close the throat. When both are affected at the outset, it is strong presumptive evidence that the attack is due to a septic cause.

Treatment.—At the outset a brisk purgative should be given, and 10 minims of tincture of belladonna every three hours. If, after forty-eight hours, the inflammation still progresses, the case will probably go on to suppuration. A hypodermic of morphin with atropia, given at bedtime, will give great relief and arrest the secretion of the sticky mucus which is so distressing. The formation of pus and the pointing

of an abscess should not be waited for. An early incision which freely opens up the tonsil will anticipate the abscess and cut short the disease by several days. In lancing the tonsil use a straight, sharp knife, wrapped round with adhesive plaster to within an inch of the point. The incision, if kept within the line of the molar teeth, will run no risk of wounding the internal carotid artery, and, as the parts are so sparingly supplied with nerves, the operation is practically painless.

Follicular tonsillitis is recognized by small, yellowish-white swellings about the size of a pea which cover the surface of the tonsil. As these little abscesses burst they form ulcers, which may run together and produce large ulcerated patches with edges swollen and undermined.

Hypertrophy is a result of repeated attacks of acute tonsillitis. It may, however, be due to a chronic catarrhal affection of the tonsil. Tuberculous children are specially liable to this affection. The enlargement can be readily seen when the patient opens the mouth, and in some cases the glands almost touch each other. Respiration is interfered with, especially during sleep, the child sleeping with the mouth open and breathing in a noisy and unpleasant manner. There is usually no pain, unless there be attacks of acute inflammation; the enlargement is slow and steady.

Treatment.—Excision of the tonsil is the only effective remedy. For this operation several tonsillotomes have been invented, of which Mathieu's is perhaps the best (Fig. 92). An assistant should steady

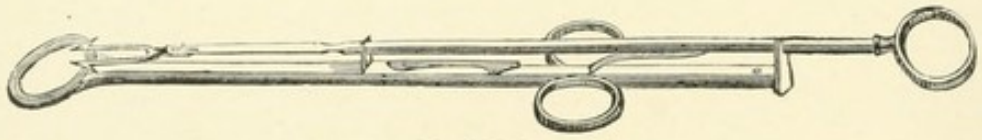


FIG. 92.—Mathieu's tonsillotome.

the patient's head, and with his fingers below the angle of the jaw press the tonsils inward. The instrument is applied (taking care that the lower portion of the tonsil lies well within the grasp of the instrument), and with a rapid movement the required portion of the gland is removed. Bleeding has often proved troublesome after removal of the tonsil, the hemorrhage coming from the tonsillar branch of the facial. To arrest it, pressure should be made from the inside with a piece of gauze held in a pair of forceps while the fingers make pressure from without. In this way the tonsil can be compressed so as to control the flow of blood, and this can be further aided by the application of strong astringent solutions, as the tincture of perchlorid of iron. It is rarely that ligation of the carotid has to be resorted to.

Calcareous and cheesy concretions are found of various sizes, sometimes large enough to increase the size of the tonsil to an enormous extent, or so small that they are only accidentally discovered when the tonsil is excised. Besides the discomfort caused by their size, concretions often cause inflammation of the tonsil.

Treatment.—Remove the concretion by cutting down upon it and turning it out of its bed, or by removing the redundant portion of the tonsil in which the concretion is lodged.

Tumors of the tonsil are rare, the form most likely to be met with being sarcoma.

Sarcoma occurs in young persons, usually below twenty years of age. It forms a tumor which steadily increases in size and soon begins to ulcerate, death often resulting from hemorrhage. The growth forms a well-defined tumor which does not involve the neighboring glands. This feature distinguishes it from carcinoma.

Carcinoma of the tonsil is of the epithelial variety. It is seldom found as a primary affection, but as an extension from the disease in adjoining organs it is not uncommon. In the early stages a primary cancer of the tonsil is difficult of diagnosis, and is generally set down as a simple hypertrophy of the gland. As the disease progresses, however, the lymphatics become involved, nodules form about the angle of the jaw, and the general characters of carcinoma become manifest.

Treatment.—Unfortunately, even the total extirpation of the tonsil is unsatisfactory for either form of malignant disease, as the growth is almost sure to return. In sarcoma, the tumor being more sharply defined and the neighboring parts free from disease, the prospect of cure is better. The tonsil can be removed, either by the mouth or by an external incision extending for about three or four inches along the anterior border of the sterno-mastoid muscle, beginning at the ear and ending below the level of the tumor. If necessary, a second incision may be made along the lower border of the jaw. Dissecting through this space, the tumor is reached, lying within the superior constriction of the pharynx. A more radical operation, however, is necessary, and the method devised by Czerny is probably the best. After a preliminary tracheotomy he makes an incision from the angle of the mouth to the anterior border of the masseter muscle, and from this point downward to the os hyoides. Mikulicz makes his incision from the mastoid process to the greater cornu of the hyoid bone. In either operation the lower jaw is divided about the position of the first molar tooth, and turned backward so as to give room for the deep dissection.

The Pharynx.

The diseases of the pharynx requiring special attention from a diagnostic standpoint are retropharyngeal abscess and tumors of the pharynx.

Retropharyngeal abscess is, in many cases, a result of caries of the cervical vertebræ. It may, however, occur as a sequel of scarlatina or as an extension of inflammation from neighboring parts, especially the glands. It is most commonly met with in tubercular children. The first symptoms to attract attention are difficulty of swallowing and dyspnea. If the patient be subject to disease of the cervical vertebræ, these symptoms are almost certain to indicate an abscess between the back of the pharynx and the cervical vertebræ. Examine the patient's mouth, and you will find projecting from the back of the pharynx, usually to one side of the middle line, a swelling which fluctuates, is soft and boggy, and does not disappear on pressure. The patient in some cases cannot move the head without intense pain, but this is due to disease in the vertebræ. As the abscess increases in size it extends

laterally, and if allowed to go untreated causes a bulging in the neck just behind the sterno-mastoid muscle. Rarely it burrows into the posterior mediastinum.

Treatment.—As soon as the presence of pus is determined an opening should be made into the tumor. The patient's head being steadied by an assistant and held slightly forward, depress the tongue, and with a long straight bistoury make an incision near the middle line into the abscess. The bodies of the cervical vertebræ lie directly behind, so that there is no danger of cutting any important structure. If the abscess is large, and there is danger of suffocating the patient by too rapid an outflow of pus, an aspirator can first be used to remove a sufficient quantity to lessen the swelling, after which the abscess can be laid freely open with a knife.

When the abscess is of old standing and points in the neck behind the sterno-mastoid, it can be opened externally. An incision is made through the skin at the bulging point, and, after the manner of Hilton, a grooved director, followed by dressing-forceps, is pushed into the abscess and the opening freely dilated. It should then be thoroughly irrigated and dressed in the usual manner. This method is in many ways preferable to the opening on the inside, as it allows external drainage and averts the unpleasantness of pus discharging into the mouth.

Tumors of the pharynx are rare. In most cases the growths are congenital, and may be papillomatous, fatty, or fibroid in character. If the tumor pulsates, it is likely to prove an aneurysm of the internal carotid artery.

Diagnosis of Diseases and Injuries of the Esophagus.

The following are the conditions to be sought for in an examination of the esophagus:

Malformations.—Branchial fistulæ may occur at any of the three positions which correspond to the branchial clefts of the embryo. The lowest of them is at the sternal end of the clavicle; the middle, opposite the thyroid cartilage; and the highest, between the thyroid cartilage and the hyoid bone. A permanent congenital fistula existing at one or more of these points may be set down as a branchial fistula. Such fistulæ may be capable of admitting nothing but a probe, though the external opening may be much larger farther in, and may expand to the dimensions of a good-sized cyst. When pressure is made along the course of the fistula a mucous fluid is found to exude. Sometimes it suppurates and gives rise to a constant discharge of pus.

Pouches, or diverticula in the esophagus, with stricture, are sometimes congenital. An infant may be found to suck well, but the milk, instead of being swallowed, runs out of the mouth. As the child receives no nourishment, emaciation rapidly follows. An important symptom of dilatation above a stricture is the regurgitation of large quantities of milk at a time, and the evidence that the milk has never reached the stomach, not being curdled nor of acid reaction.

Stricture of the esophagus may be spasmodic, cicatricial, malignant, or due to the pressure of a tumor.

Spasmodic stricture is met with in young or middle-aged women of hysterical temperament. The patient complains of a sensation as if a ball were rising in her throat, the so-called "globus hystericus." The difficulty of swallowing comes on suddenly without any perceptible cause, and it may be that the dysphagia is confined to certain articles of food, or the patient may swallow perfectly when unobserved. Pass a bougie down through the esophagus, and it will be found to reach the stomach without obstruction.

Fibrous or cicatricial stricture has a well-defined cause. A child gets hold of some lye or other caustic liquid and drinks it, severely burning the mouth and digestive tract. In the process of healing the tissues contract, and the esophagus at one or two points becomes almost closed. The most common seat of such stricture is at the level of the cricoid cartilage; that is to say, at the beginning of the esophagus. The history of these cases is usually very clear and the diagnosis not difficult. Food is taken into the mouth, passes beyond the pharynx, but sticks in the gullet and soon returns. The patient is emaciated and undeveloped.

In the *diagnosis* of stricture due to any cause the passage of the bougie (Fig. 93) gives the most satisfactory information. It is done as

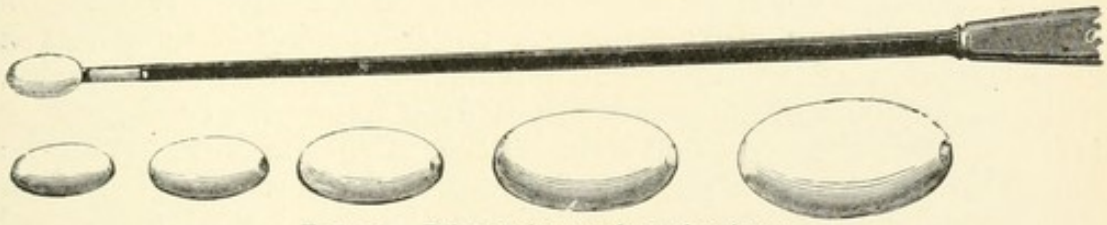


FIG. 93.—Dilators for esophageal stricture.

follows: The patient, seated in a steady chair, holds the head well back so as to bring the mouth and esophagus in line. The bougie, moistened with hot water, is passed to the back of the pharynx, and while the patient attempts the act of swallowing, it is pressed gently into the esophagus. Should resistance be met with, no force should be used, but the instrument withdrawn and gently pushed in another direction. Bougies of different sizes should then be employed, in the hope that one can be made to pass through the stricture and into the stomach. Many forms of bougie have been invented. Those most commonly employed consist of whalebone stems upon which ivory knobs of different sizes can be screwed.

Malignant or cancerous stricture is found in persons about or after the period of middle life, and more frequently in men than in women. The symptoms develop slowly. The difficulty of swallowing comes on by degrees—first as regards solids, and later liquids. Progressive emaciation is noticed, and there may be a slight discharge of bloody mucus and pus. In cases of this kind the glands of the neck should be carefully examined, and a systematic search should be made for cancer in other organs. The passage of bougies, if resorted to at all, must be done with great care, lest they greatly aggravate the disease. There is another diagnostic method which is perfectly harmless and generally reliable. This is auscultation. If the patient be asked

to take a mouthful of water, and the stethoscope be placed over the lower third of the esophagus, the fluid can be heard to trickle through the stricture.

The esophagoscope is an instrument that may sometimes be employed to advantage in the diagnosis of stricture, carcinoma, and foreign bodies in the esophagus. It is an endoscopic instrument which can be passed through the pharynx and down the whole length of the gullet. An electric-light attachment illuminates each part as it comes into view. Considerable experience and dexterity are required in its management.

Treatment.—Several methods of treating stricture of the esophagus are practised:

1. *Dilatation by Bougies.*—When the stricture is simple and not very rigid the passage of the largest bougie which can be inserted is daily employed, and the size increased as the stricture dilates. The patient is fed on liquids, milk, eggs, strong broth, etc.

In many cases the esophagus above the stricture is sacculated, rendering it impossible to pass instruments from above.

2. *Retrograde dilatation* was first performed by Von Bergmann in 1883. The first step of the operation deals with the stomach, and is either a gastrotomy or a gastrostomy according to circumstances. The gastric opening should be large enough to admit one or two fingers besides the dilating instruments. A larger opening is unsafe, as it allows leakage of the stomach-contents into the peritoneal cavity, while too small an opening makes it difficult to find the cardiac orifice (Woolsey). The second step is the dilating of the stricture. With the fingers in the stomach opening find the cardiac orifice, and guide a strong uterine, pharyngeal, or Otis dilator up through the stricture and stretch it.

Instead of dilators, it may be more expedient to use other methods in stretching the strictured part. A thread can be swallowed to the end of which is attached a shot, or a knot can replace the shot. By means of this thread bougies can be pulled up from below. Abbe followed a plan in his second case which appears to answer the purpose admirably. After opening the stomach the stricture was dilated as much as possible in the manner just described. He then by means of a "string saw" cut the remaining tissue, so as to admit of complete dilatation. The wounds were closed, and after a few days bougies were passed from above.

Bernays employs a "rosary bougie," made by taking the olivary bulbs from the ordinary whalebone bougies, and, after perforating them in their long axes, he threads them on strong silk. The smallest size is placed at the upper end of the chain, and kept from slipping by a knot on the thread. By regular gradation the size is increased to the largest bulb that can be used.

Treatment of Malignant Stricture.—For obvious reasons the use of dilating bougies is not suitable in malignant stricture. Two methods are left to us, the one dealing with an artificial opening, the other with the wearing of a tube to keep the stricture permanently dilated.

Excision of the growth has been resorted to, but the cases where such treatment is available are few and far between.

Esophagostomy is the operation of making an artificial opening in the esophagus. It of course must be made below the stricture, and, as it is impossible to prove how far down the esophagus the disease extends, the operation is very unsatisfactory. The incision is the same as for esophagotomy, only lower down.

When an artificial opening has to be resorted to, the stomach offers the best field, as it is farther from the disease and is comparatively easy, and yet the results of gastrotomy for malignant disease are exceedingly bad. Like all operations which aim only to relieve, and not to cure, it can never be looked upon with favor. This, however, it will do—it will (particularly if resorted to before he is exhausted) allow the patient to receive nourishment and prevent starvation, and lessen the suffering which attends every attempt to pass food along the esophagus.

Of the many methods of performing gastrostomy, that of Witzel is probably the best. In this operation the fistula is made to pass through both the rectus and transversalis muscles. As the fibers of the muscles run at right angles to each other, their contraction may be relied upon

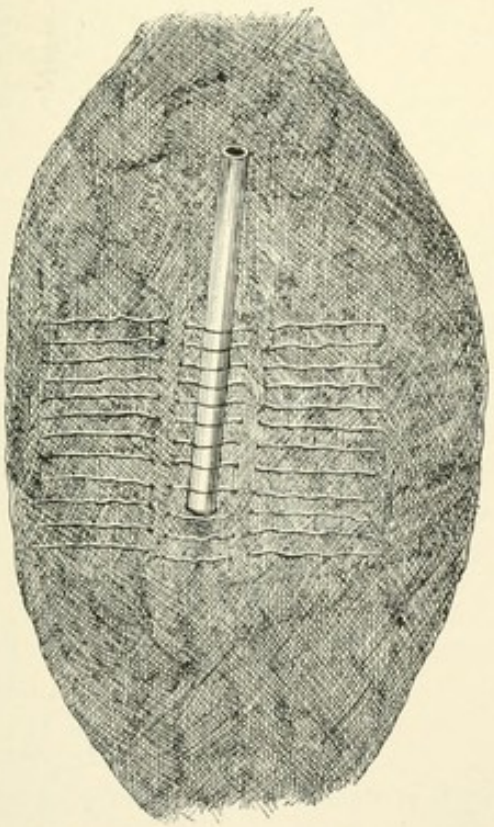


FIG. 94.—Witzel's method for gastrostomy, showing application of sutures in wall of stomach, imbedding tube obliquely therein.

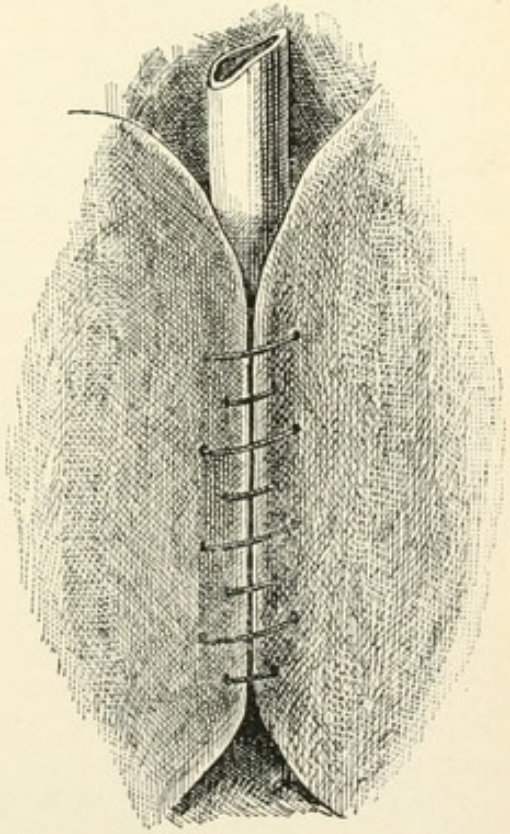
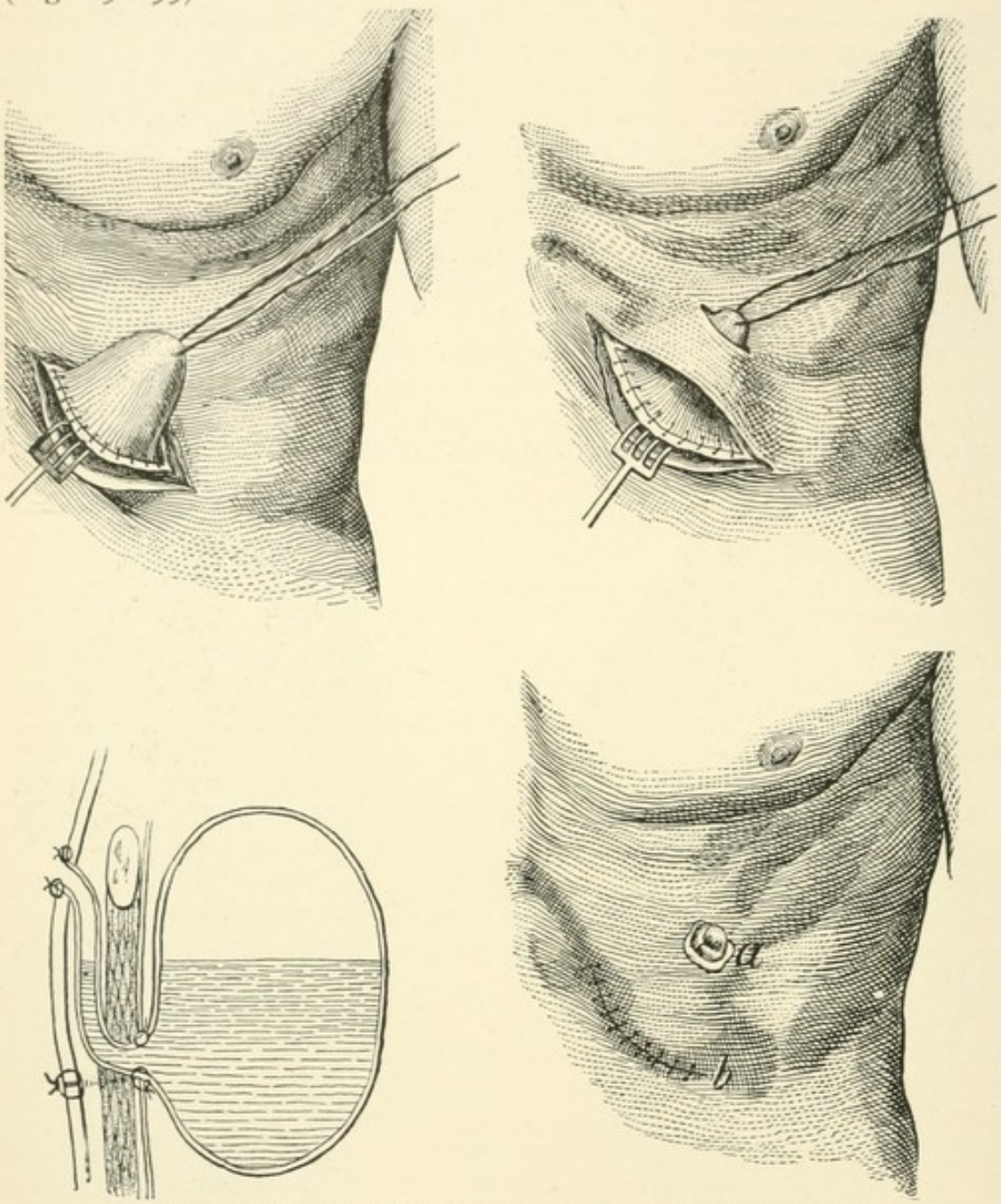


FIG. 95.—Sutures tied, completely imbedding tube for some distance.

as an efficient sphincter. The second important feature of this operation is the enfolding of the tube in the wall of the stomach, the stomach-wall being stitched over the tube so as to form an oblique cone (Figs. 94, 95).

The Ssabanejew-Frank operation may be preferred by some operators. It consists in drawing up a cone of the stomach through the ordinary Fenger incision and under a bridge of skin to a point above

the border of the ribs, where it is fixed and opened. This secures a curved fistula with a bridge of stretched skin acting as a sphincter (Figs. 96–99).



FIGS. 96–99.—Frank's method of gastrostomy in carcinoma of the esophagus.

As an improvement upon any of the foregoing methods Symonds has invented tubes which can be passed down to the stricture, and, fitting accurately there, liquids can be passed through without difficulty. The tubes are from 4 to 6 inches in length, made of gum elastic upon a silk web, and having a highly polished surface within and without. At the upper end the tube is funnel-shaped to rest upon the stricture, and slightly flattened anteriorly to fit the more accurately against the cricoid cartilage. Two perforations in the rim of the funnel are for the attachment of a silk thread. In the introduction of the tube the stricture is first accurately located and its position indicated on the

bougie. With a whalebone guide the tube is slipped very gently down to the stricture, and through it until the funnel meets with resistance. The guide is withdrawn, and the silk thread which is attached to the funnel is then made fast to the ear or secured to the cheek with adhesive plaster. After two or three days it will be found that a larger tube can be inserted as the stricture dilates. The second and larger tube may be left in position several months.

II. DISEASES AND INJURIES OF THE ABDOMEN.

Examination of the Abdomen.—For this examination the patient should lie upon a firm table or bed, the head and shoulders should be slightly raised, and the knees flexed to an angle of about ninety degrees. This posture relaxes the abdominal muscles sufficiently. If the head and shoulders be raised too high, the antero-posterior diameter of the abdomen will be increased and it becomes more difficult to palpate the organs. The abdominal cavity includes everything within the peritoneum, and for diagnostic purposes it is convenient to consider the abdominal and pelvic regions as one cavity. The anterior wall of this cavity is lozenge-shaped, the four corners of the lozenge being at the ensiform cartilage, the pubes, and the loins. This wall is composed of skin, fat of indefinite thickness, muscles, fascia, and peritoneum. In our examination it lies between us and the structures within, rendering palpation difficult, and by the contraction of the muscles presenting appearances which are likely to mislead. Patients with thin, lax abdominal walls are easily examined. The most difficult subjects are males whose abdominal walls are thick and fat.

It is customary to divide the abdomen into nine regions. This is done by drawing upon the skin two vertical and two horizontal lines. The vertical lines extend from the middle of Poupart's ligament to the cartilage of the eighth rib. The upper transverse line is at the level of the ninth costal cartilage, and the lower at the highest point of the crest of the ilium. Beginning from above downward, we have thus mapped out, in the middle, the epigastric, umbilical, and hypogastric regions; on the right side, the right hypochondriac, the right lumbar, and the right iliac; on the left side are the left hypochondriac, lumbar, and iliac. The contents of these regions are as follows:

In the epigastric region are found, from before backward, the left lobe of the liver; part of the anterior wall of the stomach with the cardiac and pyloric orifices; the gastro-hepatic omentum and foramen of Winslow. Close to the foramen are the hepatic artery, the hepatic and cystic ducts, and the origin of the ductus communis choledochus, the portal vein, and the vagus. Behind the stomach lie the duodenum, the pancreas, the celiac axis, the superior mesenteric artery, the solar plexus, the aorta, and the vena cava inferior.

The right hypochondriac region is occupied by the right lobe of the liver, behind which is the gall-bladder, a small portion of the transverse colon, and the upper end of the right kidney with its suprarenal capsule.

The left hypochondriac region contains the cardiac end of the stomach, the spleen and gastro-splenic omentum, the left flexure of the colon, the upper end of the left kidney, and its suprarenal capsule.

The umbilical region is occupied by the bulk of the small intestine, the great omentum, mesentery, aorta, and vena cava inferior.

The lumbar regions contain the ascending colon on the right, the descending colon on the left, the right and left kidney respectively with their ureters, some loops of small intestine, and cellulo-adispose tissue.

The hypogastric region contains the great omentum, portions of the small intestine, the bladder when distended, or the uterus when enlarged.

The iliac regions contain on the right side the cecum, and on the left the sigmoid flexure.

Subjective Symptoms.—The patient suffering from disease or injury in the abdomen may complain of pain, fulness, weight, distention, burning, or undue motion. Of these *pain* is the most important and most frequently met with. It may be sudden in its onset, as in colic, or it may be chronic, as in gastric carcinoma. We can form a fairly reliable opinion of the nature of a case from the character of the pain as described by the patient.

Position of the Pain.—As a rule, when pain is referred to one particular part it indicates disease in the organ or structure which is the seat of pain. Care must be taken to differentiate between pain in the abdominal wall and in the internal organs. If the skin is affected, the pain is sharply localized; there is tenderness to touch, and there may be redness, showing erythema, ulceration, erysipelas, etc. Pain in the nerves is generally neuralgic; there is usually tenderness at one or more points; it has a sudden onset and an equally sudden disappearance, and there is absence of fever. Herpes zoster is attended with violent pain before the appearance of the vesicular eruption. Disease of the vertebræ or the pressure of an aneurysm on the spinal column produces a pain which is intermittent in character, and is felt in the middle line between the ensiform cartilage and the umbilicus. When the muscles and fascia are affected the pain increases with motion of these muscles, as in coughing, laughing, or bending the body.

Sudden pain occurring in paroxysms, attended with vomiting, rapid pulse, cold sweats, pallor of the skin, and more or less collapse, is suggestive of intestinal, renal, biliary, or uterine colic. If it occur in the course of typhoid fever or ulceration of the stomach or intestine, it is very suggestive of perforation and escape of the contents of the hollow viscera into the peritoneal cavity. The rapid development of peritonitis would confirm the suspicion. But the severity and suddenness of the pain must not be explicitly relied upon. Such pain is found in simple gastralgia, enteralgia, or obstruction of the intestine. These will receive closer attention when respectively dealt with.

Pain over the whole abdomen is generally caused by peritonitis or rheumatism. If peritonitis, there is great tenderness on pressure, the limbs are drawn up to relax the abdominal walls, and the weight of the bed-clothes cannot be borne. Rheumatism is recognized by the slight amount or absence of fever, by the aggravation caused by movement, by the presence of uric acid and urates in excess.

Fulness, weight, and distention are subjective symptoms of minor importance, due to enlargement or displacement of the various organs, the presence of tumors, or the presence of inflammation.

Objective Symptoms.—An examination of the abdomen embraces inspection, palpation, percussion, auscultation, and, in exceptional cases, exploratory puncture or exploratory incision.

Inspection.—Stand at the patient's feet, and as he lies in the position already described any changes in form or contour can be readily noted.

The size and shape of the abdomen are the first to be considered. In children the abdomen is naturally more protuberant and proportionally larger than in adults. Large eaters have large bellies, and some people have their abdominal walls and omentum enormously thickened with fat. When due to such conditions the abdominal enlargement is proportionate to the enlargement of other parts of the body, while in ascites or tumors the size of the abdomen strongly contrasts with the wasted condition of the chest and limbs.

Ascites is characterized by general enlargement, and the contained fluid gravitates to the flanks, causing them to bulge outward, while the anterior wall is flattened. Change of position will be followed by corresponding change in shape, the upper parts becoming flattened, while the lower bulge. In excessive distention from ascites these signs do not hold good, for all parts are tense; the swelling is uniform and unchanged by posture.

Accumulation of gas in the intestine is an important symptom. It may be due to simple indigestion, and in such a case is usually of slight importance. It is an accompaniment of typhoid fever. Surgically, it is met with as one of the alarming results of peritonitis following operations or as the effect of obstruction in the large intestine.

Large tumors of especial organs, as the spleen, liver, or gall-bladder, may, on inspection, present the appearance of general enlargement of the abdomen, but further examination by palpation and percussion will locate a tumor in the position to which it belongs unless it is so large as to fill the abdominal cavity.

Local Enlargement.—When we observe a local enlargement of any part of the abdomen, our attention is naturally drawn to the organ or organs which normally occupy that position. And this is a pretty safe rule, for a tumor of any organ always begins to grow in the normal position of that organ, and encroaches by degress upon the neighboring regions. Thus a tumor of the kidney may be felt in the umbilical region, but its first appearance is in one or the other lumbar space, and it never reaches the umbilical until it has filled the lumbar region.

The color of the skin is not very suggestive. In ascites and edema it is pale and glistening; in Addison's disease there may be an areola; in pregnancy there is not infrequently a bronzing of the skin between the pubis and umbilicus. Enlarged veins may be easily perceptible beneath the skin, as in cirrhosis of the liver or in cases where a tumor exists large enough to make pressure upon the vena cava and thus interfere with the return circulation.

Movements.—The upper portion of the abdomen takes part in the movements of normal respiration, especially in males. Movement is restricted in peritonitis, in general enlargement, and when tumors occupy the upper portion of the abdomen. When tumors are in contact with the aorta, pulsation may be communicated to the morbid growth and

be perceptible through the abdominal walls. If the patient is placed upon his hands and knees, the tumor falls away from the aorta and pulsation ceases.

Movements of the stomach may be observed in thin subjects, especially when the viscus is much enlarged or displaced downward; hence, dilatation may be diagnosticated by inspection alone. Sometimes peristaltic waves of the stomach may be observed passing from left to right. If intense and persistent, this condition is spoken of as "peristaltic restlessness" of the stomach.

Peristaltic movement of the intestines is a common symptom when there is narrowing or obstruction of the lumen of the bowel. In the case of the large intestine the wave may be traced along the course of the colon, but when the small intestine is involved the movement is observed in the umbilical region.

Palpation.—Of all the methods of examination of the abdomen, this is the most important, and can be brought to a high state of efficiency by cultivation. The abdominal walls must be well relaxed by raising the head and shoulders and by bending the knees. If the examining hand is cold, dip it in warm water, and two points will have been gained—the sense of touch will be more acute, and the abdominal muscles will not retract, as they are sure to do when they are touched by icy fingers. The recti muscles are especially prone to contract, and great care is necessary at times to distinguish this rigidity from a tumor. The point is readily settled by directing the patient to throw the rectus into action while the fingers are placed upon it. Most patients cause contraction of the recti by the simple movement of raising the head from the pillow. If this does not succeed, direct the patient to sit up, when the very first movement will be contraction of the recti. Permanent localized contraction of the muscles is indicative of inflammation in the parts beneath.

Palpation should be commenced by placing the palm of the hand over the umbilical region, and by a gentle motion (rolling the skin over the subjacent parts) pressing it steadily downward. If no tumors be felt, the hand without much difficulty can be made to feel the spinal column and the aorta down to its bifurcation. From this region the palm is rotated outward, and the ulnar side of the hand pressed gently but deeply into the lumbar and iliac regions. This will enable you to palpate the brim of the pelvis and the upper part of the common iliac vessels. Without relaxing the pressure the hand is made to roll the abdominal wall over the parts beneath, when any irregularities, if present, can be readily felt. One area after another is gone over in this manner, the hand still firmly applied, and sliding, when necessary, over the skin. If inspection has revealed a local enlargement, palpation will confirm it and give an idea of the shape, consistence, and character of the growth or other cause. When a tumor is found, we must settle the following points in connection with it:

1. In which region is it situated, and in connection with what organ?

2. Is it circumscribed or diffuse? This is determined by passing the fingers around it as far as possible, and between it and the abdominal bony boundaries.

3. Is it solid or liquid? In tumors of dense structure, such as car-

cinoma, a feeling of hardness can be recognized, fluid tumors can be detected by their fluctuation, but between these two extremes are many grades of consistency which are very difficult to determine.

4. Is it movable or fixed? The hand should be placed upon different parts of the tumor, or the whole tumor grasped by the hand and its mobility tested. If freely movable, note the effect of change of posture. It often happens that the patient can bring the growth into prominence by lying in one particular position.

5. Is its surface smooth or irregular, and is its consistence uniform? The points of the fingers moving the abdominal wall over the tumor will detect a nodular surface if it be present, as well as any irregularity of consistence, such as would result from the formation of cysts or abscesses in solid growths.

Palpation by the vagina is a means of diagnosis which is of wide utility. By means of it tumors in the pelvis can be felt between the finger of one hand in the vagina and the other hand on the abdominal wall. The connection of the tumor with the uterus, ovaries, tubes, or broad ligament can be settled and its pedicle or base localized.

Palpation by the rectum is valuable in the diagnosis of tumors low down in the pelvis or involving the rectum itself. It was recommended a few years ago as an aid to the diagnosis of appendicitis, but I am not aware that it has ever been extensively employed. In cases of great uncertainty, as in supposed stricture of the rectum high up, it may be necessary to introduce the whole hand. The procedure is difficult and not free from danger. I have had recourse to it but once, and have never met with any one who advocated it as a valuable method of diagnosis.

Percussion.—This is not so important as palpation, of which it may be regarded as a variety. The practised diagnostication will bring out distinct sounds where the tyro finds only indefinite thuds. To percuss to the best advantage we should imitate the action of the piano. A little hammer strikes the wires with a sharp, quick stroke and rapidly rebounds, leaving the string to give out by its vibration a full, clear sound. The finger of the left hand represents the piano-wire, the middle finger of the right hand represents the hammer; the motion should be at the wrist, and the percussing finger should be brought down with a sharp, quick tap, and made to fly back as quickly as possible, leaving the vibration of the part percussed to give out a clear, unrestricted sound. Applications of percussion will be considered under the special organs.

Auscultation.—This method is valuable in the diagnosis of aneurysms, the demonstration of placental and uterine bruits, the friction-sound of peritonitis, and the pulsation of the fetal heart.

The phonendoscope is an instrument of considerable value in examination of the abdomen and thorax. It was invented by Bianchi of Florence, aided by Bazzi, the celebrated Italian physician. It is a modification of the stethoscope, the sound being amplified by means of a resonator similar to the receiver of a telephone. Its utility as claimed by the inventor lies in the following directions: 1. It enables us to appreciate normal and pathological sounds in the various organs of the body—sounds that are not audible by any other means of aus-

cultation; 2. By it may be determined the position, thickness, and relations of separate organs. It is thus employed: The instrument is placed upon the skin over the organ to be examined; the index finger of the right hand gently strokes the skin near the instrument, producing a distinct vibratory sound which varies according to the size, density, and thickness of the organ under examination. The stroking is continued farther and farther from the instrument until a change in the sound indicates that the examining finger has passed from the organ under examination to one of different conducting power. The points at which this change takes place can be marked upon the skin and the limits of the organ accurately defined.

In examining the liver the instrument should be successively placed in the following positions: beneath the ensiform cartilage; in the right mammillary line in the seventh intercostal space; in the ninth intercostal space over the mid-axillary line. For the stomach, place the instrument in the following positions: the seventh intercostal space in the left mid-clavicular line; on the linea alba near the left free edge of the ribs and below the greater curvature. In this examination the cardia, the pylorus, the coils of the intestine, and the nature of their contents, whether fluid or gaseous, can be determined.

In examining the colon, place the instrument in the right iliac fossa for the cecum, and beneath the free border of the ribs in the anterior axillary and mid-axillary lines for the ascending colon; for the transverse colon, on a line running from right to left a little above the umbilicus. The descending colon is examined by placing the instrument beneath the left free border of the ribs and also in the left iliac fossa. In all cases heavy strokes are necessary to detect fluids, and light strokes to detect gases.

When a tumor is to be examined, the instrument should be placed over the center of the growth.

Exploratory Puncture and Incision.—As a general rule, the exploring needle is dangerous in the abdominal cavity, and at this day is seldom or never resorted to by the best surgeons. When every other method of diagnosis has been carefully and exhaustively tried, and there is still doubt as to the question whether a given growth can be safely removed, it is proper to make an abdominal section. In the hands of a skilful operator a simple incision, to admit one or two fingers and explore gently the abdominal contents, is practically devoid of danger, and in a sense safer than the puncture of an exploring needle. On the other hand, there is nothing so mischievous as the idea that it should be resorted to in every case which offers obscure symptoms. The case may be obscure for want of skill and experience in the examiner; to subject a patient to an operation as an outlet for ignorance is cruel and unwarrantable.

When such an incision is decided upon, every preparation should be made for any radical operation which may be called for. The incision should at first be made only sufficient to admit one or two fingers. Through this opening a search can be made of the whole peritoneal cavity, after which the incision can be extended by scissors upward or downward as required. Unless it is reasonably certain that the radical

operation can be successfully carried out, the parts should be disturbed as little as possible and the opening closed.

Injuries of the Abdomen.

Contusions.—Owing to the looseness and mobility of the abdomen, bruises and blows may produce the most serious results without any visible marks upon the skin. Shock is always pronounced, and death has often occurred with no other symptom, post-mortem examination failing to reveal any structural lesion. Contusion of the abdominal wall may cause laceration of vessels and the formation of a hematoma in the sheath of the muscles or the areolar tissue. Hematomata are found most frequently in the flanks and may attain an enormous size. If they remain aseptic, absorption rapidly takes place, and no treatment except rest is necessary. Should they continue to enlarge by persistence of the bleeding, they should be incised, the bleeding vessel ligated, or the cavity packed with gauze. When sepsis sets in incision and drainage are demanded. A blow while the muscles are in a state of rigid contraction may cause their rupture, leaving a weak spot which may later be the seat of a ventral hernia. Rupture of muscle may also occur during severe labor or in the violent contractions of tetanus. Debilitating diseases, such as typhoid fever, weaken the muscles and predispose them to rupture. The symptoms of ruptured muscle are pain and tenderness. When the rupture is extensive a depression is found between the ruptured muscular structures. The treatment is rest and soothing applications. It may be practicable in some cases to cut down upon the injured part and suture the divided portions of muscle. It sometimes happens that septic germs find an entrance to bruised and lacerated tissues, and an abscess in the abdominal wall is the result. Such an abscess is surrounded by widespread induration, and its contents, when evacuated, are often foul-smelling like those of an abscess near intestine. The parietal peritoneum is occasionally ruptured, and the result may be peritonitis.

Injury to the Viscera from Abdominal Contusions.—The diagnosis of these internal injuries is always attended with difficulty. Shock is the most prominent symptom. The patient lies in a state of collapse. If this increases, we may assume that some organ has been ruptured or that hemorrhage is taking place. Hemorrhage is manifested by increasing pallor, paleness of the gums and lips, yawning, sighing, dilatation of the pupils, and by dulness on percussion when enough blood has been poured out to fill a part of the abdominal cavity. When an organ is ruptured we must wait for secondary effects. The bladder is the organ most easily examined. A soft catheter can be introduced. If clear urine escapes and in considerable quantity, we may know that there is no rupture; if, on the other hand, a small amount of urine comes away and it is stained with blood, it is significant of rupture. It is seldom that an empty bladder is ruptured, except in cases where there is also fracture of the pelvis.

The Stomach.—Rupture of this organ may be suspected when there is blood-stained vomiting. This, however, is not a sign of great value, for it may be due to bruising of mucous membranes, and, besides,

if the laceration in the stomach be extensive, there will be no vomiting, for the contents will escape into the peritoneal cavity. Pain in the epigastrium is significant of rupture of the stomach; pain and tenderness around or below the umbilicus point to the intestine as the seat of rupture. Escape of gases into the abdomen and inflation sufficient to give resonance over the normal position of the liver are also very suggestive. A distended stomach is more liable to suffer rupture than one comparatively empty, and the part of the organ generally torn is that near the pylorus. When the posterior wall of the stomach is ruptured the contents are confined by the lesser omentum and an abscess may result.

The intestine is most easily ruptured at the point which is most fixed—viz. the end of the duodenum. The symptoms will be considered under Wounds of the Abdomen.

The liver, owing to its size and weight, is liable to rupture. The symptoms are those produced by hemorrhage. Fracture of ribs over the liver, followed by collapse and other signs of hemorrhage, would be very strong presumptive evidence of rupture.

Treatment.—Except when the shock is slight and a positive diagnosis can be made, treatment must be expectant. Perfect rest must be enjoined, nourishment must be given by small enemata, thirst quenched by small pieces of ice, and stimulants avoided or very sparingly employed. Pain may be removed by hypodermics of morphin. The prognosis is much more grave when internal organs are ruptured. These are usually desperate cases. The patient tosses from side to side, finding no easy posture until death relieves him, or the collapse deepens till the end arrives. Rupture of the bladder calls for immediate operation, as does also any form of internal hemorrhage, provided the state of the patient warrants such interference.

Wounds of the Abdomen.

Wounds of the abdomen very naturally divide themselves into two classes: (1) Non-penetrating wounds; (2) Penetrating wounds.

The most common causes of abdominal wounds are stabs and gunshot injuries. A free incised wound can be readily examined and its depth ascertained. After washing out the clots the edges can be held apart and the divided tissues seen or felt. When, however, the wound is a small penetrating one, as a stab made by a knife-thrust or a bullet, the question of penetration is not so easily settled. Here the greatest care must be observed lest septic matter be carried into the peritoneal cavity. The skin around the wound and the wound itself should be carefully cleansed and disinfected. A director should then be passed into the wound and the opening enlarged by careful dissection down to the end of the director. Then another careful search should be made, and if the director can be made to pass farther, the dissection should be continued until it is clearly demonstrated whether the wound ends in the abdominal wall or enters the peritoneum.

A non-penetrating wound is not a serious matter. The parts having first been carefully disinfected, sutures of silk or silkworm gut are used to obtain perfect apposition of the parts, as in celiotomy, and a dressing applied. The danger of such wounds lies in the fact that the

abdominal wall is weakened at that spot, and hernia is likely to follow. The patient should lie in bed for at least three weeks to give the parts time to become firmly united. He should afterward wear an abdominal belt or supporter, and should avoid severe muscular effort for many months.

Penetrating wounds are further divided into two classes: (*a*) those without visceral complications; (*b*) those in which one or more of the viscera are perforated. When the external wound is large, the peritoneum divided, and the intestine or stomach protruding, the case is self-evident; and all that remains to be done is carefully to wash the protruding viscera with sterilized water, return them to the abdominal cavity, and close the wound. The escape of omentum is also proof of penetration. In cases of stab or bullet wounds with small tortuous tracks it is usually necessary to explore, by dissection, in the manner already described. Penetrating wounds without visceral lesions often do well when treated antiseptically. The peritoneum should be sutured by itself by means of catgut, and a row of silkworm-gut stitches can be used to close the remaining structures.

Symptoms of Visceral Wounds.—In the examination of a stab or gunshot wound of the abdomen the course of the missile should be carefully noted. A bullet is not often deflected here, as in the case of the skull, and a line between the points of entrance and exit will in most cases indicate the region transversed and the organs perforated. It may be set down as a rule that a bullet passing through the abdomen from side to side perforates the intestine in from four to fourteen places. A bullet passing antero-posteriorly about the level of the umbilicus gives a probability of no visceral perforation. The difficulty of diagnosis will be seen as we take up the symptoms one by one.

Shock.—A non-penetrating wound of the abdominal wall may be attended with profound shock. A penetrating wound which divides the intestine in several places has been known to be so free from shock that the patient has walked several blocks or even one or two miles.

Vomiting may be a marked symptom in non-penetrating wounds, so that it is no proof of visceral wound. The same may be said of pain and pallor of the skin.

Hemorrhage.—The blood that gushes from the parietal wound counts for little, as it is the flow from some muscular vessels in the wall. Blood from a wounded internal organ is poured out into the peritoneal cavity, and produces constitutional effects which are difficult to distinguish from shock. We must be guided by the ordinary symptoms of hemorrhage, such as pallor of the face, lips, gums, and conjunctiva, yawning, sighing, fainting, thirst, and jactitation. Besides these, a careful examination should be made by percussion. Blood collecting in the abdominal cavity soon gives dulness in the flanks, which changes with position, as happens in ascites.

Escape of stomach or intestinal contents through the external wound is convincing evidence, but this happens only when the opening in the viscus is opposite to that in the parietes and is not tortuous. When the contents of these organs escape, they do so into the abdominal cavity, and give no evidence until peritonitis has set in.

Emphysema signifies very little, for it may be produced by air

which has entered the wound from without, just as likely as by gas which has escaped from the alimentary tract.

Hydrogen-test.—To Senn we are indebted for a very valuable aid in the diagnosis of wounds of the stomach and intestines. Hydrogen is a harmless gas which can be injected into the alimentary canal in any quantity, producing no other effects than distention and disinfection. The gas is prepared in the usual way from pure sulphuric acid, zinc, and water, and collected in a rubber receiver which holds not less than three or four gallons. The tube from the receiver is inserted into the rectum, and, while an assistant holds it in position and presses the anus about it to prevent escape, the gas is slowly forced into the bowel. If the ear or stethoscope be placed over the position of the ilio-cecal valve, a gurgling sound will indicate the passage of the gas into the small intestine. Should there be a perforation of the intestine, the gas escapes into the peritoneal cavity, and thence through the external wound, where it can be detected by a hissing sound or may even be ignited with a match; or, if it should fail to escape by the external wound, it will fill the abdominal cavity, getting between the liver and the parietes, and giving a resonant note in the normal position of hepatic dulness. When this test is to be applied to the stomach, a soft stomach-tube is employed and the gas injected as before. The hydrogen-test may also be found valuable in deciding the question of penetration. The gas is injected into the wound of entrance. If there is no penetration of the peritoneum, the hydrogen will pass along the bullet-track and escape by the wound of exit. Compress the wound of exit and increase the gas-pressure, and emphysema will be felt along the course of the bullet. If there is penetration, the whole abdomen will quickly become distended and tympanitic.

Objections to the use of hydrogen are the dangers of over-distention, the difficulty of returning the bowel to the abdominal cavity, and the fact that it frequently fails as a test.

Prognosis.—Wounds of the abdomen must always be looked upon as of the utmost seriousness. In considering the probability of recovery it is safe to estimate the three divisions as follows:

1. Non-penetrating wounds, prognosis favorable. Careful antiseptic treatment will result in prompt healing. Accurate apposition by sutures and prolonged rest in bed will guard against ventral hernia.

2. Penetrating wounds without visceral injury, while more dangerous than the preceding, are not necessarily fatal, a large portion recovering without intra-abdominal treatment, provided nothing of a septic nature has entered the abdominal cavity.

3. Penetrating wounds with visceral injury. These are almost surely fatal, death resulting from hemorrhage or peritonitis. When a large vessel is wounded or when there is profuse parenchymatous hemorrhage, as from the liver or spleen, death follows quickly. A wound of the stomach or intestine allows the escape of the contents of the injured organ into the peritoneal cavity. Peritonitis speedily follows, and death takes place within forty-eight hours, more from shock, perhaps, than from sepsis. There is a bare possibility that recovery may follow even so desperate an injury as this. The stomach or intestine, being empty at the time of the accident, may at its injured point

form an adhesion with a neighboring serous surface, and the general peritoneal cavity be thus protected. This contingency, however, is too remote to enter into our calculations in making a prognosis. In this third class of cases nothing but prompt operative interference with the view of arresting hemorrhage or closing wounds in the viscera will change the prognosis. The mortality after these operations may be set down at about 62 per cent.

Treatment.—A non-penetrating wound must not be treated with indifference. The shock is often severe, and frequently it is so more from fright than from the extent of the traumatism. Soldiers have been picked up on the battle-field in a state of profound shock, and have quickly rallied and gone on fighting when assured by the surgeon that the supposed fatal injury was only an abrasion of the skin. The treatment of a non-penetrating wound consists in disinfecting the wound and surrounding parts. None but perfectly aseptic fingers and instruments should be used in exploring the wound. Care must be taken in application of sutures to restore the abdominal wall to its original strength and thus prevent ventral hernia. When drainage is called for, a few strands of catgut are better than non-absorbent drainage-tubes.

In penetrating wounds, when the omentum or viscera protrude, these structures must be examined for injury. They should then be carefully washed with sterilized water and returned to their normal position. The peritoneum should be closed by a continuous catgut suture and the abdominal wall by silkworm gut or strong silk. When the wound is of considerable size, the greatest care should be taken to guard against a subsequent hernia; this is best averted by keeping the patient in bed for three or four weeks, and by having him wear an abdominal belt or support for several months afterward.

Penetrating wounds with visceral injury either forbid interference or demand the promptest action. If the patient is evidently sinking, and his general condition such that he cannot endure a prolonged operation, he would better be left alone.

Two conditions demand operation: (1) Profuse internal hemorrhage; (2) Perforation of stomach or intestine large enough to allow the escape of its contents.

No rules can be laid down as a guide in such cases; the condition of the patient and the special indications must be left to the surgeon's individual judgment. When there is profound shock it is necessary to employ suitable remedies and wait for reaction. Symptoms of peritonitis should not be waited for. When they appear the case is almost beyond hope. Adhesions by this time will have taken place and perforations cannot be found. The perplexing point to the surgeon is this: There is evidently perforation, but the patient's condition does not appear serious enough to demand operation. On the other hand, if he waits for these serious symptoms to come on, the case will then be beyond hope. It is unquestionable that the earlier an operation can be resorted to the better will be the result. Coley has shown that of 39 cases operated upon within twelve hours, 18 recovered. Of 22 operated upon after twelve hours, only 5 recovered.

Operation.—*Instruments Required.*—Besides the ordinary instru-

ments required for an abdominal section, there should be at hand the following:

Four intestinal clamps; ten round milliner's needles for enterorrhaphy threaded with fine silk; stout catgut for suturing wounds in the solid viscera.

Preparation of the Patient.—For the relief of shock and for prolonging anesthesia a hypodermic injection of $\frac{1}{4}$ grain of morphin and $\frac{1}{150}$ grain of atropia should be given. If there is indication that the stomach is the seat of injury, this organ should be emptied by the stomach-tube and washed out with warm sterilized water. The bowels can be emptied by an enema containing a little salt. Some advocate the use of whiskey as a stimulating enema. The whole abdomen should be thoroughly washed and disinfected and the wound carefully cleansed.

The Incision.—Except when the position of the external wound would strongly indicate to the contrary, a median incision is to be chosen. It gives better opportunities for examining intestines and stomach and a broader field in which to search for bleeding vessels. No rule, however, can hold good here. The course of a bullet or the direction of a stab wound will afford a pretty safe indication of the organs injured, and these must be reached by the incision which best exposes them.

Arrest of Hemorrhage.—When hemorrhage is the prominent symptom, a free incision is necessary to bring the bleeding points into view. If one of the solid organs be wounded, the character of the bleeding will be parenchymatous. A wound in the liver should be treated with a suture of stout catgut or packed with a strip of iodoform gauze, the end of which is left projecting from the parietal wound. A profusely bleeding kidney may require nephrectomy; a wounded spleen may bleed so profusely that nothing but splenectomy will suffice. When there is a copious flow of blood, which accumulates as fast as it can be sponged out, the aorta should be compressed by an assistant. This requires a larger incision than ordinary, to allow the hand of the assistant to reach the vessel just below the diaphragm. Compression of the aorta in this manner controls the flow of blood from all the abdominal organs, and gives the operator time to find the bleeding points. The vessels of the mesentery are best controlled by ligature *en masse*.

Perforations.—Having checked all hemorrhage, a rapid search must be made for perforation of the stomach or intestines. As soon as an opening is found it should be immediately closed with pressure-forceps, and held in the angle of the wound by an assistant while the operator continues his search. Every opening, as soon as discovered, is clamped in a similar manner until all are secured. Greig Smith advises the use of abdominal irrigation during the whole of the time that closure of visceral wounds is being carried out. It cleanses the abdomen and thus saves time, and if water at a temperature of 110° F. be employed, it will prove an excellent remedy for shock.

Suturing the Perforations.—One by one the wounds are closed. Sponges are arranged around the abdominal opening and the intestine or stomach brought out. Lembert sutures are the most suitable. The

lacerated edges of the intestinal wounds are turned inward and the serous surfaces brought together. Four to six sutures should be applied to every inch of incision, and the best material for this purpose

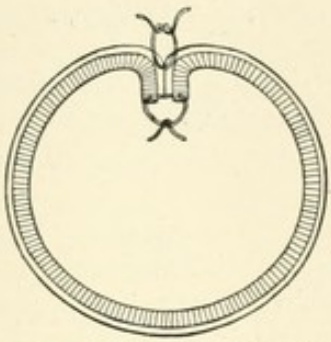


FIG. 100.—Czerny-Lembert suture.

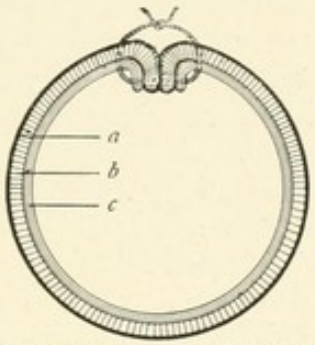


FIG. 101.—Jobert's suture for partial division of gut: *a*, serous; *b*, muscular; *c*, mucous coat.

is fine silk. Wounds in the intestine should be sutured transversely to prevent constriction of the lumen; in the stomach the direction should be in the long axis of the organ. When the bowel is wounded near

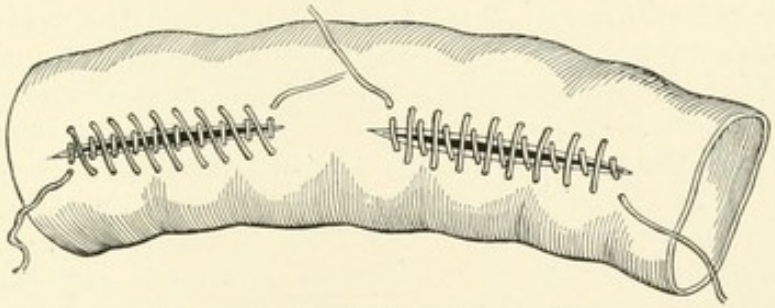


FIG. 102.—Lembert continuous stitch.

its mesenteric border gangrene is apt to result, as there is a danger of the blood-supply being cut off from that part of the intestine. This may necessitate the removal of a portion of the bowel. A section of the

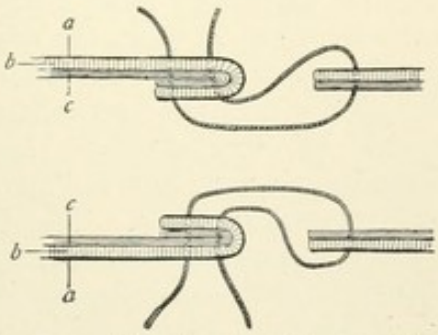


FIG. 103.—Jobert's suture for complete transverse division of gut: *a*, serous; *b*, muscular; *c*, mucous coat.

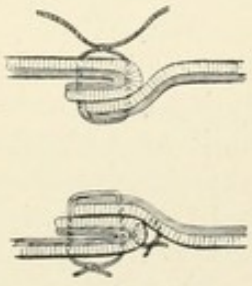


FIG. 104.—The suture tightened, showing Lembert's suture introduced to give additional security.

bowel will also require removal when there is a double perforation or a laceration so large as to destroy a great part of the circumference of the tube. When this has to be done the mesentery attached to the condemned part of intestine is tied off in sections with fine silk before

removal of the bowel. When the intestine is simply contused, the injured portion may be turned inward and sound serous surfaces brought together with Lembert sutures; then, should sloughing take place, the necrotic portion will fall within the bowel. Each wound after having been sutured is carefully washed, and, if possible, rendered more secure by an omental graft. This is accomplished by taking an adjacent portion of the omentum and laying it upon the contused or sutured surface of bowel, retaining it in position by two catgut sutures loosely tied. Adhesions will be hastened if the opposing surfaces are first scratched by the point of a needle.

Irrigation of the Abdominal Cavity.—Having closed every perforation and stopped all bleeding points, the cavity of the abdomen is next thoroughly washed out with warm water. If this has been kept up during the preceding steps of the operation, very little time will be required for a final flushing. In any case a full stream of warm sterilized water or mild antiseptic solution is allowed to flow into the cavity, while the bowels are moved gently about to allow the fluid to reach every part, and this is kept up until the water returns as clear as it went in. The cavity is then dried with warm sponges.

Drainage is necessary, as a rule, when there has been gross infection by the extravasation of visceral contents or when there is a continuance of parenchymatous hemorrhage. The parietal wound is closed by means of silkworm-gut sutures, as in any abdominal section.

After-treatment.—When the intestine has been the seat of operation perfect rest of the organs, even from their own peristaltic action, is necessary. The stomach and upper part of the small intestine are rested by taking no food into the mouth for three or four days, and then only liquids, such as peptonized milk, diluted peptons, or jellies. Opiates are recommended for the purpose of restraining peristalsis. It is doubtful whether this is a wise procedure. If the dose of morphin and atropia be given just before the operation, as already advised, its effect will be to keep the intestines quiet for some time. Adhesions of serous surfaces take place rapidly, and, if union is to occur at all, it will be pretty firm at the end of twenty-four hours or even in less time. The arrest of peristalsis is not necessary beyond this, and opiates are certainly contraindicated as interfering with the absorbent action of the peritoneum. When a drainage-tube is employed care must be taken to keep the fluid drawn out at frequent intervals by means of an exhausting syringe. Should the temperature rise and other symptoms of sepsis set in, it is probably because the peritoneal cavity is shut off around the drainage-tube and a collection of pus is taking place. The best thing to do in this case is to remove the drainage-tube, insert one finger into the opening, carefully break up the newly-formed adhesions, and wash out the collection of pus by irrigation. I am confident of having saved at least two cases of general peritoneal sepsis in this way.

When all goes well, liquid food can be given by the stomach at about the end of the third day, and solid food in an easily digested form at about the end of a week. The parietal wound is treated as in other abdominal sections, care being taken to allow a good firm cicatrix to form before the patient is allowed to go about, and an abdominal

support should be worn for several months with the view of preventing ventral hernia.

III. EXAMINATION OF THE STOMACH.

Inspection.—Valuable data in the diagnosis of diseased conditions of the stomach can be obtained from the amount of distention of the organ. A flat, collapsed condition at the epigastrium is sometimes seen when there is obstruction at the cardiac orifice; bulging and tumefaction occur when the pylorus is the seat of stricture. Tumors in the anterior wall or at either orifice may cause a bulging at the epigastrium. Peristaltic movements may be observed in certain cases. Normal waves begin at the cardiac end and extend to the pylorus. Anti-peristaltic waves take the opposite course, and are an indication of stricture at the pylorus. These movements are increased by the use of the faradic current, or by the application of the ether spray, or by striking the abdomen with a wet towel.

Palpation.—The first thing to be sought for is localized pain, which can be readily detected by making gentle pressure with the fingers over the region. Any inequalities in the abdominal wall should be carefully noted and a tumor sought for. Sometimes a growth is lower down than the normal position of the stomach, its own weight causing it to sink to a lower level in the abdominal cavity. Dilatation of the stomach may force a pyloric tumor downward. In its early stages a tumor of the pylorus is freely movable, later it becomes fixed.

Percussion.—The whole of the stomach cannot be outlined by percussion. On the right side the liver overlaps a portion of the organ, while the lung encroaches upon it on the left. The lower limit is about midway between the ensiform cartilage and the umbilicus, and passes in a curve to the lower border of the end of the tenth rib. In percussing the stomach it is convenient to begin with the right hypochondriac region. From liver dulness we come abruptly upon the tympanitic stomach, and find no difficulty in determining where one begins and the other ends. On the left side the pulmonary resonance is easily distinguished from the tympanitic note over the stomach. At the lower border considerable difficulty may be met with. The stomach here is bounded by the colon, and it may happen that the note in both has the same pitch. As a rule, however, the note over the stomach is more tympanitic, louder in tone, and lower in pitch than that over the colon, so that in the majority of cases the lower border of the stomach can be accurately mapped out. Allowances must always be made for the nature and amount of the stomach-contents. When the organ is full the note is dull and muffled, and the area of dulness corresponds with the degree of gastric distention. Change of position will be found to change the percussion-note. Gas rises to the surface, giving a tympanitic resonance, while fluid gravitates to the most dependent parts and affords a dull note.

As an aid in ascertaining its exact size, Piorry suggested filling the stomach with water. About a liter is given the patient to drink, and he is examined when standing. The stomach thus distended gives a dull note, in contrast to the tympanitic sound produced when the colon is percussed.

The method of Dehio consists in giving the water in fractional quantities. The liter of water is divided into four parts, each part being taken separately at short intervals, and an examination made after each dose. The area of dulness is marked upon the abdomen after each examination. This method is valuable in detecting dilatation of the stomach and atony of the organ. When the area of dulness descends below the umbilicus, it indicates dilatation. When the dull area descends rapidly after each addition of water, atony of the gastric muscle may be diagnosticated. The lower limit of a healthy stomach never descends below the umbilicus.

Frielich was in the habit of distending the stomach with carbonic-acid gas. The patient took 2 grams of sodium bicarbonate dissolved in water, and then an equal quantity of water containing 2 grams of tartaric acid. A rapid disengagement of carbonic acid takes place in the stomach, which so distends it that the contour of the organ may be seen through the abdominal wall. This method is not free from danger, as the distention may be excessive and is always beyond control. Sometimes the quantity of gas is not sufficient to distend the stomach.

The method of Runeberg is the most satisfactory. It consists in distending the stomach with air by means of a tube to which is attached a rubber bulb. The quantity of air is thus under direct control, and the stomach is examined in different degrees of distention. At the end of the examination the air can be withdrawn through the tube. All these examinations are greatly aided by the use of the phonendoscope. (See Examination of the Abdomen.)

The stomach itself is movable, rising beneath the chest-wall when pushed upward by abdominal distention, and sinking lower into the peritoneal cavity when anything depresses the diaphragm. An enlarged liver encroaches upon the stomach from the right, and an enlarged spleen from the left. Contraction of the liver, on the other hand, increases the area of stomach-resonance.

Auscultation is of little value in the diagnosis of stomach-diseases. Splashing, gurgling, and metallic sounds may be produced by rapid voluntary movements of the diaphragm, by the natural movements of the stomach itself, by moving the patient quickly from side to side, or by pressing upon the stomach and suddenly relaxing the pressure.

If you direct the patient to swallow fluid and place your stethoscope over the esophagus, two sounds are heard: the first is a spurting sound, and is due to the passage of the liquid along the esophagus; the second sound is produced by the escape of the fluid from the esophagus into the stomach. In healthy conditions the interval between these two sounds should not exceed ten seconds; in cases of constriction of the cardiac orifice the interval may be extended to a minute or more.

Chemical examination of stomach-contents (see Cancer of the Stomach).

Injuries and Diseases of the Stomach.

The chest-wall above and the thick muscular abdominal wall in front protect the stomach from external injury. A sharp instrument can readily pierce the organ, but a blow from a blunt object throws the

abdominal muscles into strong contraction, and the stomach readily yields before the pressure or slips from under the force. If, however, the stomach contain a considerable quantity of food or be distended with gas, **rupture** may take place. One or more coats may give way or the whole thickness of the gastric wall may be lacerated, permitting the contents to flow into the peritoneal cavity, and producing death by peritonitis within forty-eight hours. When one coat only is ruptured, it is usually the peritoneal, that being less elastic than either the muscular or mucous covering.

Symptoms of Rupture.—When only the peritoneal coat is ruptured, the symptoms are pain and localized peritonitis. The torn peritoneum almost immediately becomes adherent to the peritoneal surface of some other organ, adhesive inflammation throws out a barrier against further mischief, and the process of repair rapidly takes place. A localized peritonitis, following a blow or kick over the stomach, is very suggestive of this form of rupture, and such a condition should be treated by placing the organ at perfect rest by withholding food for several days and by nourishing the patient with nutrient enemata.

When the mucous or muscular coat is ruptured hemorrhage into the stomach is the prominent symptom. Vomiting of blood must therefore be regarded as very important when it follows a traumatism in the epigastric region. Rupture of the whole thickness of the stomach-wall is followed by the most serious symptoms. Shock is severe and pain is intense. The contents of the stomach are poured out into the abdominal cavity, and the symptoms of general peritonitis rapidly appear. Some patients never rally from the first shock; others die of peritonitis in about two days.

Treatment.—If ever there is a condition requiring prompt and immediate heroic measures, it is here. Once the diagnosis of complete rupture has been made, there is not a moment to be lost. A free incision, beginning at the ensiform cartilage and extending to the umbilicus, is required. The rent should then be sought and brought to the surface. If situated at the posterior wall of the stomach, the gastro-colic omentum must be divided before the laceration can be reached. Having brought the edges of the rent to the abdominal wound, the stomach should be washed out with sterilized water, after which it should be sutured by two rows of silk stitches, the one passing through the muscular and mucous coats and cut short. The second row takes the peritoneum and passes into the muscular coat, so that it buries the first row and brings the peritoneal surfaces together. Any stomach-contents found in the peritoneal cavity should be mopped out with sponges, and, if there be general contamination, the whole should be flushed with sterilized water or Thiersch's solution. Drainage is necessary when the contamination has been extensive or long continued. The after-treatment requires stimulation by hypodermics of strychnia or brandy and perfect rest to the stomach.

Foreign Bodies in the Stomach.—Children frequently swallow coins and other small bodies with impunity. I had until recently in my possession a pocket-knife blade, one and three-quarter inches in length, which passed through the alimentary canal of a four-year-old boy.

The blade was somewhat eroded, but the boy was none the worse for the mishap. Bodies which pass through the pharynx and esophagus are pretty sure to pass through the remainder of the digestive tract, particularly if the friends abstain from the common practice of giving purgatives. Food should be allowed which ensures the formation of bulky stools, and for this purpose an exclusive diet of mashed potatoes and milk answers admirably.

Mechanical Fixation of the Stomach.—When from injury, disease, or as a sequel of celiotomy the stomach becomes adherent to the parietes, considerable suffering and inconvenience may result. Such cases are often set down as gastric neurosis. Landerer of Leipzig has reported three cases of intense gastralgia attended with vomiting and tenderness at the epigastrium. In the first case a band of adhesion was found between the parietal peritoneum and the stomach, the removal of which was followed by perfect recovery. In the second case the stomach was found adherent to the left lobe of the liver, and recovery followed the breaking up of the adhesion. The third was produced by a small umbilical hernia, to which a section of the stomach the size of a small apple was firmly adherent. All the symptoms subsided after freeing the stomach and stitching the hernial ring.[1]

A case is reported by Dr. Davis of Omaha in which persistent attacks of vomiting, severe gastric pain, nervousness, cardiac depression, and high temperature were finally traced to a small hernia in the linea alba, to the sac of which was attached a band of omentum. Tracing the omentum inward, it assumed the form of a band the end of which was adherent to the greater curvature of the stomach. Division of the band and radical treatment of the hernia effected a complete cure.

Landerer points out a very simple and reasonable symptom of this condition. *It is the production of pain in the stomach from movement of the viscus.* Washing out the stomach and movements of the body which cause a dragging of the stomach at the adherent point are followed by long-continued pain.

Ulcer.—Ulcer of the stomach until a recent date was regarded as entirely within the domain of medicine. At present it may be looked upon as an outpost on the frontier of surgery. Perforating ulcer has long been recognized. Its starting-point is in a small arterial branch which becomes occluded, and thus the supply of blood is cut off from a portion of the stomach-wall. Necrosis of the area thus cut off follows. The necrosed part takes the form of a cone with its apex toward the peritoneal and its base at the mucous coat. The destruction of tissue is hastened by the action of the gastric juice, and the slough, coming away *en masse* or by molecular death, leaves an ulcer which the term "perforating" aptly describes. Not infrequently severe hemorrhage follows, and by repeated losses of blood the patient may be brought to a state of great anemia and even unto death itself.

Symptoms.—Two leading symptoms attract our attention in gastric ulcer—a fixed pain with localized tenderness on pressure, and vomiting soon after taking food. Surgically, we are interested in ulcer from the

[1] *Annual of Universal Medical Sciences*, 1894.

fact that perforation is a not infrequent termination. Haslan of Birmingham, England, describes perforating ulcers under three classes:

1. Where no adhesions have formed around the base of the ulcer, and the stomach-contents pass at once and freely into the peritoneal cavity. The location of ulcers of this class is usually on the anterior surface of the stomach The symptoms here are sudden and severe, almost identical with those following rupture of the stomach. Shock is more or less marked; there are abdominal pain and tenderness on pressure, with the train of symptoms which make up the sum-total of general peritonitis. The duration of life after perforation occurring in this manner ranges from seven hours to five days, the majority dying within twenty-four hours.

2. Where adhesions around the base of the ulcer have fixed the stomach to some adjacent organ, the leakage causing a localized peritonitis. Suppuration follows perforation of this class, but the collections of pus are shut off from the general peritoneal cavity. The diagnosis here must rest upon the history of gastric ulcer, the occurrence of localized peritonitis, followed by induration, and such other signs as indicate a collection of pus.

3. Cases in which adhesions have formed between the stomach and some hollow viscus or serous cavity, into which an opening from the stomach becomes established. In this way the stomach-contents have found their way into the colon, the pericardium, or the pleura.

Treatment.—In the first class of cases clinical experience teaches us that there is only one termination—death—and that the fatal issue occurs in the majority of cases within twenty-four hours. Any attempt, therefore, which gives a hope of placing the patient in a more favorable position is justifiable. The operation recommended consists in making an incision above the umbilicus a little to the left of the middle line, in order to avoid the falciform ligament. The patient, being the subject of shock, must be treated for this condition by hypodermics of strychnin and by surrounding him with hot bottles. The most common seat of ulcer is found to be at or near the lesser curvature. As a rule, the portion of the stomach which presents at the parietal wound in this operation is the greater curvature or the part a little above it. The finger should be made to pass over the surface of the stomach upward and backward in search of the perforation, and, as already stated, it will be found at or near the lesser curvature. The succeeding steps of the operation are identical with those in the operation for rupture of the stomach.

Gastric Fistula.—In the rare cases in which adhesions form between the stomach and the abdominal wall and shut off the peritoneal cavity before the occurrence of perforation a gastric fistula may be the result. A similar condition may arise after a wound of the abdominal wall which extends into the stomach, or the fistula may be intentionally made for the relief of a constriction at the lower end of the esophagus or at one or other of the orifices of the stomach.

Treatment.—The operation for the closure of the gastric fistula will vary according to the length and connections of the fistulous tract. If the fistula is short and the stomach in close connection with the abdominal wall, the closure can be effected without opening the peritoneal

cavity. An incision about two inches in length down to, but not through, the peritoneum exposes the opening in the stomach. The edges of the whole fistulous tract should next be thoroughly freshened by paring them with a sharp knife or scissors.

Four rows of sutures are then applied, as follows:

1. Fine silk passing through the mucous and submucous coats.
2. Catgut sutures to include the remainder of the stomach-wall.
3. A deep row of catgut to unite the deep layers of the abdominal wall.
4. A row of silkworm gut to unite the skin. Over this a copious aseptic dressing is applied and retained by long strips of adhesive plaster. The stomach is kept at rest by giving all nutriment by the rectum for the first four or five days.

When the fistulous tract is larger and the stomach is not in close connection with the abdominal wall, the peritoneal cavity must be entered. The stomach is completely separated wherever it is found to be adherent to the parietes, and the opening closed as in wounds of this viscus.

Cancer of the Stomach.—"Obscure in its symptoms, frequent in its recurrence, fatal in its event." Such is the description of cancer of the stomach given by Brinton.

Of the tumors found in connection with the stomach, carcinoma is by far the most common. Sarcoma is exceedingly rare. Benign tumors are seldom found in this locality, and, if they do exist, require no surgical treatment. Of all cases of cancer, 35 to 45 per cent. occur in the stomach, which is more liable to the disease than any other part of the alimentary canal except the tongue and lips. The maximum liability lies between the ages of fifty and sixty. It is rare before the thirtieth year, and congenitally it almost never occurs.

True to the pathological law that carcinoma is most likely to occur where two kinds of epithelial cells meet, cancer of the stomach begins, as a rule, either at the cardiac or pyloric orifice. One-half of all cases, according to Bernays, begin at the pylorus. Of 903 cases analyzed by Gussenbauer and Winnewarter, 542 were pyloric. The pylorus is perhaps more susceptible, owing to repeated slight injury due to the passage through it of hard or indigestible masses of food. It is quite a common thing to find post-mortem old cicatrices in the mucous membrane of this locality, which, combined with the clinical fact that cancer has a tendency to occur in scar-tissue, gives some show of reason to the theory.

Next in frequency of situation is cancer of the greater curvature. In other positions the disease is extremely rare. Once the neoplasm has started, it tends to grow toward the lumen of the stomach. The mucous membrane is the structure first affected; next the submucous loose connective tissue; and only in the last stage are the muscular and serous coats invaded. Early and accurate diagnosis is of the utmost importance, and I would submit the following points as a practical mode of procedure in any case of suspected gastric cancer:

1. *History.*—If a patient more than forty years of age gives a history of disturbed digestion dating back for several months or a year, combined with cardiac or pyloric stenosis, the suspicion of cancer

of the stomach must be entertained. Pain, as a rule, is not felt until an advanced stage of the disease. Vomiting occurs without much effort and with little nausea. At first the vomit consists chiefly of mucus, remnants of food, and watery fluid mixed with bile, but by degrees the stomach-contents are expelled in a more and more undigested state. It is not until ulceration has become established that blood is vomited. The blood may be in small amounts as bright-red streaks in the mucus, or the quantity may be large and changed in appearance according to the length of time it has remained in the stomach and the changes it has there undergone. Then it may be in bright-red or brownish-red clots or coagula, varying in shade from brown chocolate color to black. This, the so-called "coffee-grounds" vomit, was formerly supposed to be pathognomonic of cancer of the stomach, but experience has proved this to be an unreliable sign, for other diseases are attended with "coffee-grounds" vomit.

At the same time it must be borne in mind that, as a rule, the blood remains longer in the stomach in cancer than in other diseases, and "coffee-grounds" vomit has therefore considerable significance, considered with loss of strength and progressive emaciation. The fat and muscles rapidly waste away, and ere long the patient becomes decidedly emaciated.

2. *Physical Examination.*—In all cases of abdominal examination it is convenient to map out by means of a colored pencil the abdominal areas—viz. epigastric, right and left hypochondriac, etc. Besides these I would draw a line from the points of the false ribs on either side to the umbilicus. On the right side this line with the linea alba and line of the false ribs forms a triangle in which tumors of the pylorus are to be sought for. On the left side the line marks the boundary of normal stomach-dilatability. If the stomach falls below this line, we may say that there is abnormal dilatation. For a thorough examination the patient should be anesthetized.

3. *Inspection.*—Standing at the patient's feet and looking down upon him, we can observe any irregularity in the abdominal wall. A growth in the stomach may be visible as an elevation over the situation of the organ. A depression in the epigastrium points to obstruction in the esophagus, a fulness in the epigastrium to pyloric stenosis.

4. *Palpation and Percussion.*—We may expect to find a tumor in three-fourths of the cases. A tumor at the cardiac orifice is hard to find by palpation, owing to its distance from the surface. It is only when it has attained considerable size that its presence is clearly demonstrated. At the pyloric end, however, the tumor is more easily felt, and its common position is between the ensiform cartilage and the umbilicus, a little to the right of the middle line. Having found the growth, we may ask ourselves the following questions:

First. Is the tumor movable? Its weight may drag it downward, so that it falls below the line we have marked upon the skin from the border of the false ribs to the umbilicus. If freely movable, it is an indication that there is no invasion of neighboring organs. Still, this rule cannot be insisted upon, for in one recorded case the tumor was freely movable, and yet the adhesions were so strong and so numerous that the operation had to be abandoned. On the other hand, fixation

does not certainly indicate extension of the disease to neighboring structures. When it has become adherent to the liver and diaphragm, it rises and falls with respiration. Dilatation of the stomach may cause mobility of the tumor. If the stomach be greatly dilated and the pylorus fixed in an abnormal situation, it strongly suggests extension of the disease. If irregularity of the surface of the growth coexists with these conditions, we may certainly infer that the disease has spread, and then operation is out of the question (Greig Smith).

Second. Is the stomach dilated? This can be ascertained by distending the organ. Frerichs employed for this purpose carbonic-acid gas generated outside the body—for example, from an inverted siphon of mineral water. Safer and more satisfactory is the method of Runeberg, which consists in introducing a stomach-tube and then insufflating air by the double bulbs of a spray apparatus. As a rule, we have other reasons for introducing the tube, so that the inflation of the stomach with air gives very little additional trouble. Besides percussion of the stomach, we may with advantage employ succussion in its two forms—viz. digital and total or Hippocratic. The writings of Bouchard have brought this matter of examination into considerable prominence. It is thus employed: The patient lies on his back with the abdominal muscles relaxed. The surgeon makes a series of rapid taps with the extremity of the fingers on the abdominal wall along the line running from the umbilicus to the edge of the false ribs on the left side. If a certain amount of liquid and gas is present, we obtain in this way a sensation of splashing to which Bouchard attaches great importance. The presence of a gastric succussion-sound when it is perceived below a line extending from the umbilicus to the border of the false ribs on the left side indicates a permanent dilatation of the stomach. It is important only when obtained a long time after a meal, and especially when a patient is fasting in the morning (Mathieu).

The significance of dilatation lies in the fact that it corroborates obstruction at the pylorus. Contraction, on the other hand, argues in favor of obstruction at the cardiac orifice.

5. *Examination of the Contents of the Stomach.*—The surgeon is not justified in neglecting this means of diagnosis in any chronic gastric disease. As the procedure is not yet so generally employed as its importance demands, I may perhaps be pardoned if I very hurriedly run over the steps of most practical utility in aiding diagnosis.

It is important in the examination of the stomach-contents that a uniform method should be followed.

Different results will be obtained at different periods of the digestive process. A scanty diet will not call forth the activity of the gastric glands to the same degree as a hearty meal. For convenience and uniformity, a so-called test breakfast is given on an empty stomach, and the contents are drawn off an hour to an hour and a half afterward. This breakfast consists of an ordinary dry roll without butter, and about two-thirds of a pint of weak tea or coffee without milk or sugar. Such a repast contains albuminoids, sugar, starches, non-nitrogenous extractives and salts, thus offering the stomach all the ingredients that are usually taken, while at the same time liquefaction takes place

rapidly, and there are no solid pieces of food, such as meat, to plug the opening in the stomach-tube.

The patient having taken the test breakfast at about 8.30 A. M., presents himself at 9.30 or 10 for examination. To obtain the stomach-contents, the simplest plan is that known as Ewald's expression method. A soft-rubber stomach-tube is passed, and when the end has entered the stomach from twenty-three and a half to twenty-five and a half inches from the incisor teeth, the patient, by contraction of the abdominal muscles, forces the stomach-contents through the tube into a receiving vessel. This fluid is then filtered, and, as a rule, presents the appearance of an amber-colored liquid resembling normal urine.

Before proceeding further we must bear in mind that during digestion the stomach normally has acid contents. Ewald and Boas by numerous experiments found during the normal digestion of the test breakfast the following three stages:

1. As early as ten or fifteen minutes after a meal the stomach-contents often are acid. The acidity depends upon the free acids, acid salts, or both. The free acid is the lactic acid. Up to thirty or forty-five minutes the lactic acid predominates, while the color-tests for hydrochloric acid are negative.

2. Then comes a stage in which both hydrochloric and lactic acid can be found.

3. The lactic acid disappears, and only hydrochloric acid can be found after the first hour. The secretion of hydrochloric acid begins, however, immediately after the food is taken.

A sample, therefore, drawn one hour and a half after the test breakfast should be acid, showing a total acidity of 40 to 65 per cent., as we shall afterward explain, and this acidity should be due to hydrochloric acid in the proportion of 14 to 24 per cent. The questions we have to answer are as follow:

1. Are the stomach-contents acid? Litmus-paper quickly settles this point.

2. How acid are the contents? or, in other words, what is their total acidity? This is obtained by trituration of volumetric solutions and the burette. We need for this purpose a burette and two solutions. The first is a decinormal solution of caustic soda. The atomic weight of caustic soda (NaHO) is 40. Forty parts, then, of soda in one thousand parts by weight of distilled water is a normal solution (40 to 1 liter). A decinormal solution is one-tenth of this strength, or 4 grams to a liter. The other reagent is a solution of phenol-phthalein in alcohol. Phenol-phthalein is a buff-colored powder freely soluble in alcohol. It remains colorless in acid or neutral solutions, but assumes a carmine color in alkaline solutions.

Fill Mohr's burette with the decinormal solution of caustic soda. Into a glass beaker pour 10 c.c. of filtered stomach-contents and add one or two drops of the phenol-phthalein solution. (It gives a milky character to most stomach-contents, but that does not interfere with the test.) Next add very gradually the solution in the burette. As the drops fall upon the fluid in the beaker a carmine color is produced which disappears on shaking. This will continue as long as the contents of the beaker are acid. When the carmine color no longer disappears

on shaking, stop and read off the number of c.c. of decinormal solution of caustic soda which have been employed. Suppose 9½ c.c. have been used to neutralize 10 c.c. of stomach-contents. Ten times that quantity, or 95 c.c., would be required to neutralize 100 c.c. It is convenient to express this as a percentage according to the amount of decinormal solution used. In this case 95 c.c. were required to neutralize 100 c.c. Hence we express it as 95 per cent. total acidity. The normal acidity after the test breakfast is 40 to 65 per cent. So that in the sample before us the total acidity is too great, being 30 per cent. above the normal limit.

At this point I might state that if we knew that the total acidity is due to hydrochloric acid, we can readily calculate the amount of acid. Each c.c. of soda solution used represents .003646 of the hydrochloric acid. We have used 95 c.c., which, multiplied by .003646, equals .346370 per cent. The normal limit is $\frac{14}{100}$ to $\frac{24}{100}$ of 1 per cent.

The next point is to determine whether the acidity is due to the presence of free acids or to acid salts. The readiest method is by the use of Congo-red paper. Dip a piece of Congo-paper into the fluid and slowly dry it. The bright red is changed to a sky-blue, showing the presence of a free acid.

3. What acids are present? The most important are hydrochloric, lactic, butyric, and acetic.

For the detection of hydrochloric acid the best test is Günzberg's reagent. It surpasses the anilin dyes and all the other tests, being so delicate as to show hydrochloric acid when it is as low as 1 in 20,000. The reagent is made as follows:

Phloroglucin,	gr. 30;
Vanillin,	gr. 15;
Absolute alcohol,	℥j.

Nothing can be more simple than the application of this test. Take a small porcelain dish and place upon it two or three drops of the gastric contents, and add an equal quantity of the reagent. Now gently heat the dish over a spirit lamp, and as the fluid evaporates around the edges will be seen a bright rosy-red color. Blowing upon it, and thus aiding evaporation, brings out the color more distinctly. This is proof positive of the presence of hydrochloric acid, and from the intensity of the color may be roughly estimated the amount of hydrochloric acid present. We know that the limit of reaction lies at 1 to 20,000. By successively diluting the stomach-contents one-third, one-fifth, one-tenth, till the reaction is no longer obtained, we can roughly estimate the amount of hydrochloric acid.

The next acid to search for is lactic acid. Until recently it was believed that the presence of any of the organic acids was pathological, since it was proved that the only acid secreted by the gastric glands is hydrochloric acid. Ewald and Boas, however, found that lactic acid can generally be detected in the early stages of digestion in healthy stomachs, and that this condition is normal. If organic acids are found in the later stages in such quantities that they can be detected with the ordinary reagents, then they always have a pathological sig-

nificance. They are the results of fermentation of some of the substances acted upon by the gastric juices, such as sugar and albumins.

Lactic acid can exist under two conditions: (1) as the result of fermentation; and (2) as it exists normally in meat in the form of sarcolactic acid. In chemical character these two forms do not differ from one another.

The simplest test for lactic acid is the neutral ferric-chlorid solution. A diluted solution of this salt turns canary yellow in the presence of lactic acid. The only difficulty about this test is that we have to distinguish between two shades of yellow. We are indebted to Uffelmann for an excellent improvement upon this method. He takes a few drops of a neutral ferric-chlorid solution and adds one or two drops of pure carbolic acid (or about 10 c.c. of a 2½ per cent. solution of carbolic acid); he then adds water until the solution assumes a beautiful amethyst-blue color. If to this fluid be then added even a trace of lactic acid, the canary-yellow color is produced; fatty acids produce an ashy-gray color; if inorganic acids are present, the solution is decolorized. So delicate is the test that lactic acid can be detected in solutions containing 1 : 2000.

4. What is the digestive power of the stomach? The albuminates are changed in the healthy stomach into propeptones and peptones, which are thus examined:

(*a*) Propeptones. To a small quantity of the filtrate add an equal part of a saturated solution of sodium chlorid. If propeptone is present, it is precipitated, and the more turbid the fluid becomes the greater is the quantity of propeptone. When no precipitate is formed, add a drop or two of acetic acid; the precipitate quickly follows if propeptone is present. On heating, the precipitate is dissolved, but returns as soon as the fluid cools.

(*b*) Peptone. After precipitating the propeptone and filtering, the filtrate is made strongly alkaline by the addition of a solution of sodium hydrate. A few drops of a 1 per cent. solution of sulphate of copper are then added. A violet-red or purplish color is produced if peptone is present

(*c*) Pepsin. A disc 1 mm. in thickness and 1 cm. in diameter of the white of a hard-boiled egg is added to 5 c.c. of the filtrate in a test-tube and kept at the temperature of the blood. If pepsin is present, the egg disc is digested and disappears in from two to six hours. If the filtrate contains no hydrochloric acid, a few drops of the dilute acid should be added.

(*d*) Rennet ferment. To 5 c.c. of milk in a test-tube add three or four drops of the filtrate. After thoroughly mixing place the tube in a glass of warm water. If rennet ferment be present, the milk will become curdled in from ten to fifteen minutes.

Starchy foods are converted into dextrin, erythrodextrin, achroödextrin, and maltose. The test for all of them is Lugol's solution (iodin 0.1, potassium iodid 0.2, distilled water 200). A few drops of the solution are added to a small quantity of the filtrate. The result is as follows:

(*a*) Dextrin turns the fluid blue.

(*b*) Erythrodextrin turns it red.

(*c*) Achroödextrin discolors the solution.

(*d*) Maltose does not change the color of the solution.

What do we learn by this examination? Simply this: If hydrochloric acid be present in normal amount, it is strong evidence against cancer. If it be absent or greatly diminished, it is very strong corroborative evidence of the existence of a cancer. Much discussion has taken place on this question. When Vander Velden expressed the opinion that cancer of the pylorus accompanied by dilatation of the stomach leads to suppression of hydrochloric acid, the view was rapidly applied to all forms of cancer of the stomach indiscriminately. Later investigations showed that this statement could not be maintained in its entirety, yet it has led to results of great diagnostic and therapeutic significance. When the new growth is confined to a small area, when the accompanying catarrh of the mucous membrane is moderate, and when there is no atrophy, then the secretion of hydrochloric acid may remain ample. Clinically, however, one of these features is absent, and the secretion of hydrochloric acid is entirely annihilated or is reduced to the smallest quantity. It is true that other conditions of the stomach give rise to a diminution of the secretion. These conditions are atrophy and amyloid degeneration of the membrane, mucous catarrh, and certain neuroses, but, notwithstanding all this, the absence of hydrochloric acid seldom fails clinically to corroborate a diagnosis of cancer of the stomach.

The significance of lactic acid has been recently receiving attention. Boas uses as a test meal flour soup quite free from lactic acid, and states that this acid was never found in any conditions except those of carcinoma. His results have been confirmed by Dr. D. Stewart.[1]

Ischochymia, or the retention of chyme in the stomach, is a symptom of great value. In this condition the organ has not the power to empty itself, and contains food even while the patient is fasting. As a rule, it is associated with dilatation of the stomach, and the commonest cause of dilatation is stricture at the pylorus. But dilatation is not necessarily present, for it does not usually appear until the stricture at the pylorus has existed for some time. The value, then, of ischochymia as a symptom lies in the fact that it can be recognized at an earlier period in the disease than that at which dilatation can be detected. To recognize the condition it is necessary to examine the stomach-contents while the patient is fasting. Einhorn instructs his patient to have at his supper on the night preceding the examination soup, meat, bread, and some rice, as this latter is very easily recognized, and, as a rule, retained in the stomach when there is stricture of the pylorus. The stomach-tube is employed in the usual manner, and if no chyme can be withdrawn by expression, it is necessary to wash out the stomach. If ischochymia is present, the rice and particles of the other articles of diet are found in an undigested state.

Microscopic examination may sometimes throw light on the case. In the vomited matter, in the gastric contents obtained after a test breakfast, in the washings after lavage, or in the tube after an exploratory examination shreds or small particles of tissue may be found.

[1] *Medical Record*, Mar. 9, 1895, quoting from *Medical News*.

These should be examined under the microscope, and may decide the question of cancer.

Examination of the urine may be employed for further testimony. The presence of indican, which is the form in which indol is eliminated from the urine, is perhaps suggestive of cancer, but as it may be found in almost any wasting disease, its diagnostic value is not worth mentioning. Its qualitative determination is very easy. Take 10 c.c. of hydrochloric acid and 1 c.c. of chloroform. To this add 10 c.c. of urine, and by means of a glass rod add one or two drops of a concentrated solution of chlorid of calcium. The mixture is next shaken, and, if indican be present, the chloroform assumes a blue color, due to the formation of indigo.

Gastroscopy, or the examination of the gastric mucosa by electric illumination, is not only of little value, but dangerous.

Gastro-diaphany, or transillumination of the stomach, has never come into general use.

In spite of all the care that can be exercised, some cases of gastric carcinoma will prove puzzling, to say the least. The gastric crises of locomotor ataxy have been mistaken for the symptoms of pyloric cancer, and operated upon to find no evidence of malignant disease or pyloric obstruction. Gastric cancer has been mistaken for pernicious anemia, and transfusion of blood resorted to. Simple fibroid contraction of the pylorus is often indistinguishable from scirrhus, except after microscopic examination. Moreover, cancer of the stomach may occur without any symptoms whatever, and be discovered after death from other causes. Such being the status of our methods of research, we have to resort to something more definite in search of evidence, and complete the examination in these doubtful cases by making an exploratory incision. To quote the words of Loreta: "It may now be accepted as a maxim in surgery that an exploratory abdominal incision is to be recommended in cases of malignant disease of the stomach where a diagnosis cannot be arrived at by other means."

Are there any conditions under which the diagnosis of cancer can be positively made without exploratory incision? Einhorn gives the following as sufficient evidence to answer this question in the affirmative:

If particles of tumor are found (in the wash-water or in the sound) which under the microscope reveal the characteristic picture of a malignant growth;

The presence of a more or less large tumor with an uneven surface, belonging to the stomach and associated with dyspeptic symptoms;

The presence of a tumor associated with frequent hematemesis;

Constant pains, frequent vomiting, ischochymia, emaciation, all these symptoms being quite permanent, and not extending over too long a period of time (six months to one year);

Tumor and ischochymia;

Emaciation, ischochymia, presence of lactic acid.

Constant anorexia and pain, not yielding to treatment, accompanied by frequent small hemorrhages (of coffee-ground color).

Treatment.—The surgical treatment of carcinoma of the stomach may be curative or palliative in its aim.

The simplest and most readily applicable remedy is lavage. Ewald calls it the sovereign remedy for dilatation. The ordinary stomach-tube with funnel attached is all the apparatus required. Warm water in large quantities should be alternately introduced and removed by siphonage until turbidity ceases and all shreds, fragments of food, or flakes of mucus cease to come away. This treatment is of course but palliative. Obstruction at the cardiac orifice may prohibit the employment of lavage and may call for more formidable measures. Life may be prolonged by keeping the strictured portion patent by dilating it with esophageal tubes. Through the tubes liquid and finely-divided food may be introduced. In far-advanced stenosis a small rubber tube or catheter may be introduced by one of the nasal passages, retained in position, and through it liquids injected into the stomach.

Failing in this, operative procedures may be resorted to. The available surgical procedures resolve themselves into—1. pylorectomy; 2. gastro-enterostomy; 3. combined pylorectomy and gastro-enterostomy; 4. gastrotomy; 5. jejunostomy; 6. curettage of the cancerous portion of the stomach.

At the pylorus the disease is more accessible, and if diagnosed at an early stage and operated upon before the glands becomes involved or adhesions have formed, the operation of pylorectomy is indicated.

The history, so far, has not been very encouraging. Bremer collected 72 cases with a mortality of 76 per cent. Winslow found practically the same ratio in a smaller number of cases. Of 18 cases which I have been able to collect in the past two years, 8 recovered and 10 died. The time may come when a remedy for cancer will be found, but at present our hope for radical cure lies in early diagnosis and complete removal. Could these two conditions be complied with, the results following pylorectomy would be much more favorable than our present figures show. Gastro-enterostomy is a palliative operation, and shows better results than pylorectomy. The mortality is lower and prolongation of life is from two months to a year or more, while in pylorectomy the immediate dangers of the operation are much greater, and in those who survive the disease proves fatal in a period varying from four to eight months. In the early operations, according to Billroth, the mortality was 50 per cent. Lücke of Strasburg reduced it to 31 per cent.

Gastro-enterostomy does not cure the disease, but it very often brings about a very noticeable improvement in the local and general conditions, showing what an important part the pyloric stenosis plays in the production of many of the symptoms. The pain also disappears. This is explained by the fact that the stomach-contents no longer come in contact with the cancerous ulceration, but pass directly into the small intestines along the new route opened up by the operation. This is why in similar cases the employment of lavage is followed by so much relief (Mathieu).

In the *Annals of Surgery* for December, 1887, Dr. Bernays of St. Louis described an operation whereby, after making an incision in the walls of the stomach, he removes by curette or other suitable instrument

cancerous growths bulging into the stomach-cavity. His method consists in—first, an accurate examination of the outside of the stomach. He then fixes a fold of the stomach to the parietal wound by numerous sutures. The stomach is now opened and its lips carefully stitched to the lips of the wound in the parietes. The stomach-cavity being completely shut off from the abdominal cavity, he proceeds with fingers and curette to tear and scrape away masses of the growth. Bleeding is free, but soon ceases. The results of the operation in several cases have been fairly satisfactory, but a radical cure cannot be relied upon.

Stricture of the Cardiac Orifice.—Stenosis of either orifice of the stomach may be a result of carcinoma, or may be due to the cicatricial contraction which follows the healing of an ulcer or a wound caused by a foreign body.

The first symptom to attract attention to stenosis of the cardiac orifice is a gradually increasing difficulty in swallowing solid food. Liquids can pass through the narrowed opening, but with less rapidity than in the normal condition; solids are regurgitated. The epigastrium is often retracted and the stomach collapsed, strongly contrasting with the full epigastrium and dilated stomach which attend stenosis of the pyloric orifice. The passage of olive-pointed bougies, as in the case of esophageal stricture, will confirm the diagnosis. The question of malignancy must be settled by the age of the patient and the history of the case.

Stricture of the pylorus is in the vast majority of cases due to carcinoma. As the lumen of the pylorus becomes lessened, and there is increasing obstruction to the passage of the gastric contents toward the intestine, dilatation of the stomach results, and is a prominent symptom.

A case of pyloric stricture has a history of long-continued dyspepsia, and every chronic dyspeptic should be carefully examined for this condition.

It is not uncommon to find such a stomach rejecting food which has remained in it for days or even weeks. If the stomach-tube be used, the contents may be found to amount to several quarts, and the distended organ may reach considerably below the umbilicus. The presence of a tumor in the pyloric region must not be depended upon as a diagnostic point, for, although the absence is indicative of cicatricial stenosis, some of the worst cases of cancerous stricture afford no evidence of a tumor.

Einhorn thus tabulates the differential diagnosis between benign and malignant stenosis of the pylorus:

Differential Diagnostic Points.

	Benign Stenosis of Pylorus.	Malignant Stenosis of Pylorus.
Duration of illness.	Long duration of illness (two to fifteen years).	Short duration of illness (five months to one and a half years).
Course of the disease.	Long intervals without pain, or periods of perfect euphoria.	No periods of perfect euphoria, but constant and gradual aggravation of symptoms.
Tumor.	As a rule, absent.	Present in most cases.

Condition of Gastric Contents.

	Benign Stenosis of Pylorus.	Malignant Stenosis of Pylorus.
Free HCl.	Present in the great majority of cases.	Nearly always absent.
Lactic acid.	Absent in the great majority of cases.	As a rule, present.
Acidity.	Always increased.	Fluctuates between 30 and 90.
Rennet.	Always present.	Varies.
Odor.	Unpleasant, disagreeable.	Very frequently fetid.

Treatment.—Non-cancerous stricture of the cardiac orifice should be treated by the introduction of bougies gradually increased in size until the largest instruments can be passed. Nor should the treatment cease at this stage. Full-sized bougies should be passed once or twice a week to prevent recontraction. When this method of treatment fails, gastrostomy must be resorted to for the double purpose of supplying the stomach with food and of dilating the stricture from below. The manner of carrying out this procedure is described under Esophageal Stricture.

At the pyloric orifice the measures to be adopted are forcible dilatation through an opening in the stomach, the various plastic operations, and gastro-enterostomy.

Forcible dilatation was first practised by Loreta in 1883. He made an incision in the stomach a little nearer to the pylorus than to the cardiac end. Through this opening he introduced the index finger of the right hand and passed it through the stricture. The fore finger of the other hand was then inserted, and by separating the fingers the

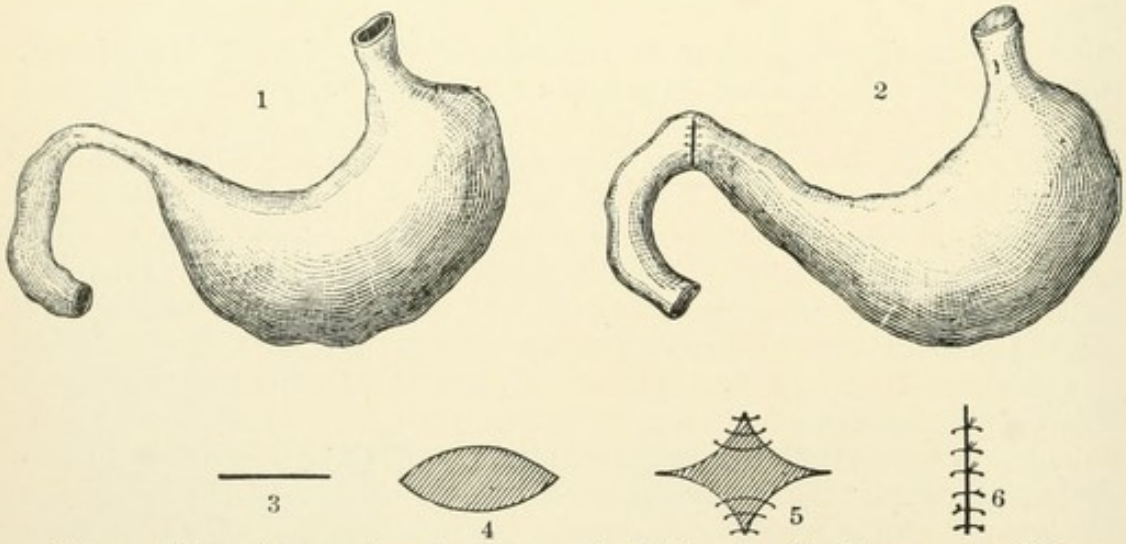


FIG. 105. Pyloroplasty: 1, linear incision; 2, the final result. The lower series of figures show the transformation of the horizontal linear incision (3) into the oval (4), the sutures (5) converting it finally into (6) a vertical linear incision (Heineke and Mikulicz).

stricture was forcibly stretched. The gastric opening was closed, as in gastrotomy for other purposes. This operation is attended with considerable danger, and has been largely replaced by the pyloro-plastic operation of Heineke and Mikulicz.

The operation consists in making a longitudinal incision at the

pylorus, and then suturing it so that it becomes transverse. First Step: After preparation of the patient by washing out the stomach with boracic-acid solution or salicylated water, an incision is made in the middle line from the ensiform cartilage to the umbilicus, the pylorus brought to the opening and packed around with sponges. Second Step: An incision is made into the pylorus and extended one inch along the stomach and one inch along the duodenum (Fig. 105). Third Step: Place a tenaculum at the middle of each side of the pyloric incision and draw the edges apart. The line of incision will thus become transverse to the axis of the stomach. In this position two rows of sutures are applied—first at the angles, and lastly in the central portion of the wound.

The results of this operation have been very encouraging. It is attended with no more danger than a gastrostomy, and when properly performed recurrence of the stenosis is impossible. For cancerous stenosis it is of no value.

Gastro-enterostomy is the operation by which a communication is established between the stomach and the upper part of the small intestine. Wölfler was the first to propose and practise this operation. His technique has been improved upon, and at the present time operators resort to one of two methods—the approximation by Senn's decalcified bone-plates or the anastomosis by Murphy's button. The junction with the intestine should be made from twenty-four to thirty inches below the pylorus. As this point is difficult to find, the following directions may be useful: The first loop of intestine presenting itself at the abdominal wound should be brought out and held by an assistant. The operator then follows the intestine in one direction. If this happens to be toward the pylorus, the intestine will be found to grow paler and the walls thicker as the duodenum is approached. The duodeno-jejunal fold is taken as a landmark, and a point twenty-four to thirty inches from it is selected for the intestinal opening. Should the operator find that the bowel becomes thinner and its color increasing to a bright red, he may know that he is going away from the pylorus, and must drop that part and start out in the opposite direction. The application of the bone-plates or button is the same as in intestinal anastomosis, described already.

Dilatation of the Stomach.—This is a condition attended with much more serious consequences than might at first thought appear. A dilated stomach may be defined as one that cannot empty itself (Mathieu). A distinction must be made between distention and dilatation. A distended stomach gradually disposes of its contents, and at the end of the interval between meals, as in the early morning, the organ is empty. A dilated stomach, on the other hand, has not the power to empty itself, and in it may be found food which has remained there for days or even weeks. This retention of food is followed by fermentation and the production of toxic substances, so that the patient is poisoned by the material formed in his own stomach. An extreme dilatation of the stomach may be regarded as a fatal disease unless relieved. It is as serious in its effects as cancer of the pylorus.

Causes of Gastrectasia.—1. Mechanical dilatation due to obstruction of the pylorus and to organic changes in the wall of the stomach. Of

this variety the great majority of cases occur in connection with cancer of the pylorus. Chronic gastritis leads to atrophy of the muscular tissues, with loss of contractility and elasticity, and lastly to dilatation.

2. Hyperchlorhydria, or the excessive secretion of hydrochloric acid, is a frequent cause of dilatation. Such cases often present symptoms which closely resemble gastric cancer. The presence of hydrochloric acid in large quantities readily settles the diagnosis. Early treatment is of the utmost importance, for it not infrequently happens that what would be only a temporary dilatation may become permanent, even after the hyperchlorhydria has disappeared.

3. *Atony of the Stomach.*—In this variety the patients suffer from dyspepsia of nervous character and the disease is purely medical. Proper treatment resorted to at an early period can be relied upon to prevent dilatation.

Symptoms of Dilatation.—When stricture of the pylorus is the cause, there is usually a feeling of weight at the epigastrium or there may be pain more or less severe. Acid eructations often prove troublesome, and there is a peculiar kind of vomiting which is pathognomonic. It occurs at long intervals, two or three days, and is then very copious. Pints or quarts of liquids are ejected containing particles of food but little changed. This is particularly noticeable if a patient has eaten Indian corn, peas, beans, or other vegetables. Sometimes the vomited matter contains blood. If red in color, it is suggestive of gastric ulcer; if black, it indicates cancer. If the stricture is in the duodenum and below the entrance of the common bile-duct, large quantities of bile will flow backward into the stomach and form an important constituent of the vomited matter. The patient should be given a test breakfast, and about an hour afterward the stomach-tube should be passed. If a large amount of fluid is removed at this examination, the diagnosis of dilatation may be safely arrived at, and especially if unchanged food be observed or food that has lain in the stomach for days. Having emptied the stomach, it can be distended with air before the tube is removed. In many cases the form and size of the organ can be seen by the bulging of the abdomen; by percussion it can be accurately mapped out. Roughly speaking, a stomach is dilated if it comes below a line drawn between the umbilicus and the line of the false ribs.

When dilatation attends hyperchlorhydria the pains in the stomach are delayed, coming on three or five hours after a meal. Frequently the patients are aroused from sleep by the pain, which persists until vomiting occurs and affords relief.

Remote effects of gastric dilatation may be summed up as follows: In the nervous system, neuralgia, headache, insomnia, melancholia, nightmare, giddiness, and disorders of vision; in the liver, congestion and enlargement. The respiratory system is affected, as evidenced by bronchitis, asthma, and pharyngitis. Albuminuria and peptonuria are evidences of kidney-involvement.

Treatment.—In cases due to atonic dyspepsia regulation of the diet and washing out of the stomach will greatly aid the medical treatment; it is seldom that the dilatation is so great as to necessitate operative measures. When hyperchlorhydria is the cause the stomach-tube will

be found invaluable. Washing out the stomach before bedtime ensures rest for the night and saves the mucous membrane from contact with irritating gastric fluids. Mathieu advocates evacuation of the stagnating liquid once a day, actually washing out the viscus only two or three times a week.

Dilatation due to stricture of the pylorus demands a surgical operation. When the stenosis is cicatricial, forcible dilatation or a pyloroplastic operation is indicated; when the obstruction is cancerous, gastro-enterostomy is the best. One of two operations may be resorted to—gastro-enterostomy, which deals only with the obstruction, or a partial gastrectomy, which removes the pylorus and a part of the stomach, thus diminishing the size of the dilated organ. Out of 18 cases of gastro-enterostomy collected by Lowenstein there were 6 deaths; in 21 cases of resection of the pylorus there were 7 deaths. In all cases of dilatation particular attention should be paid to the following points: The food should contain the greatest possible nutriment in the smallest bulk; it should be finely divided, so as to come speedily in contact with the gastric juice and leave as little residuum as possible. Meat-powder, milk, and the farinas are specially useful.

The diet should consist of articles which are least likely to undergo fermentation. On this account sugar, alcohol, and vinegar should be avoided. The muscular action of the stomach should be increased by the use of strychnin, ipecacuanha, electricity, massage, etc.

Antisepsis of the stomach should be, as far as possible, secured by the avoidance of fermentable food and by frequent washings of the stomach. Patients soon learn to carry out this by themselves, and what is at first a very disagreeable procedure becomes a source of great comfort. In the words of Ewald, "Lavage is the sovereign remedy for dilatation."

IV. DISEASES AND INJURIES OF THE INTESTINES.

Examination of the Intestines.—**Inspection** may give us considerable information. A solid tumor, such as a carcinoma, causes the abdominal wall to bulge outward. Obstruction of the lower portion of the small intestine is often attended with tympanites and pain in the umbilical region; that is to say, in the normal position of the bulk of the small intestine. Peristaltic action of the intestine in an exaggerated degree may be seen through the abdominal wall when there is obstruction and the intestine is making strong efforts to overcome that obstruction. General distention of the abdomen and tympanites form a very unwelcome sight after celiotomy, and stand out in strong contrast to the flat abdomen which is the joy and pride of the abdominal surgeon.

By **palpation** we ascertain the presence of tenderness. A dull diffused pain is a common accompaniment of intestinal catarrh; an acute diffuse pain is an indication of general peritonitis. Tenderness in the right iliac fossa is a characteristic of typhoid fever, appendicitis, and intestinal tuberculosis. In the left iliac fossa it is a symptom of trouble in the descending colon, and is commonly found in dysentery. When tenderness is very acute and shifting about, it is strongly suggestive of invagination of the small intestine.

Having settled the question of tenderness, we further use palpation to search for tumors. By a rotary motion of the abdominal wall over the subjacent structure the presence of tumors can be detected long before they can be recognized by inspection. When a tumor of the intestine is felt it must be placed in one of three classes: 1. Fecal masses or scybala, found in the large intestine: this is the only tumor which retains an indentation. 2. Tumors of the intestine, carcinoma, sarcoma, etc.: they are often lobulated and of firm consistence. In the small intestine these tumors are apt to change their location, while in the large intestine they are more fixed. 3. Invagination of one portion of the small intestine into another or of the small into the large intestine. Tumors of this character are round and smooth, the pain is violent and comes in paroxysms. The other indications of intussusception described under Acute Intestinal Obstruction are also present.

Tumors at the junction of the transverse with the descending colon are usually difficult to detect, for they lie deep and are liable to be confounded with tumors of the kidney or spleen.

Percussion.—In health every part of the intestine gives forth a tympanitic note, the pitch varying according to the amount of fluid or gaseous contents. The size of the intestine cannot be accurately determined by percussion, nor can we always determine the boundary between colon and stomach or between the part of intestine above and that below a constriction. Tumors of the intestine may grow to a considerable size and yet not produce dulness on percussion. This diagnostic measure is therefore not so reliable as palpation. Nevertheless, there are cases in which it proves very satisfactory. By noting the difference in pitch between the stomach, colon, and small intestine in the normal area occupied by each we can map out their relative positions. Tumors which in light percussion elude us are often detected when examined by "deep percussion" and when the overlying coils of intestine are pushed aside. Inflation of the colon with air facilitates percussion. For this purpose carbonic-acid gas has been considered preferable to air, for the reason that its irritating character causes closure of the ilio-cecal valve, while air passes through and distends the small intestine as well.

The phonendoscope is of great utility in examining the intestines. The manner of using it has been described in Examination of the Abdomen.

Diseases of the Intestines.

Cancer of the intestine is a disease of advanced life. Its onset is obscure. Generally there is constipation, frequently diarrhea, always emaciation. The first warning of anything of a serious nature may be obstruction of the bowel. The growth may constitute a palpable tumor. In examining for it the patient may with advantage be placed upon his hands and knees, so that the intestines fall toward the palpating hand instead of away from it. The tumor is very illusive. One day it can be felt with the greatest ease, the next you may search for it in vain. If connected with the small intestine, the neoplasm is freely

movable; if in the colon, it is firmly fixed. It is always tender, and as it increases in size the growth is in the direction of the axis of the intestine. Its surface is lobulated or knotty, and it is incapable of receiving an impression like a fecal tumor. You are liable to fall into the trap of calling it sciatica if the growth is in the lower end of the colon, for the sacral region is the part to which the patient refers his pain.

It may be difficult to diagnosticate the portion of the bowel which is the seat of the disease. In the small intestine cancer, as a rule, takes an annular form, and on this account the leading feature is stenosis. The symptoms of the stenosis will vary according to position. In the duodenum we cannot always undertake to say which portion is affected. The first portion is horizontal in direction, is almost surrounded with peritoneum, is the most movable, and lies nearest to the abdominal wall. It must be regarded clinically as a part of the stomach and partaking of the diseases of the stomach. Hence cancer of this portion cannot be distinguished from cancer of the pylorus.

A very important dividing-line is the ampulla of Vater. Stenosis below this point is characterized by a permanent backward flow of bile and pancreatic juice into the stomach. Cancer which involves the ampulla has characteristics which partake of the symptoms found in both the first and third portions.

In the other portions of the small intestine the presence of a movable tumor in the long axis of the bowel will afford our strongest evidence. In the sigmoid flexure and cecum the tumor is generally distinct. In all cases blood is not infrequently passed by the bowels, and there even may be masses of cancerous tissue.

The rectum is the portion of the intestinal tract in which the disease can be detected with the greatest degree of certainty. One of the earliest symptoms is *pain in defecation.* Whenever this is complained of an examination of the rectum should be made as a matter of routine. As the disease advances the pain increases and is more or less constant. Blood and mucus are passed in the stools, and in many cases there is morning diarrhea.

In making an examination of the rectum the patient should lie upon the left side. The finger is vastly superior to any speculum. The sensation conveyed to the finger by cancer is peculiar, and when once recognized cannot be mistaken for anything else. If the growth be epithelioma, the mucous membrane will be found thickened, firm, and freely movable, at least before the disease has reached an advanced stage. If scirrhous cancer be present, hard nodules will be found involving the submucous tissues, and later infiltrating the other tissues and involving the glands, the liver, and other organs.

Two diseases are likely to be mistaken for cancer of the rectum—simple ulceration with inflammatory thickening and syphilitic ulceration with or without stricture. In simple ulceration there is usually a history of dysentery or of the presence of foreign bodies. The ulcer is clean cut, and has the same kind of discharge as simple ulceration in other parts of the body. There is no infiltration or gland-involvement, and the growth does not show a disposition to break down.

Syphilitic deposit with stricture must be carefully taken into consideration in the diagnosis, as it is a common source of error. The

history, the condition of the throat, the skin, the scalp, and the bones, will usually clear up any doubt.

Treatment.—Carcinoma of the intestine only requires surgical interference when it is producing obstruction. In the duodenum gastro-enterostomy is in many cases the best that can be done. In other portions of the small intestine resection with circular enterorrhaphy is the operation which is most radical and easiest of performance. Care must be taken to remove the corresponding portion of mesentery, lest the cancerous infiltration should spread through the mesenteric glands.

Cancer of the rectum must be treated according to the extent of the disease. When the highest point of the cancerous mass can be reached by the examining finger, and there is no involvement of the glands or neighboring tissues, excision of the growth should be undertaken. When the upper limit of the disease cannot be reached, or when the vagina, the prostate, etc. are affected, excision of the rectum should not be attempted.

Operation.—For several days before the operation the intestines should be well emptied by purgatives and the rectum washed out with injections of boric-acid solution. The patient is placed in the lithotomy position, and a final flushing given to the rectum, the bladder emptied, and the buttocks elevated. If the growth is small and freely movable and confined to the posterior wall of the rectum, it will be sufficient to dilate the sphincter, draw down the rectum, excise the growth by a transverse elliptical incision, and close the wound with catgut sutures or pack it with iodoform gauze.

The great majority of cases, however, will require a more extensive operation. An incision is made from the anus back to the coccyx in the middle line or a little to the left. Crescentic incisions, one on each side, are made to surround the anus. These incisions should be through the skin when the sphincter ani is diseased, through the mucous membrane when the sphincter is healthy. The bowel should then be dissected up quickly behind, and bleeding arrested by pressure-forceps. In front of the rectum the dissection must be slower, as there is danger of getting into the prostate or vagina. When the bowel has been separated well above the disease, cut it off with curved scissors. If in this procedure the peritoneum has been opened into, it must be closed with sutures. A large drainage-tube guarded with a chemisette is inserted and loosely packed with iodoform gauze. Drawing down the divided gut and suturing it is no longer practised, as the tension is too great and there is a risk of retaining secretions which interfere with healing. The packing can be removed at the end of forty-eight hours. Daily injections with boracic-acid solution should then be employed. When granulation is well advanced cicatricial stenosis must be guarded against by passing a full-sized bougie daily, beginning about the end of the second week.

Kraske's operation has several advantages over the method just described, inasmuch as it allows more complete access to the bowel. By it a greater extent of the rectum can be removed, and the external wound need not be extensive. The incision is made from the anus to the second bone of the sacrum in the middle line. The soft parts are then separated from the bone on the left side until the edge of the

sacrum is freely exposed. The coccyx is removed, the sacro-sciatic ligaments divided, and, if necessary, the left side of the sacrum partly chiselled away. This gives complete access to the rectum. The posterior part of the bowel is cut open down to the sphincter, and then, by transverse incisions above and below the cancerous growth, the diseased portion of the rectum is removed. The external wound is packed with iodoform gauze, and the rectum irrigated twice a day, as in other operations.

In far-advanced cases of cancer of the rectum, when the disease goes high above the point which can be reached by the examining finger and causes obstruction of the bowel, colostomy is the proper treatment.

Intestinal Obstruction.—Intestinal obstruction may be considered under two heads:

(1) Acute obstruction, in which the symptoms come on suddenly without any previous history of disease;

(2) Chronic obstruction, where there is previous intestinal disease and a slow gradation from partial to complete occlusion.

Acute Intestinal Obstruction.—The almost uniform failure to cure acute intestinal obstruction by medical treatment has led the profession to look to surgery as the only hope of rescuing a class of cases otherwise practically hopeless. The operation has a long but unfavorable history. For centuries it has been approved and as strenuously condemned. Almost uniform disaster has attended its employment until recent years, when the advancement along the whole line of abdominal surgery has thrown new light upon its use and inspired its advocates with new hope.

Acute intestinal obstruction practically exists under three conditions:

1. Intussusception;
2. Volvulus;
3. Strangulation by bands or through apertures.

By *intussusception* or invagination of intestine is meant a prolapse of a part of a bowel into the lumen of the adjoining part. One-third of all the cases of obstruction are due to this cause. One portion of bowel grasps—swallows, as it were—the portion immediately above it. Grasping the bowel as if it were food, more and more is invaginated, until, in extreme cases, several feet of bowel may be involved. The name *intussuscipiens* is given to the receiving portion of intestine, while the part invaginated is called the *intussusceptum*.

This unnatural condition is followed by serious consequences: adhesions form between the opposed surfaces of peritoneum, the walls become swollen and inflamed, curving of the intestines by dragging of the mesentery is produced, intense congestion results, followed by discharge of blood from the rectum or gangrene, and finally complete obstruction.

According to Senn, sloughing is caused by obstruction to the return of venous blood by constriction at the neck of the intussusception.

Curiously enough, intussusception is very commonly found in the post-mortem room, one body in four showing this condition. It is also believed that many cases right themselves, and that a large proportion of cases of acute colic belong to this class (Greig Smith).

The most common situations are—(1) in the small bowel, and generally the lower part of the jejunum. It occurs in the ileum in the proportion of one case to four in the former class. (2) The colon may be the seat of an intussusception at any part of its course, but it is by no means common, and when it does occur only a small portion of bowel is involved. (3) The most common of all situations is the ileo-cecal region, and here it may be produced by the ileo-cecal valve forming the apex of the intussusception, and, passing up the colon, followed by the cecum and ileum, or the ileum may pass through the ileo-cecal valve and be invaginated up the colon.

A rare and complicated variety is where a primary invagination of the end of the ileum is either passed through the valve into the colon or invaginated into the colon along with the cecum (Greig Smith).

By *volvulus* is meant an occlusion of bowel by torsion or rotation round its axis of attachment. This may be caused by simple twisting or two suitable coils may be intertwined.

The sigmoid flexure is the most common situation, constituting two-thirds of all the cases. The tendency in this direction is increased by the shape of the bowel, the length and loose attachment of the mesentery, and the tendency of the bowel to become overloaded and displaced by collections of feces. The bowel may be twisted once, twice, or even three times around the axis.

Next in point of frequency is volvulus of the cecum or cecum and colon adjoining. Here obstruction is easily brought about; even an acute flexure of the cecum is sufficient to block the passage; it may be produced by intertwining of the small intestine. In the ascending colon the disease is rare and is due to anatomical abnormality. In the cecum it may be subacute or chronic.

The small intestine is rarely the seat of volvulus. An old hernia with a long mesentery may be a predisposing cause.

Strangulation by bands or through apertures is internally what an ordinary hernia is externally. In either case a loop of bowel is constricted by a tight, unyielding opening, obstructing its lumen and compressing its vessels. In both cases strangulation results, producing symptoms and calling for treatment almost exactly alike.

Bands of organized inflammatory material, the so-called "peritoneal false ligaments," occur in an endless variety of forms. They are the result of old attacks of peritonitis. They may pass from coil to coil of the intestine, or from organ to organ, as the liver and uterus, or from the intestine to the abdominal or pelvic wall. Tubercular glands may form their starting-point, and the bands may stretch from gland to gland in the mesentery, or, springing from one side of a gland, may bend around the intestine and become attached to the opposite side of the same gland. They may be round or flat, short or long, single or multiple. The bowel may slip under a band when it is short, or it may be caught in a loop or twisted when the band is long. The small intestine, most commonly the lower part of the ileum, is likely to be the seat of the strangulation.

The *prognosis* of acute intestinal obstruction is exceedingly unfavorable. In ordinary strangulated hernia the chances for recovery are almost *nil*, yet there is a bare chance, for gangrene of the bowel

may take place with the formation of a false anus. In strangulation by bands there is not even a chance. If gangrene takes place, there is but one termination—death. It is believed that spontaneous recovery after volvulus is unknown.

Intussusception in a very small proportion of cases may right itself and the patient recover, but such fortunate terminations are few and far between.

The *diagnosis* of acute obstruction is of the utmost importance, and in many cases exceedingly difficult. The symptoms are, roughly speaking, those of strangulated hernia in an aggravated form. The abdominal pain is agonizing. In some instances, however, it is not severe, and frequently it is intermittent in character. The severity of the pain appears to bear a direct ratio to the force of the peristaltic movements; and this explains the intermittent character of the suffering. When constriction takes place, the bowel makes an effort to overcome it, and wave after wave of peristaltic movement is directed against the obstruction. The motions grow stronger and stronger, and the pain increases in severity till from exhaustion of the bowel-muscle the movement ceases and the pain subsides. After a period of rest, the wall of the intestine, having regained its tone, renews its fruitless attack, and with this new effort the pain returns to its former intensity. It may be like severe colic, or it may convey the sensation of a tight band around the abdomen. Besides pain, the prominent symptoms are vomiting, constipation, collapse, and tympanites.

Temperature is of little value as a symptom. It is usually subnormal, and even when peritonitis occurs it may remain subnormal to the end.

Vomiting is one of the early and most important symptoms, and we may set it down as a rule that the higher the obstruction the more violent is the vomiting. At first the ordinary contents of the stomach are voided, either in gushes without much effort or with violent retching. Later the vomit is bile-stained, then of a dark, grumous material, the so-called coffee-grounds. Finally, fecal matter is vomited more or less diluted. This requires that the constriction should not be higher than the jejunum. Constipation is of the most obstinate and insuperable nature. When once the intestine below the seat of constriction is emptied, absolutely nothing passes from the bowels, except in certain cases of intussusception, when blood may escape.

Local meteorism is a symptom upon which von Wahl lays great stress. The intestine above the seat of obstruction becomes distended, and the enlargement gradually continues along the course of the constricted bowel. The peristaltic action is also increased, and both the contour of the bowel and its peristaltic movements may be seen through the abdominal wall.

Rosenbach, Rosin, and others claim that in complete obstruction of the ileum there is always indican in the urine. When the obstruction is in the colon or high up in the small intestine, this reaction is not produced. The simplest test is to boil a small quantity of the urine in a test-tube and add nitric acid, drop by drop. The urine turns red, and throws down a precipitate of a similar color. On shaking a violet-

colored foam is produced. So long as this reaction can be detected in the urine Rosenbach considers the case one of great gravity, and its continuance after an operation proves that the obstruction has not been relieved. It disappears within twenty-four hours after the relief of obstruction. The fallacy in this symptom lies in the fact that it may exist in a variety of morbid conditions.[1]

Diagnosis from Other Diseases.—Every case of abdominal pain, and especially when the pain is attended with vomiting, should be closely investigated for hernia. The ordinary hernial outlets should one by one be examined, for strangulated hernia is the condition most likely to be mistaken for acute obstruction.

Appendicitis probably comes next, but here there is the history of localized inflammation, fever rising to and not above 101° or 102°, with great tenderness over the position of the appendix, and possibly the formation of a tumor.

Diagnosis of the Locality of the Obstruction.—For diagnostic purposes it is convenient to divide the intestine into three portions:

1. *The Duodenum and Jejunum.*—When acute obstruction occurs at the duodenum or upper portion of the jejunum the first indication is sudden and intense pain at the epigastrium, followed by violent vomiting. This vomiting is constant until the obstruction is relieved or the patient dies. It never becomes stercoraceous, for it is too high up to contain fecal matter. The parts above the constriction have a tendency to become dilated, the parts below to become collapsed. Hence we often find the stomach dilated and tympanitic, while the abdomen below is flat and contracted. The bulk of the bowel being below the constriction, flatus and feces may pass naturally.

2. *The Ileum, or Lower Part of the Jejunum.*—The constriction being much lower than in the preceding, accumulation of gas is a marked symptom, and we consequently find the abdomen becoming rapidly *distended.* Vomiting does not come on so suddenly, but it is persistent and changes in its character—first normal stomach-contents, next bile, and lastly fecal matter. The pain is colicky, paroxysmal at the beginning, but soon becoming persistent.

3. *Colon and Sigmoid Flexure.*—Here the symptoms come on more slowly. The patient can often point out the seat of obstruction by the localized pain. Tympanites is a very marked symptom after the first few days. No fecal matter or flatus passes from the bowel and the rectum is empty.

Is it possible to diagnose the variety of obstruction? In certain cases it is. An examination by the rectum will, in a small proportion of cases, discover the bowel descending in intussusception. This form occurs particularly in children. The pain comes in waves, gradually gaining in intensity till a climax is reached, when it for a time subsides. Vomiting in this form is not so characteristic a symptom as in the other varieties. It may be a feature from the outset or it may not appear till late; it may be severe and copious or slight and almost painless, or it may not exist at all. The abdominal wall is seldom distended; indeed, it may even be retracted. There is one symptom, however, which is valuable, and that is a discharge of blood from

[1] *American Year-Book of Medicine and Surgery*, 1896.

the rectum, which is often associated with tenesmus and diarrhea. If besides these a tumor can be found by palpation through the parietes, we have about all the evidence we can obtain that the case is one of intussusception.

So rapid is the progress of the disease that death may take place within twenty-four hours. In more favorable cases the fatal event is postponed for several days; in those still more favorable the condition may become chronic and last for several weeks.

In volvulus of the large intestine there is usually a previous history of constipation. It is commonly found in males above middle life. Its usual situation is at the sigmoid flexure. The pain comes on suddenly, is felt at the hypogastrium or in the back; constipation is marked from the first; vomiting is a later development and is not necessarily severe. Feculent vomiting occurs in about 15 per cent. of the cases. In later stages of the disease there is tenderness on pressure.

Volvulus of the small intestine and strangulation by bands so closely resemble each other in symptoms that it is probably impossible to distinguish them. In both the pain is severe and continuous from the outset, with frequent exacerbations, and is felt most commonly at the umbilicus. There is no tenderness on pressure. The vomiting begins early, is frequent, copious, and becomes stercoraceous about the fourth day.

In the following table I have tried to place side by side the diagnostic differences in the three forms of obstruction:

Strangulation by Bands.	Volvulus.	Intussusception.
	Age.	
Young males.	Males above forty.	Young children.
	Pain.	
At umbilicus; severe from the beginning.	Hypogastrium or back; comes on at once, but not so severe;. intermits.	Prominent; comes in waves.
	Vomiting.	
Early, frequent, copious, stercoraceous, fourth or fifth day.	Late or not at all; never very urgent; 15 per cent. of cases feculent.	Very variable symptoms.
	Constipation.	
Complete from first.	From first.	Blood from bowels, with tenesmus.
	Abdominal Distention.	
Not at first marked; no tumor.	Rapid accumulation of gas, causing great distention; no tumor.	Usually absent; tumor felt through parietes or in rectum.
	Duration.	
Die about the fifth day.	Average six days.	Twenty-four hours to several days or weeks.

Treatment.—Perhaps no condition requires more promptness, accuracy, and good judgment than intestinal obstruction. Temporizing in the diagnosis may allow the only chance of saving the patient to slip

away. Purgatives, although apparently demanded, may produce irreparable injury. If medical treatment be persisted in till the condition becomes desperate, no amount of surgical skill can make amends for an opportunity for ever lost. As regards medical treatment little need be said. When we consider that the condition is analogous to strangulated hernia, the question of drugs becomes a secondary matter. The chief value in medical treatment is the relief of the distressing symptoms that are ever present. Vomiting is one of these. Food by the mouth is not only useless, but positively harmful. Alimentation must be kept up by rectal enemata of beef-tea, brandy, and other easily-assimilated nutriments. When the vomiting is feculent the stomach should be washed out with mild antiseptic solutions, such as salicylate of soda. This greatly relieves the patient's discomfort and, according to Jessett, arrests peristaltic action. For the relief of pain and the lessening of peristalsis opium in small and repeated doses is valuable. One serious objection to its use, however, is that it is apt to mask the symptoms, and, by giving a feeling of false security, to prevent the surgeon from making an early diagnosis. Enemata or aperients are dangerous, as they increase the peristaltic action of the bowels, aggravate the vomiting, and hasten collapse.

Surgical Treatment.—Surgical procedures may be resorted to for two objects—viz. (1) for diagnosis, and (2) for relief of the obstruction. It is not discreet to advocate exploratory incisions as a routine practice, but when delay is attended with such disastrous consequences as often happens in these conditions, if ever an exploration is advisable it is here. When there is positive evidence of acute obstruction due to a constriction, operation with the utmost promptness is demanded, for we might just as reasonably treat a strangulated hernia by the expectant method as to trust to medical treatment here. The diagnosis should be made, if possible, and the operation resorted to, before fecal vomiting and prostration have set in.

Various minor procedures have been employed for the relief of obstruction. These will receive brief mention:

Evacuation of the Stomach.—This has been mentioned as a valuable remedy for the relief of stercoraceous vomiting.

Distention of the Colon.—The injection of fluid into the colon is a favorite remedy, and one almost instinctively resorted to. Many cases of intussusception have been relieved by this method. To be of any use it must be employed early, before adhesions have formed or obstruction to the circulation at the seat of the stricture has taken place. The water employed should have a temperature of 105° to 108° F. and should contain a small proportion (0.7 per cent.) of common salt. The fountain syringe from which it flows should be held at a height of four feet, which gives a pressure of about two pounds to the inch. The fluid should be slowly injected, four ounces to the minute (Martin and Hare). This treatment should not be persisted in beyond thirty or forty minutes, and in case of failure abdominal section should be resorted to without delay.

Distention with hydrogen gas or with filtered air is now regarded with more favor than the injection of fluid. It is only to be thought of in the early stage of intussusception or volvulus, and great care

must be taken lest too forcible distention produce overstretching or rupture of the bowel.

Manual Exploration of the Rectum.—In children a digital examination may reveal an intussusception low down. The introduction of the whole hand is a procedure to be discouraged, except under very special circumstances. It is not warrantable, except when the patient is an adult and the surgeon is possessed of a small and slender hand.

Puncture of the Intestine.—When there is great distention of the intestine with gas, and the circumstances are such that no more suitable operation can be resorted to, puncture of the bowel by a small aspirating needle affords temporary relief. It is needless to say that this treatment is unscientific and not to be recommended.

Taxis and Massage of the Abdomen.—This method has had its ablest advocate in Mr. Jonathan Hutchinson, who described the procedure in the following words: "The first point in abdominal taxis is the full use of an anesthetic, so as to obliterate all muscular resistance. Next (the bowels and bladder being supposed to be empty) the surgeon will forcibly and repeatedly knead the abdomen, pressing the contents vigorously upward, downward, and from side to side. The patient is now to be turned on his abdomen, and in this position to be held up by four strong men and shaken backward and forward. This done, the trunk is to be held uppermost, and shaking again practised directly upward and downward; whilst in this position copious enemata are to be given. The whole proceedings are to be carried out in a *bonâ fide* and energetic manner. It is not to be merely the name of taxis, but the reality, and patience and persistence are to be exercised. The inversion of the body and succussion in this position are on no account to be omitted, for they are possibly the most important of all. I do not think that I ever spend less than a half or three-quarters of an hour in the procedure."

It may well be questioned whether this energetic treatment is not attended with as much danger as a carefully executed celiotomy, while it only affords a haphazard means of righting an obstruction.

We have to deal with a disease that is invariably fatal in from twenty-four hours to six days. Volvulus has never been known to recover under medical treatment. Spontaneous recovery in cases of strangulation by bands is beyond the bounds of possibility, and recovery in cases of intussusception is a matter of the merest chance. Looking at the matter in this light, the choice is left us either to stand by with idle hands and see our patient die or to make the attempt to save his life by timely operation.

The mortality may be fairly stated at 95 per cent. in cases treated without operation.

The statistics of celiotomy for obstruction have been studied by many writers, including Schramm in Germany, Delaporte in France, Treves in England, and Whithall, Sands, and Ashhurst in America. Of 346 cases collected by Ashhurst, the mortality was as follows:

Intussusception,	65	cases;	mortality,	75.4	per cent.
Volvulus,	29	"	"	71.4	" "
Strangulation by bands,	119	"	"	67.8	" "

In the aggregate of 346 cases from all causes the mortality after the operation was 69.3 per cent. We thus see that the chances in favor of operation are as 95 to 69.3, or a saving of nearly 25 per cent. In Ashhurst's earlier statistics he found the mortality to be 67.6, and argues that, contrary to the history of most operations, the gravity of this one increases rather than diminishes as it is more often resorted to.

It must, however, be remembered that statistics of this character are misleading. The difficulty of getting the results of unsuccessful cases must always be great. The operation has hitherto been resorted to in the most hopeless cases, and, as a rule, when every other means had failed and death was imminent. With increasing confidence and diminished fear of operating it is likely that the operation will be resorted to at an earlier period and the main danger will be eliminated—the danger of delay. An early resort to operation might confidently be expected to bring about such good results as have followed the early use of forceps as compared with ancient practice, or the success which follows early herniotomy. Given a competent operator, cases treated before abdominal distention has come on, before the bowel has become inflamed or gangrenous, before adhesions have formed, before the patient's strength has become exhausted, would it be too much to say that the mortality would be reduced to 15 per cent., as predicted by Dr. Greig Smith?

Operations.—Having decided that obstruction exists, the course to pursue, as a rule, would be as follows: Distention with warm water should be given a fair trial, provided we are satisfied that the obstruction is recent and there are no firm adhesions nor a gangrenous bowel. Some prefer hydrogen gas or filtered air. The advantage of using warm water is that in the event of failure to overcome the obstruction it fulfils another indication which is a necessary preliminary to operation—*i. e.* it washes out the lower portion of the intestinal tract. One trial only of this method should be employed. If there is a tumor, showing the probable presence of intussusception, success will be manifested by disappearance of the tumor. In some cases the question can at once be settled, for the tumor remains as large as before, occupying its original position. In such an event we would better proceed to operate at once, without letting the patient come out of the influence of the anesthetic. When there is still doubt as to whether the distention has been successful or not, the patient should be allowed to regain consciousness. The symptoms will soon decide the question beyond doubt.

Enterostomy (ἔντερον, the intestine, and στόμα, a mouth) is the formation of an artificial opening in the intestine by which the contents can be discharged. The operation has by long usage gone under the name of enterotomy (ἔντερον, the intestine, and τομή, an incision). This term should be limited to the making of an incision into the bowel as for the removal of a foreign body.

Enterotomy, as it was improperly called, was first performed by Nélaton on a patient of Trousseau's about the time the great French clinical teacher was delivering those delightful lectures at the Hôtel Dieu. Nélaton advocated this operation in cases of intestinal obstruction which had lasted six or eight days, attended with fecal

vomiting and great abdominal distention. Resorted to under such desperate circumstances and without the aid of modern technique, we need not wonder that the operation was attended with such indifferent success. It has no future, for it will be employed only in cases which from neglect have been allowed to run on till profound collapse has left the patient in such a condition that the only thing possible to save his life is to draw up a loop of intestine, open and drain it. An artificial opening of the bowel through the skin must always place the patient in a pitiable condition. An artificial opening from one part of the intestine to another is a different thing, and will take the place of the old operation.

Enterostomy is a very simple operation. The abdominal wall is divided by an incision one and a half to three inches in length parallel to and a little above Poupart's ligament, between the anterior superior spine of the ilium and the epigastric artery. Stitch the parietal peritoneum to the skin by a continuous suture. A loop of distended bowel—which, as a rule, proves to be some part of the lower portion of the ilium—is drawn out and attached by sutures to the abdominal wound. If the case is not very urgent, the bowel need not be opened for several hours. This greatly lessens the risk of infecting the peritoneal cavity, as it allows adhesions to form between the bowel and the abdominal wound. If the bowel has to be opened at once, great care should be observed in placing the sutures so as to shut off the abdominal cavity. A portion of the surface of the bowel about the size of a silver quarter-dollar can be secured to the edge of the wound by fine silk sutures, either continuous or interrupted, and an opening made by scissors or tenotomy-knife large enough to admit the finger. This opening must be kept patent by placing a single stitch on each side to connect the margin of the intestinal wound with that of the parietal opening. Having established the artificial anus, we can utilize it in four ways :

1. We can allow the patient to rally and regain strength, performing a radical operation later.

2. In cases where the obstruction does not admit of removal, as in cancer, the opening can be allowed to remain permanently.

3. Under fortunate but rare circumstances a cure has been effected by enterostomy, the obstruction being removed by spontaneous correction of the mechanical conditions which produced it.

4. When the operation has been performed for fecal accumulation, the fistula may be closed as soon as it shall have fulfilled its purpose.

Celiotomy for Acute Obstruction.—This is the operation which deals radically with the obstruction and promises the best results. If possible, a diagnosis should be made before the obstruction has lasted twenty-four hours.

Preparation of the Patient.—When there is vomiting, and especially if it be of a feculent character, the stomach should be washed out with a 5 per cent. solution of salicylate of soda. The bowels also should be emptied by a warm-water injection, and an enema of brandy and beef-tea given just before the operation. The skin over the abdomen, having been washed with warm water and green soap, is next cleansed with ether or turpentine, and lastly with corrosive-sublimate

solution, 1 : 2000. Chloroform is the best anesthetic, as it is attended with more placid breathing and there is less venous congestion than when ether is administered. In some cases the patients are so deeply collapsed that general anesthesia cannot be borne. The injection of cocain along the line of incision is then the best means of making the operation painless, and the most that can be accomplished is the formation of an artificial opening in the intestine, as already described under Enterostomy.

The Incision.—For most purposes a median incision midway between the umbilicus and pubes will answer best. It should be long enough to admit three fingers, and can be extended up or down as required by dividing the parietes with strong scissors. It may be set down as a rule that all parts of an intestine above a constriction are distended, all parts below are collapsed. The fingers inserted into the wound should first search for the cecum. Distention at this portion of the intestine means that the colon, sigmoid flexure, or rectum is the seat of obstruction. Collapse here is an indication that the obstruction is in some part of the small intestine, the ileo-cecal valve, or higher up (Jessett). The abdominal incision should be extended as may be necessary ; coils of intestine should be allowed to escape, care being taken to keep them well protected by cloths or flat sponges wrung out of hot water. If the search in the neighborhood of the cecum has been fruitless, the sigmoid flexure should next be examined, for in nine cases out of ten the obstruction will be found in the lower half of the abdomen and in one or other inguinal region. Still failing to find the constriction, a systematic search is to be made as follows : Pick up a loop and, drawing it out so that it can be held by an assistant, examine it in one direction ; observe whether distention and congestion increase as you pass along its course. If so, you are getting nearer and nearer the point sought for ; but if the bowel becomes more healthy, push the loop back and continue your search in the opposite direction.

Once the cause is found, its removal may be attended with some difficulty. Bands may be divided between ligatures, an opening may be enlarged, as in the case of an ordinary hernia, a volvulus may be untwisted, an intussusception drawn out. When the operation has been resorted to before adhesions have formed or gangrene has commenced these methods of relief are possible ; but, unfortunately, complications and difficulties must often be encountered, and these we shall consider under the different forms of obstruction.

Intussusception.—Interference with circulation at the constriction sets in at an early period, and consequently congestion and edema are serious obstacles to reduction. An analogous condition is found in paraphimosis. The swelling and edema must be removed before the telescoped portion of bowel can be relieved. Three maneuvers may be successively tried :

1. Apply steady pressure to the intussusception, and when the swelling disappears draw gently down upon the neck of the intussusceptum.

2. Pass a director around between the intussuscipiens and the intussusceptum, and very gently break down any adhesions that may have formed.

3. Failing in both of the above methods, the bowel may be inflated per rectum with water or hydrogen gas, aided by traction and manipulation.

When invagination has been relieved by one or other of these methods the bowel must be carefully examined: slight rents in its peritoneal coat should be closed with Lembert sutures of fine silk; abrasions and gangrenous spots should be protected by omental grafts.

It often happens that adhesions have become so firm that they cannot be separated, or the bowel has been so long strangulated that it has become gangrenous. For the first of these complications we resort to intestinal anastomosis, for the second to resection of the gangrenous portion of bowel, intussusception and all.

Intestinal Anastomosis.—Where rapids occur in the St. Lawrence River the obstacles to navigation have been overcome by connecting the river above and below the rapids by means of a canal. In like manner we get rid of intestinal obstruction by inosculating a loop of intestine above to a loop below the stricture, and thus compelling the intestinal contents to take a shorter course, by which they avoid the portion of bowel which contains the obstruction. This idea was first suggested by Maisonneuve. Billroth and Von Hacker also gave it considerable study, but the operations were never attended with satisfactory results until Senn designed and carried out the method of forming anastomosis with decalcified bone-plates. As regards the indications for the operation, Prof. Senn has arrived at the following conclusions: "1. If the external surface of the bowel presents evidences of gangrene, disinvagination should not be attempted, and in such cases resection is absolutely indicated. 2. The resection under such circumstances should always include the whole intussusceptum, but only so much of the intussuscipiens as is threatened by gangrene. 3. If the continuity of the bowel cannot be restored by circular suturing, either on account of the difference in size of the lumen of the resected ends or of inflammatory softening, the same object is attained in an equally satisfactory manner, and more safely, by lateral implantation or intestinal anastomosis. 4. If the invagination is not extensive, but irreducible, and the bowel presents no sign of gangrene, the obstruction should be allowed to remain, and the continuity of the intestinal canal restored by making an anastomotic opening between the bowel above and below the invagination by the use of perforated decalcified bone-plates. 5. If the invagination is extensive, irreducible, and the bowel presents no indications of gangrene externally, the intussusceptum should be made accessible through an incision below the neck of the intussuscipiens, and resected after securing the stump with an elastic ligature, after which the obstruction is permanently excluded by an intestinal anastomosis. 6. In irreducible colico-rectal invagination, or when this form of invagination has been caused by a malignant tumor, the intussusceptum should be drawn downward and removed by the operation devised by Mikulicz."

Manner of Using Bone-plates (Fig. 106).—Having selected the two loops which are to be united, (1) shut off the remainder of the bowel from the part to be operated upon by clamps, rubber bands, or strips of iodoform gauze, two for each loop. (2) Make in each loop a longi-

tudinal incision on the convex side of the intestine at the part most distant from the mesentery. This incision should be two to two and a half inches in length. Allow the contents of the loop to escape and wash with sterilized warm water. (3) Slip a bone-plate into each incision. The lateral threads are made to perforate all the coats of the bowel; the end threads are left lying in the angles of the wound (Fig. 107). (4) Tie the threads and allow the knots to lie between the serous surfaces. (5) Additional security is gained by inserting Lembert sutures at intervals to unite the serous surfaces around the margins of the plates (Fig. 108). Scratching the serous surfaces with the point of a needle may hasten their union when brought into apposition. This, however, is of doubtful value. Serous surfaces readily unite without this, and the dangers of infection through even a slight scratch should not be overlooked.

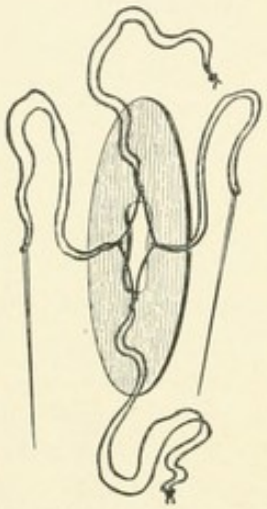


FIG. 106.—Senn's decalcified bone-plate.

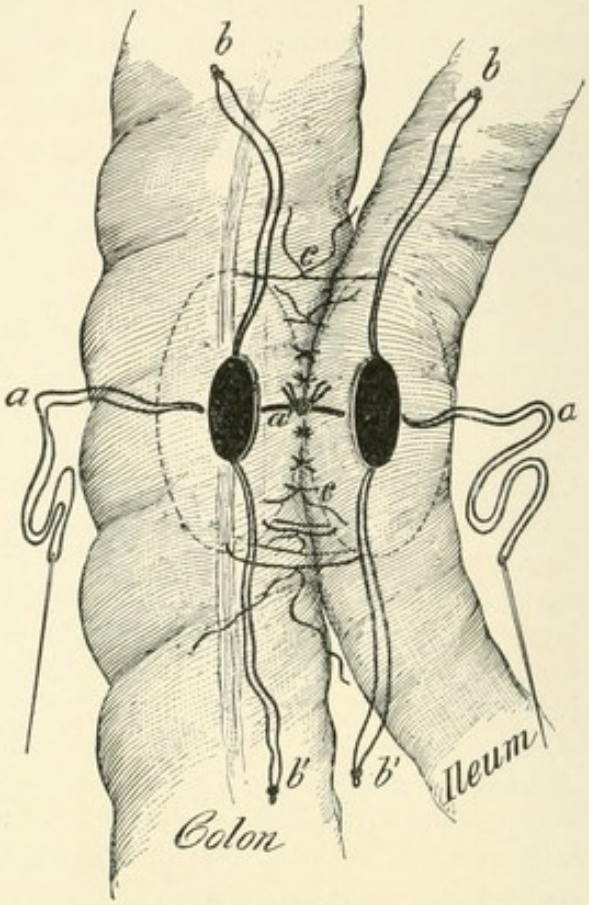


FIG. 107. — Ileo-colostomy with decalcified bone-plates, showing plates in position, one in the ileum, the other in the colon: *a, a, a*, lateral or fixation-sutures passed through the margins of the wound, *a* to be tied to *a*; *b, b, b', b'*, end- or apposition-sutures, to be tied *b* to *b* and *b'* to *b'*; *c*, posterior or sero-muscular sutures (Keen and White).

Abbe of New York objected to Senn's bone-plates on account of the difficulty of getting plates of bone large enough for use in the human subject, the trouble required for preparing them, and their tendency to warp and bend, and has devised rings composed of several strands of thick catgut around which are wound spirally other threads of the same material.

Plates composed of raw turnip or potato have been used.

Murphy of Chicago has invented a very ingenious and easily applied "button," which can be utilized with great rapidity and is suitable for any operation to which bone-plates can be applied. The

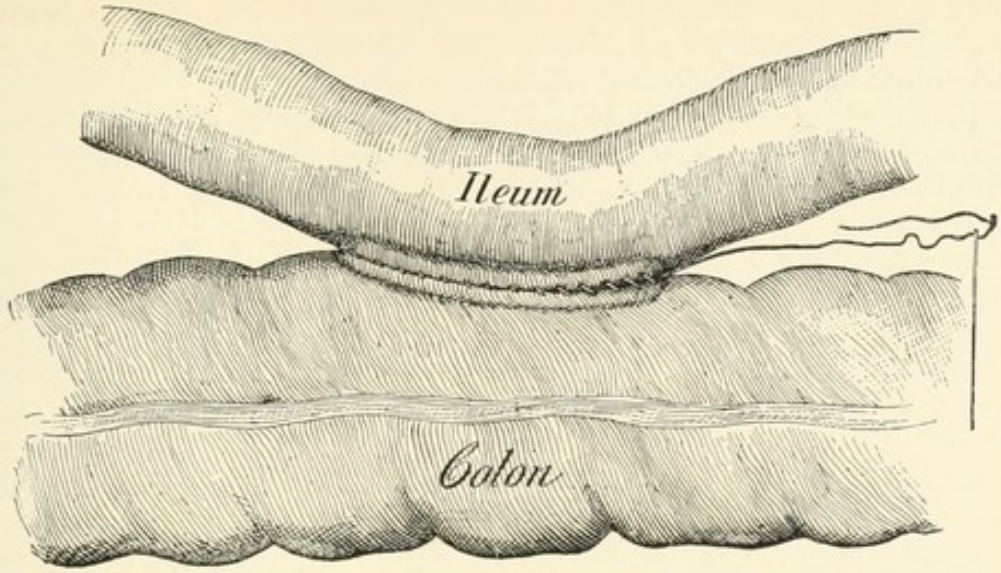
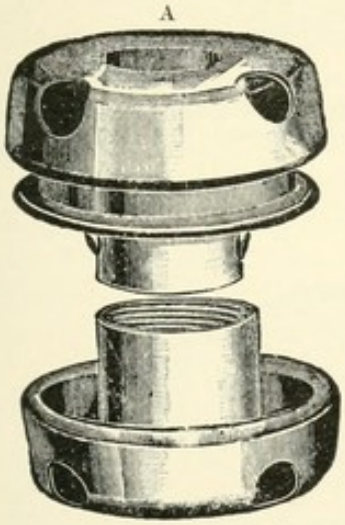


FIG. 108.—Showing the anterior continued sero-muscular suture as the final step in ileo-colostomy (Keen and White).



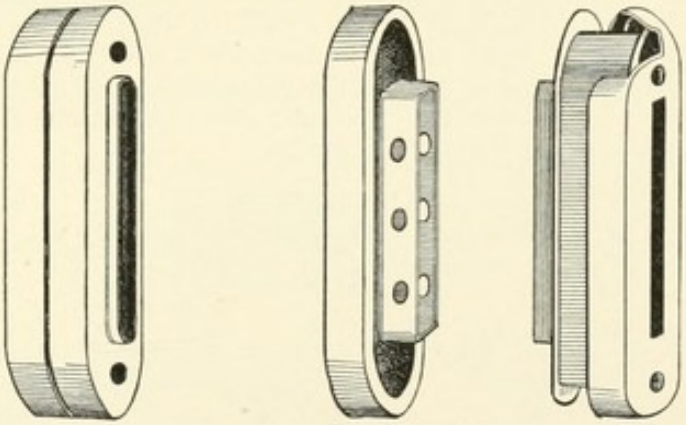


FIG. 110.—Oblong Murphy button.

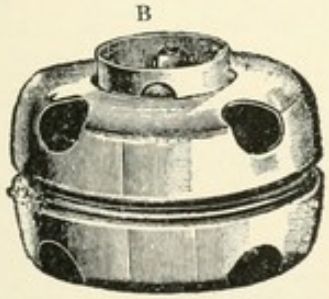


FIG. 109.—Murphy's button (enlarged): *A*, open; *B*, closed.

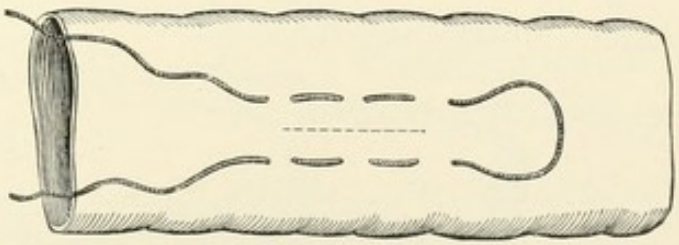


FIG. 111.—Method of applying purse-string suture in using the Murphy button.

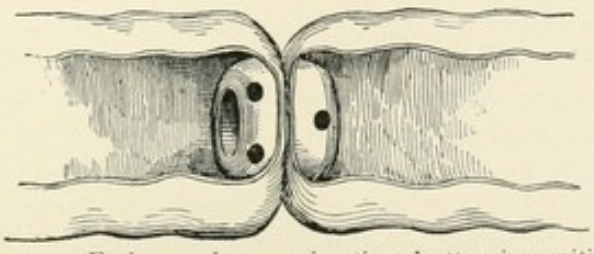


FIG. 112.—End-to-end approximation, button in position.

following objections have been urged against it: The serous surfaces brought into apposition are too limited in extent to afford safety; the button required for the small intestine is of so small a size that a constriction at the seat of operation is a common result, and the button is not always passed in the alvine evacuations. Notwithstanding these

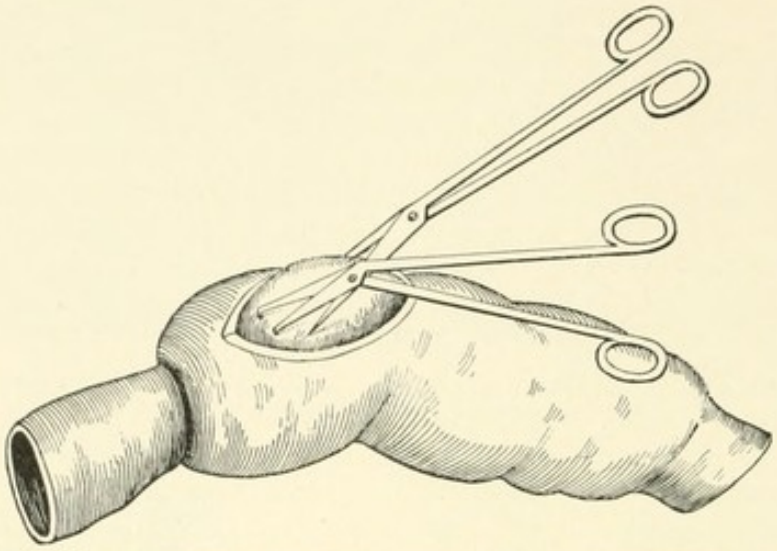


FIG. 113.—Showing incision into the intussuscipiens, the intussusceptum being seized by volsellum forceps and cut across with scissors (first stage) (after Jessett).

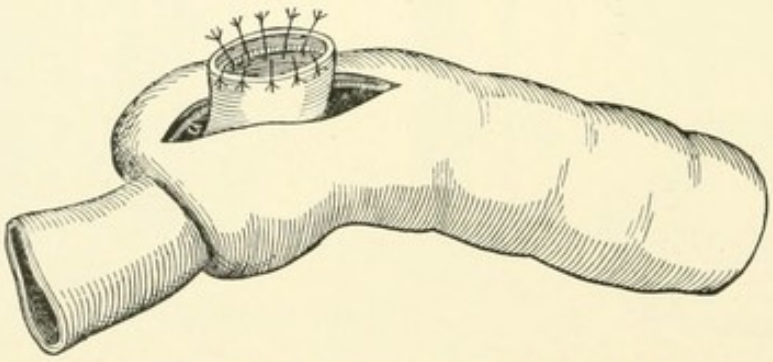


FIG. 114.—Showing intussusceptum detached, and the divided end of intestine sutured (second stage) (after Jessett).

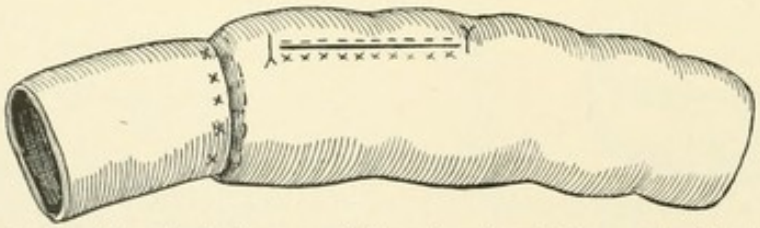


FIG. 115.—Showing incision in the intussuscipiens closed, and the neck of the intussusceptum united at end with sutures (final stage) (after Jessett).

criticisms most excellent results have been obtained by this method, and the "button" is gaining in popularity. The method of using the button is shown in Figs. 109–112. In each loop of intestine to be united a purse-string suture is placed, as shown in Fig. 111. The intestine is then opened, and one half of the button is grasped in a pair of hemostatic forceps inserted into the opening. The purse-

string suture is then tied, care being taken to include all the free edges of the incision, so that they will come between the halves of the button. The other loop of intestine is dealt with in a similar manner, and the sections of the button are then clasped together. The peritoneal surfaces unite, and by the constant pressure exerted by the spring of the button the compressed parts slough, allowing the button to pass *per anum* in ten or twelve days. The operation has a wide application, and can be used for lateral anastomosis, end-to-end anastomosis, gastro-enterostomy, enterectomy, pylorectomy, and cholecystenterostomy.

Jessett has devised an operation which may prove useful from its simplicity. He makes a longitudinal opening into the intestine on the side farthest from the mesentery, directly over the intussusception, about one and a half inches long. Through this opening he exposes the invaginated portion, and with scissors cuts it off close to its origin (Figs. 113, 114, 115), and, seizing the distal part with volsellum forceps, draws it out of the intussuscepiens, ligating any vessels that bleed. The cut ends are next stitched together with a few interrupted sutures, the stump dropped back into the intestine, and the opening through which it was withdrawn closed with a double row of quilt sutures. The advantages claimed for this operation are that it is much less dangerous than resection or anastomosis, and that it is certainly preferable to an artificial anus.

It may happen that the surgeon is so situated that he must operate without any of the artificial aids just mentioned, and some surgeons who are expert in the use of the needle prefer the old method. Abbe has described a procedure by simple incision and suture which in the hands of expert operators gives good results:

1. The two portions of bowel which are to be united are placed side by side (Fig. 116).

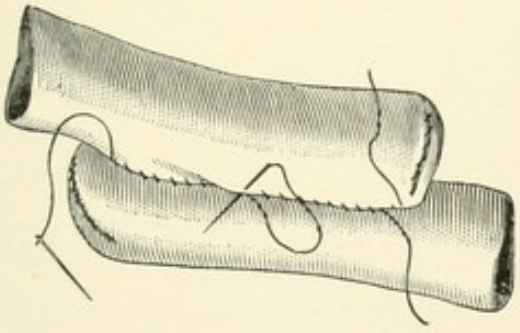


FIG. 116.—Suturing intestines in apposition before incision (Abbe).

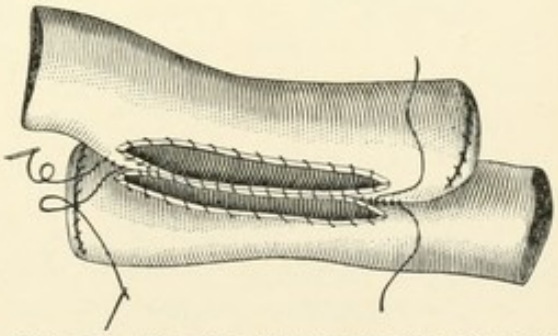


FIG. 117.—Showing the four-inch incision and the sewing of the edges (Abbe).

2. Two rows of continuous Lembert sutures a quarter of an inch apart and an inch longer than the necessary incision are applied as in Fig. 117, and each thread left with its needle at the end of the line of suture.

3. The bowel is opened parallel to and at a distance of a quarter of an inch from this line of sutures. The length of the incision is four inches, and both rows of sutures are at one side of the incision. Hemostatic forceps are applied to bleeding points and left there temporarily. The opposite portion of the intestine is similarly opened.

4. The two adjacent cut edges are united by an overhand continuous suture, the mucous and serous coats being included. As this arrests the hemorrhage, the forceps can be removed as they are reached. The other free edges are similarly stitched.

5. The openings are now approximated and the two serous surfaces brought together. The needles left at the end of the first double suture are now used to apply a similar double line to the parts last approximated, and thus the whole circumference of the four-inch opening is securely closed.

Besides intussusception, intestinal anastomosis is indicated in—

1. Volvulus;
2. In inoperable carcinoma if the disease is located high enough up in the colon to admit of an opening being made below it;
3. Cicatricial stenosis of the intestine.

Resection of Intestine (*Enterectomy*).—This operation is indicated in all cases where a portion of the bowel is gangrenous, or when the intestine is the seat of a malignant tumor and it is possible to remove the disease completely, or in the case of a benign tumor which cannot be removed by enterotomy. Any length of bowel from a few inches to three or four feet may be resected, but beyond this latter limit it is not safe to go, for in case of recovery the patient is almost sure to suffer from want of nutrition, and he gradually wastes away.

Operation.—1. Draw the loop of intestine to be resected well out of the abdominal wound. At the upper and lower limits of the segment perforate the mesentery close to the bowel, and pass a piece of rubber tubing or strip of iodoform gauze through each opening, squeeze out the contents of the segment, and tie the tubes or gauze sufficiently tight to occlude the bowel. Place flat sponges or sterilized gauze pads beneath the segment, so as to protect the remaining abdominal contents.

2. Tie off the mesentery in small sections with fine silk ligatures close to the intestine, divide the bowel with scissors or knife, making sure that you are cutting beyond diseased tissue. Wash out the lumen of each divided portion with warm sterilized water.

3. The divided ends are approximated in either of the following ways:

(*a*) By lateral anastomosis, the ends being turned in and sutured, and the remaining steps as in Abbe's method.

(*b*) End-to-end anastomosis. One continuous suture through mucous membrane only, and the serous coat stitched with Lembert's suture.

For end-to-end anastomosis Murphy's button is very convenient and quickly applied, and, if the part resected is a portion of the colon and the large-sized button is employed, there cannot be any of the objections which are urged against its employment elsewhere.

4. The mesentery may be treated by excising a V-shaped portion or by folding the redundant portion upon itself and stitching it at its free edge.

The after-treatment of resection consists merely in feeding the patient by rectal enemata for the first week. Nothing should be given

by the stomach except light liquid diet, and for the first twenty-four hours small pieces of ice.

Volvulus.—The occurrence of a twist in the bowel is soon followed by great distention, peritonitis, and firm adhesions. If we remember that when the peritoneal surfaces are placed in close apposition there is thrown out, even by the end of the first hour, a thick coating of coagulable lymph, we can readily understand that adhesions soon become so firm that separation of them is out of the question. The bowel may be simply twisted upon itself or one coil may be intertwined with another. Strangulation in such cases quickly comes on, and gangrene is inevitable. Having exposed the volvulus, an attempt should be made to straighten out the twisted portion; if this cannot be done, the distended bowel should be pulled out, opened above the constriction, and emptied. A second attempt should then be made at reduction. If this fails, the safest procedure is to make an artificial anus. Resection is not advisable, as the extent of the volvulus is likely to include a considerable part of the intestine. The cases in which only a small portion of the intestine is involved are usually amenable to reduction.

Strangulation by Bands.—As a rule, it is a simple matter to get rid of a band when once it is reached. A ligature should be placed at each extremity of the band as close to its attachment as possible and the band divided. One point should be guarded against, and that is the possibility of a second band. It has happened more than once that the successful removal of one band has not effected a cure, owing to the existence of a second band, which, unnoticed at the time of operation, caused death by strangulation of the bowel at a later period.

Meckel's diverticulum, a common cause of strangulation, must be dealt with in the same manner, care being taken not to mistake it for bowel, and using care in disinfecting the pervious ends when divided. When the diverticulum is pervious its mucous membrane should be turned inward and its fibrous coat stitched on the outside.

After the obstruction has been relieved by any of the methods just described the remaining steps of the operation are conducted on the same principles as celiotomy for any purpose. The toilet of the peritoneum requires due attention. The abdominal wound should be carefully approximated, drainage employed when demanded, asepsis adhered to throughout, and the patient kept in bed long enough to allow a firm cicatrix, and thus guard against a subsequent ventral hernia.

Chronic Intestinal Obstruction.—In this variety the intestine becomes gradually encroached upon and the lumen narrowed. At any time the occlusion may become complete, and then the case is practically one of acute obstruction. Chronic obstruction may be produced by—

1. Stricture of the intestine, cicatricial or malignant. A cicatricial stricture is, in the majority of cases, the result of the healing of an ulcer in the wall of the intestine. Much depends upon the size of the ulcer and upon its shape. If the ulcerative process extends along the course of the gut, contraction is likely to be slight; if, on the other hand, the ulcer is annular, the lumen is greatly lessened and may become entirely occluded. Strange as it may appear, the large bowel

is affected six times as frequently as the small intestine (Treves). When the small bowel is affected it is generally the middle and lower end of the ileum.

Malignant stricture is almost always cancerous and of the cylindrical epithelial variety (cylindroma). It has a tendency to encircle the gut, and thus constriction is more readily produced. It rarely occurs in the small intestine. Of 43 cases tabulated by Jessett, the small intestine was the seat of the disease in only 1 instance, the rectum in 20, the sigmoid flexure in 10, and other parts of the colon in 12. This would indicate that the nearer the anus the greater the liability to malignant stricture.

2. Benign growths affecting the wall of the intestine may cause obstruction, but these are rare. They are such growths as adenomata, fibromata, myomata, fatty and cystic tumors.

3. Foreign bodies obstructing the lumen of the bowel. Among these are classed gall-stones, which may grow to sufficient size to cause obstruction, bodies swallowed and becoming aggregated, small polypi, and enteroliths.

4. Tumors outside of the intestine, but pressing upon the gut and obstructing its lumen.

5. Fecal accumulations.

6. Paresis of the intestinal wall. This form is found in connection with peritonitis following celiotomies. There is really no occlusion of the bowel, but the peristaltic action is completely arrested and gases are retained, producing great abdominal distention and discomfort. Sometimes paresis results from reflex action, as in cases reported by Pitt and Jessett.

7. Adhesions following celiotomy or hysterectomy. One of the most annoying distant results of operations on the abdominal or pelvic organs is the occurrence of intestinal obstruction. If an abraded surface on the bowel comes in contact with the parietal wound or any serous surface, an adhesion is likely to take place at that point, which gives trouble sooner or later. Experience goes to show that this occurs more readily in suppurative cases. Two very practical points should therefore be borne in mind in abdominal operations—namely, to spread the omentum out carefully over the intestine and to avert suppuration by the most scrupulous asepsis. These obstructions sometimes prove fatal directly, or they may necessitate the opening of the abdominal cavity for their relief. It is a statistical fact that these secondary operations are followed by a large proportion of fatal results.

Diagnosis of Chronic Obstruction.—The symptoms of chronic obstruction are the same as those of the acute form, only milder in degree. The history of the case will reveal some chronic intestinal disease, such as carcinoma, ulceration, or morbid growth. Repeated occurrences of obstructive symptoms will be followed by periods of relief, but the tendency is for these attacks to return with increased frequency, and finally wind up with complete occlusion, when the symptoms will be intensified into the typical character of complete obstruction. Pain is not so marked a symptom as in the acute variety, in many cases coming on after eating. It occurs in paroxysms and has periods of

complete intermission. Vomiting appears later or not at all, and is rarely feculent. Constipation is usually present, but may alternate with attacks of diarrhea. Instead of the abdominal distention which is so marked a character of acute obstruction, we may have only attacks of flatulence, which, however distressing, may not cause dyspnea except when death is approaching.

In the large intestine the most common form of obstruction is carcinoma of the rectum. Its diagnosis is not difficult, but obstruction higher up may be obscure. The symptoms of obstruction in the large intestine as distinguished from the smaller bowel may be summed up as follows: Vomiting is less frequent, distention is more marked, and there is tenesmus with discharge of blood or pus.

Diagnosis of Fecal Accumulations.—These occur in the large intestine only, and for obvious reasons the cecum and the sigmoid flexure of the colon are the two points at which obstruction most frequently takes place. In a case reported by Jessett the hypochondriac and right iliac regions were filled by a tumor which extended to the umbilicus, and, having the shape of the liver, was diagnosticated as carcinoma of that organ. The patients are for the most part women who have passed the active period of life, and lunatics. The history of a case of this kind is one of obstinate constipation, going on from bad to worse. In some cases there is diarrhea, which, paradoxical as it may appear, is often present when the bowel is obstructed by a mass of feces. The tumor is not only plainly to be felt, but may be visible. Its consistency is frequently an indication of its character. *There is no other tumor in which a permanent indentation remains after pressure by the fingers.*

Treatment.—Purgatives are not only useless, but dangerous. If the accumulation is low down in the sigmoid flexure and filling the rectum, the masses can be broken up and removed with a scoop or the handle of a tablespoon. Repeated enemata of sweet oil, followed by copious injections of soap and water, give good results. Strychnin has a good effect in restoring the muscular contractility of the bowel and increasing peristalsis. To these measures may be added massage and the use of the faradic current. It must be remembered that a person who has once suffered from fecal accumulation is liable to a recurrence, hence every care should be taken to maintain the bowels in a healthy state.

V. HERNIA.

The protrusion of a viscus from its natural cavity through a distended normal or an artificial opening is called a hernia. It includes not only abdominal protrusions, but also those occurring in the thorax, the cranial cavity, etc. In common parlance the term is applied to the escape of abdominal contents through the parietes, either at one of the natural openings, as the inguinal or femoral canals, or at weak points, such as the umbilicus or the thin cicatrix left after abdominal section. Clinically, we meet with hernia under various circumstances. One case may be strangulated and threatening to prove fatal in a few hours unless relieved; another demands attention, owing to the inconvenience and pain produced by an ever-increasing tumor which cannot be kept within the abdomen. "The life of a person afflicted with a hernia," says

Championnière, "is generally a sad and painful one. He has to carry all his lifetime a truss more or less fitting, more or less adapted to his needs. He is incapable of vigorous exertion, and the intestines, passing in and out of the hernial sac, give rise to colic more or less severe. Sometimes the hernia is never reduced completely, and the patient is always threatened with strangulation.

"Besides these inherent defects accompanying a hernia, it is demonstrated that the sufferers are subject to a peculiar lack of vitality, especially in those afflicted with herniæ of large size or of long standing. The majority of these cases are troubled with diabetes or albuminuria. Hernia thus leads to an inevitable cachexia of which albuminuria and diabetes are very grave results."

The *diagnosis* of hernia seldom presents great difficulty, but the most serious consequences frequently arise from failure to recognize this condition. A young physician is called to attend a man who is suffering intense abdominal pain. He makes a hasty examination, employs a hypodermic of morphia and hot fomentations, with assurance that the disease is only colic and that the patient will be all right next day. For three days the condition grows steadily worse; vomiting sets in and becomes feculent. Another physician is called, who, recognizing a strangulated hernia, sends the man to a hospital. An operation is performed at midnight, but the patient dies upon the operating-table. There are few surgeons of large hospital experience who have not seen cases with this unfortunate history. *In severe abdominal pain or vomiting an examination for strangulated hernia should never be neglected.*

The *causes* of hernia are predisposing and exciting. Certain parts of the abdominal wall are naturally weaker than others, as the inguinal ring, the femoral ring, and the umbilicus. Certain abnormalities tend to hernia, as late descent of the testes, patulousness of the inguinal canal, patency of the tunica vaginalis, lengthening of the mesentery, and separation of the recti muscles. Among acquired defects may be mentioned abdominal operations, in which the tissues have not been brought into perfect apposition or where undue tension or suppuration has prevented the formation of a firm cicatrix. Repeated pregnancies and distention of the abdomen by ascites and sudden emaciation are also predisposing causes. The immediate or exciting causes are chiefly the action of the abdominal muscles. Consequently, those persons who engage in laborious occupations and frequently make strong muscular efforts are most liable to hernia, and especially if there is a predisposition. Violent efforts in coughing, straining at stool, and in urination are also exciting causes.

A long mesentery favors the descent of a hernia in adult life. The congenital variety occurs more frequently on the right side than on the left, owing to the fact that the root of the mesentery lies lower on that side. All perversions of function or diseases of the intestinal tract which cause relaxation of the mesentery favor descent of a hernia.

Prolapse of the mesentery has been considered very important. It occurs during late adult life, and is accompanied by a characteristic and readily recognized bulging of the lower part of the abdomen. The epigastric region is depressed, while below there is a bulging both at the sides and in the median line, where the muscles are the weakest,

and a radical cure which is attempted for the purpose of rendering the abdominal parietes more firm and resistant must of necessity fail, for the reason that the root of the mesentery has been weakened from some cause and has slipped down.

Certain hereditary conditions no doubt predispose to hernia. The inguinal forms occur more frequently in men than in women, while the femoral and umbilical are more common in the latter.

Varieties.—Hernia is classified according to the position which it occupies—viz. inguinal, femoral or crural, umbilical, ventral, diaphragmatic, etc. Of these the inguinal is by far the most common, occurring in 80 per cent. of all cases. Classified according to the manner in which the sac is formed, herniæ are divided into two classes—*congenital* and *acquired.*

The contents of a hernial tumor are made up of—(1) a sac, which is always the peritoneum, except in the very rare cases where a portion of bowel uncovered by peritoneum escapes; (2) a loop of *intestine*, generally the ileum; (3) *omentum.* The character of the contents is expressed by using the Greek name of the viscus and the termination *cele* (κήλη, a tumor); thus we have enterocele when the tumor contains intestine; epiplocele when the *omentum* occupies the sac; entero-epiplocele when the sac contains both intestine and omentum. In addition to the foregoing, it is common to find in any hernial sac a small quantity of serous fluid.

From a clinical standpoint every hernia falls into one of three classes: *Reducible*, when the contents of the sac can be returned to the abdominal cavity by simple manipulation; *irreducible*, when, owing to the formation of firm adhesions, reduction cannot be accomplished; and *strangulated*, when constriction at the neck of the hernia not only prevents the passage of the intestinal contents at that point, but obstructs the circulation in the bowel-wall and speedily leads to gangrene.

Symptoms.—Four-fifths of all cases of hernia occur in males. The patient, as a rule, only consults a surgeon after he or his friends have recognized the existence of a tumor in the groin, scrotum, or elsewhere. There are many cases in which the patient is unaware of the nature of his infirmity, and yet there are certain warnings which should arouse the surgeon's suspicion. These are—

1. A feeling of weakness at a certain point, relieved by the support of the hand or on assuming the recumbent posture.

2. Colicky pain and griping, supposed to be due to dragging on the mesentery. This is more noticeable on exertion and after eating.

3. During sudden efforts, in which the abdominal muscles are brought into violent contraction, the patient feels that something has given way.

4. Most important of all is the agonizing pain which is characteristic of strangulation. It is generally felt at the umbilicus, and patients describe it as twisting in character.

The Tumor.—Drawn to make a local examination by one or more of these warnings, a tumor will be found, the character of which depends upon its contents. If composed of intestine, the surface is smooth and elastic, and if large enough for percussion it is resonant. Place your

fingers upon it and ask the patient to cough—a distinct impulse is felt. This impulse on coughing may be regarded as the pathognomonic sign of hernia, and an examination without looking for it is no examination at all. The patient should be examined while he is standing up, as well as while he is lying down. If he stands upon a chair, it is still better, as the hernia can be examined at the level of the surgeon's hand. This is a very favorable position for the determination of multiple herniæ (Championnière). When omentum constitutes the bulk of the tumor the impulse is not so expansile; the tumor is hard, doughy, and uneven.

An enterocele slips back quickly when reduced, and there is a peculiar gurgle which is a welcome sound to the surgeon's ear. Epiplocele, on the other hand, goes back slowly, and, containing no gas, there is of course no gurgle.

Having settled the point that the tumor is a hernia, the next question is whether it is above or below Poupart's ligament. If above, it is an inguinal hernia; if below, it is a femoral hernia. The spine of the pubis is an important landmark. An inguinal hernia always protrudes at the external ring just at the spine, and lies above Poupart's ligament. A femoral hernia is always below the spine.

Inguinal hernia occurs as a tumor near the center of Poupart's ligament. There are two varieties—viz. oblique or external, direct or internal. In the indirect hernia the bowel escapes from the abdominal cavity at the internal abdominal ring, pushing the peritoneum before it, and, following the inguinal canal, emerges at the external ring. Along this same route the testicle, on the way to the scrotum, has been the pioneer, and the intestine may follow it the entire distance. The epigastric vessels lie to the inside of the neck of the tumor. In the direct form the bowel does not enter the internal ring or traverse the inguinal canal, but, pushing the fascia before it, escapes directly through the external ring.

In examining the tumor these two forms can generally be differentiated. The indirect form is by far the more common; the tumor is oval in shape or, when it has descended to the scrotum, it is pyriform. The history of the case will show that the tumor began to appear at the middle of Poupart's ligament and gradually extended toward the pubes. The pulsation in the epigastric vessels is usually obscured. The size of the tumor is sometimes immense, in some cases filling the scrotum and causing it to drag downward until it comes almost to the knee. The indirect hernia usually contains intestine. It is reduced by pressure outward and backward.

Direct inguinal hernia is rare. The tumor is small and globular, usually making its appearance a little to the inside of the middle of Poupart's ligament. It generally contains omentum, and the epigastric vessels lie to the outer side. It is reduced by pressure directly backward. The finger-tips can be pushed through the canal directly into the abdominal cavity. On the inner side of the opening can be felt the conjoined tendon and the posterior upper surface of the pubis; on the outer side is the epigastric artery. When a hernia is large and of long standing, the differential diagnosis may be impossible, for the internal may be dragged downward until it is opposite to the external ring.

Femoral hernia is a female hernia; that is to say, it is much more frequently met with in women than in men. Its position is in the crural canal, which has the following anatomical boundaries: In front, Poupart's ligament, the deep crural arch, and the falciform edge of the fascia lata; on the outer side, the femoral vein; on the inner side, Gimbernat's ligament; and behind, the bone. The anatomical landmark for this hernia is the spine of the pubes. *A femoral hernia is always below it and to the outer side.*

In hernia of long standing and of considerable size it may be difficult to say whether the tumor is above or below Poupart's ligament, for as it enlarges it turns upward and toward the abdomen, giving the appearance of an inguinal hernia. What adds to the difficulty is the existence in some women of a fold of the groin which extends across the thigh lower down than Poupart's ligament, and may be mistaken for it. When a femoral hernia remains in the crural arch it is said to be incomplete; when it protrudes at the saphenous opening it is called complete.

Diagnosis between hernia and other swellings of the inguinal or femoral region:

Bubo is generally associated with chancroids, gonorrhea, and syphilis, and there are redness of the skin and tenderness. If the swelling and subcutaneous infiltration are not too great, the outline of the inflamed gland can be felt. Chronic inflammation of a gland in the groin seldom leads to confusion, as the glands are distinct and movable. Glands enlarged by malignant disease are hard and frequently occur in chains.

Undescended testicle has the characteristic pain on pressure peculiar to these organs, and, besides, there is absence of the testis in the scrotum.

Varicocele is a swelling resembling a bunch of worms, commencing in the lower portion of the cord and increasing upward. There is no impulse on coughing. The swelling may disappear when the patient lies down, as is sometimes the case in hernia. If the part be supported and the patient stand up, the swelling will return in the case of varicocele, but not so if the case be one of hernia.

Hydrocele is translucent, and the swelling begins at the lowest part of the scrotum, while in hernia this is the *ultima thule*. Hydrocele of the cord is never very large, and has but a slight impulse on coughing. The swelling moves with the cord.

Abscess in the neighborhood of Poupart's ligament may assume the shape of a hernial tumor, but there are the characteristics symptoms of suppuration, pain, high temperature, etc. Psoas abscess has a history of spinal or pelvic disease; the tumor, if superficial, fluctuates and gradually disappears under pressure.

Irreducible Hernia.—When, without impairment of the circulation or the passage of feces, a hernia cannot be returned into the abdomen, it is said to be irreducible. This may be brought about by a variety of causes: the hernia may be composed of omentum, which takes a mushroom shape, a small neck and an expanded body; a large quantity of fluid in the sac may interfere with direct manipulation of the bowel; or the great size of the tumor may in itself be an obstacle

to reduction. The most frequent cause, however, is the existence of adhesions, either between the sac and its contents or between the contents themselves. Irreducible herniæ are the cause of great discomfort. More and more of the intestine slips down into the sac until the tumor reaches an enormous size. Continual dragging pain, dyspepsia, colic, and the ever-present danger of strangulation make the patient's lot anything but pleasant.

Incarcerated or Obstructed Hernia.—When, without any interference with circulation, the loop of bowel contained in a hernia becomes impacted with feces and gases, the hernia is said to be incarcerated or obstructed. This only happens when the colon goes to form the hernia, as the contents of the small intestine are always liquid. This condition is most frequently met with in umbilical hernia, especially in that form which afflicts women who have borne many children. It is easy of recognition. The tumor is hard and uneven, and in some cases tympanitic. It hangs down from the umbilicus, and usually attains considerable size, attended with colic, nausea, and total constipation after the lower bowel has been emptied.

Strangulated Hernia.—A strangulated hernia is one in which constriction at the neck is so complete as to arrest the circulation, paralyze the nerves, and stop the flow of contents through the bowel. Such a condition is naturally attended with the utmost danger, and its progress is rapid—from strangulation to gangrene is a short step. It is not essential that the hernia should contain intestine, for when the sac contains omentum, or, in fact, any other structure, the course and symptoms are the same. When the bowel is involved it may be constricted at one side or in its whole circumference. In either case perforation is the usual consequence, the contents of the bowel escaping in some instances into the peritoneal cavity, setting up general peritonitis. In others they are poured out into the sac and followed by suppuration.

Symptoms.—If once the existence of hernia be recognized and the symptoms of strangulation superadded, error in diagnosis is impossible, The danger of making a false diagnosis lies in the fact that the condition may be regarded as due to gastritis when vomiting is an early and prominent symptom, or to peritonitis when pain and abdominal tenderness are most marked. Two classes of symptoms must be recognized—one due to *obstruction of the bowel, the other to strangulation.* In every case of severe abdominal pain or persistent vomiting the question of hernia should be considered, and every probable site of hernia should be carefully examined.

Pain is usually an early and prominent symptom. It is generally referred to one spot, the seat of the hernia, but frequently, and especially at a later stage, it is felt at the umbilicus, and described as if the intestines were being violently twisted at that point. Tenderness is most marked at the seat of hernia, but is commonly a marked symptom over the whole abdomen. When gangrene has become complete pain ceases, and its sudden cessation may be regarded as a harbinger of death. Too much reliance should not be placed upon pain as a symptom. In some cases it is almost absent, and in others its onset is delayed.

Vomiting may come on at the very commencement of strangulation, or it may appear at a much later period. The higher the strangulation in the bowel, the earlier, as a rule, will vomiting set in. At first the food newly received into the stomach is ejected undigested and unaltered. After a time the gastric secretions, still later the chyle and bile, are ejected, and lastly the vomit assumes all the characteristics of fecal matter.

Obstruction is manifested by constipation, which is persistent and complete. After the bowel below the strangulation has been emptied nothing more, not even flatus, comes away. The abdomen gradually becomes distended and tympanitic, but the area of liver-dulness remains intact, thus showing that the gas is in the intestine and not in the peritoneal cavity. The part of the intestinal canal implicated may be approximately determined. If, after the onset of the symptoms, a considerable evacuation takes place from the bowels, it may be concluded that the obstruction is in the small intestine. Distention also comes on slowly if the lower intestine be the strangulated part.

The *temperature* is seldom above normal, and in the late stages it becomes subnormal.

The pulse is generally rapid, and becomes feeble and intermittent toward the close.

Examination of the hernial tumor will reveal tenderness at the seat of strangulation. There is absence of impulse on coughing. The later history of a case of strangulation is the history of gangrene. If we were restricted to the use of two words in describing the course of a strangulated hernia, we would not be far astray if we used *peritonitis* and *gangrene*. The first acute onset with its violent pain and other signs of peritonitis passes into a stage in which the constitutional symptoms play a more prominent part. More and more offensive becomes the vomited matter, and it comes in great gushes without any effort; the pulse becomes feeble and intermittent; hiccough is constant and distressing; the abdomen becomes more and more distended; the face is haggard; the mind wanders; the surface of the body becomes cold and clammy; and death by exhaustion ends the fearful scene.

In rare cases nature brings relief and prevents a fatal termination. The tumor is swollen and edematous, and even tympanitic from the putrefying gases; the skin ulcerates and the contents escape, leaving the patient his life, but with it the misery of an artificial anus.

When the hernia contains omentum only, or when only a part of the circumference of the bowel is strangulated (Littré's hernia), the symptoms are the same, only in a less marked degree.

Differential diagnosis of strangulated hernia must rest between hernia and—

1. Acute peritonitis. The existence of a hernia previous to the onset of symptoms and the presence of a tumor must be mainly relied upon to exclude peritonitis.

2. Inflamed or obstructed irreducible hernia. The pain, constipation, and collapse are never so marked as in strangulation. The vomiting is not fecal.

Treatment of Strangulated Hernia.—A condition so grave and violent in its progress demands the most prompt and decisive treat-

ment. Strangulation must be relieved or death will most certainly result. Two measures are relied upon—taxis and operation. In employing taxis or manipulation the first point demanding attention is to secure complete relaxation of the parts. The head should be lowered and the pelvis raised. If the hernia be inguinal, flex and adduct the thigh; if femoral, flex and rotate inward. Steady the neck of the sac with the left hand while the right gently manipulates the tumor with the view of emptying it of part of its contents. If intestine slips back, a welcome gurgle announces the fact; omentum goes back more slowly, but with an equal sense of relief. Should gentle efforts at reduction fail, more complete relaxation of the parts must be secured by putting the patient under chloroform. But before doing so every preparation should be made for an operation in the event of taxis proving a failure. This is required for two reasons—first, because the patient should be subjected to anesthesia only once; and second, because the case, if unrelieved by taxis, will not admit of a moment's delay.

The *operation* for strangulated hernia or herniotomy consists in cutting down upon the constriction, dividing it, and returning the bowel to the abdominal cavity, or otherwise dealing with it as circumstances demand. The pubes, scrotum, and neighboring parts having been shaved and thoroughly disinfected, an incision is made in the long axis of the tumor, the center of the incision corresponding with the position of the neck of the sac. The next point is to find the sac, which, to an inexperienced operator, may be a little difficult. It is recognized by the fat which usually covers it; grasped by the finger and thumb, its surfaces can be made to slip over each other. Carefully dissecting down through the tissues, we know that we have entered the sac by the escape of a yellow or dark-brown fluid. Through the puncture in the sac a grooved director is passed, and an opening made sufficient to admit the finger, upon which the sac is divided to the full extent of the tumor. The finger is now passed up to the constriction, palmar surface upward, and the nail slipped into the opening. A long probe-pointed bistoury is passed up, the flat surface of the instrument against the palmar surface of the finger, until it slips between the sharp edge of the constriction and the nail. The edge is now turned upward and the ring sufficiently divided to relieve the strangulation.

The contents of the hernia should now be carefully examined, and especially the bowel. Warm sterilized gauze is applied to the wound, and allowed to remain for several minutes in the hope that circulation may be re-established in the strangulated tissues. A strangulated intestine varies in color from a pinkish gray to black; if in the course of five to fifteen minutes it changes to a healthy red, circulation is restored and the bowel can be returned to the abdomen. The sac is then treated in the same manner as in the radical operation for hernia, and the operation completed as described under the radical operation. When omentum is contained in the sac, it should be separated if adherent, tied in sections, and cut off.

Should the intestine prove to be gangrenous, it may be dealt with by one of three methods: 1. The gangrenous portion is exsected; the healthy divided ends are brought together by end-to-end anastomosis (enterectomy). 2. An artificial anus is formed by suturing the bowel

to the edge of the wound and opening into its lumen. 3. The bowel is returned to the abdominal cavity, stitching it to the abdominal wall inside the ring, and placing a drainage-tube in contact with it. This is only applicable when the portion of gangrenous bowel is small.

The Radical Cure of Hernia.[1]—In the case of strangulated hernia "the radical cure" is a term applied to a method of treating the sac and closing the canal which prevents recurrence of the hernia. Its usefulness is, however, by no means limited to strangulated hernia, for it is almost universally adapted to those unfortunates who are doomed to carry a truss through life, who are constantly threatened with the dangers which are for ever hanging over the heads of the ruptured, or who are shut out from many of the active walks of life by these inflictions.

Long is the history which deals with the various attempts at the radical treatment of hernia. Some were subcutaneous, as Wood's and Spanton's, but the advance of aseptic surgery has proven that not only greater accuracy, but equal safety, is gained by operations which lay the parts open to view and deal with the separate structures as their condition demands.

The operation is imperative in—(1) strangulated hernia; (2) in herniæ whose volume is gradually increasing.

The operation is indicated in (1) irreducible herniæ; (2) congenital herniæ with ectopic testicles; (3) painful herniæ; (4) herniæ in subjects afflicted with diseases that form dangerous complications, as spasmodic asthma, chronic cough, etc.; (5) social necessities may demand the operation, as in those who have to perform manual labor, those who wish to enter the military service, etc.

The operation is contraindicated in—(1) old men and very young children (under six years of age); (2) persons who have albuminuria, diabetes, or tuberculosis: those afflicted with emphysema are the most dangerous of all; (3) those predisposed to hernia.

If we bear in mind the conditions essential to the existence of a hernia, the indications of treatment will be better understood.

1. In every hernia there is an enlarged foramen or canal in the abdominal wall (Fig. 118).

2. Protruding through this opening is a serous sac which forms an inclined plane, smooth and slippery, on which the viscera glide.

3. The viscera which form the hernia are generally the intestines and the omentum. Everything tends to place the intestines upon this slippery surface. Ordinarily the intestine is loose on this inclined plane, but sometimes it forms adhesions with the omentum, which goes down with it.

In view of the principles just laid down we have three indications which must be fulfilled as much as possible:

1. The serous membrane must be modified or destroyed, for the destruction of the slippery surface will remove the tendency of the intestines to slide over it.

The opening of the sac, and then its removal at the highest possible point, will destroy the slippery inclined plane. In order that this de-

[1] For much that follows I am indebted to the excellent work of Championnière, *Cure radicale des Hernies*, Rouff, Paris.

struction be complete, the serous membrane away above the neck of the sac must be removed with it and the opening closed by a strong ligature, so that no cul-de-sac or infundibulum be apparent, and that in the

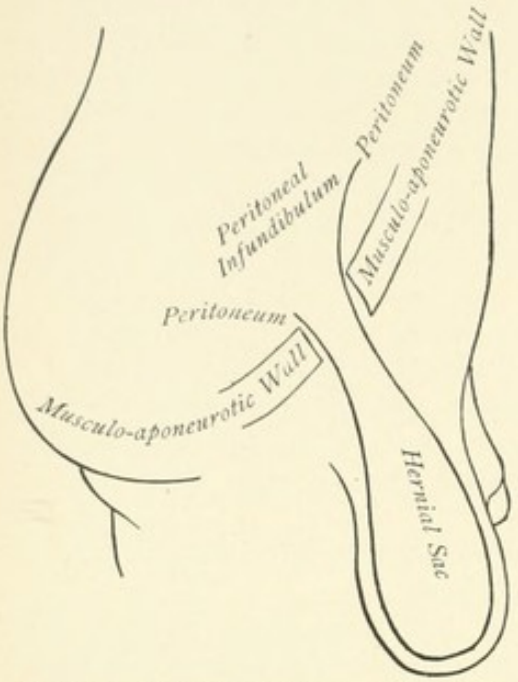


FIG. 118.—Schema of the constituents of a hernia; sac and slippery surface traversing the wall (Championnière).

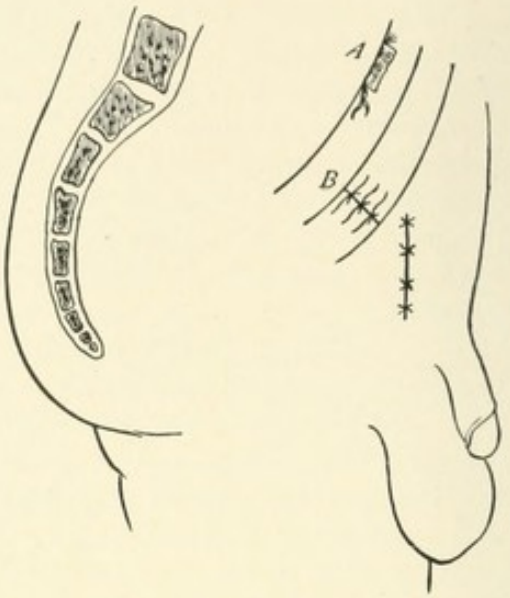


FIG. 119.—Schema of the radical cure, restoration of the wall, closure of the serous membrane: *A*, closure of the wall; *B*, closure of the skin (Championnière).

region which the hernia occupied we find only a smooth plane continuous with the rest of the deep surface of the abdominal wall (Fig. 119).

2. We must build up at the opening in the abdominal wall a most resisting cicatrix as a powerful barrier to prevent the forcing out of the

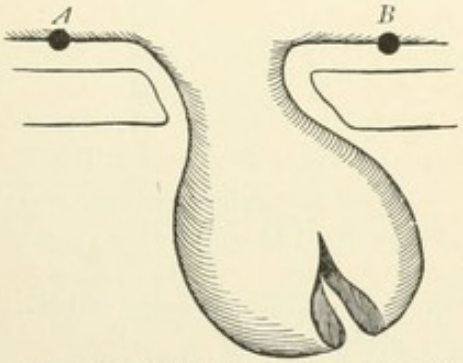


FIG. 120.—Serous sac of a hernia with the points (*A* and *B*) at which the destruction of the serous sac must take place (Championnière).

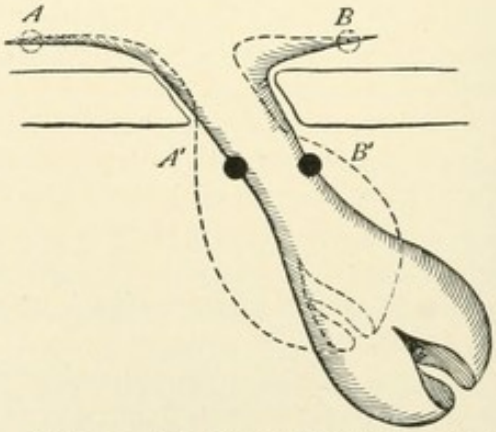


FIG. 121.—Sac drawn down by traction and dissection; the points *A* and *B* have descended to *A'* and *B'* (Championnière).

viscera which have a tendency to come down. This point is gained by the close approximation of a large operation-wound. The extensive dissection of the serous membrane is an important preparatory step,

and it may be said that the larger the incision the more powerful will be the cicatrix.

3. If intervention with the contents of the sac be possible, we must destroy the parts not essential to the functions of the abdomen—*e. g.* the omentum. The omental mass contained in the sac should not only be removed, but all that can be drawn down by strong effort. This is all cut off, thus creating in the abdomen a corresponding vacuum (Figs. 120 and 121). In this way the omentum cannot play its customary part in producing a recurrence of the hernia (Fig. 122).

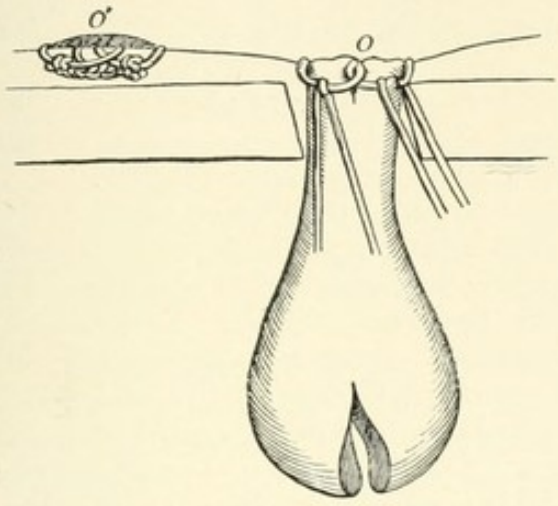


FIG. 122.—Sac of the preceding, with the ligature of the pedicle placed at the highest possible point. After resection the pedicle *O*, by retraction of the peritoneum, ascends to *O'* (Championnière).

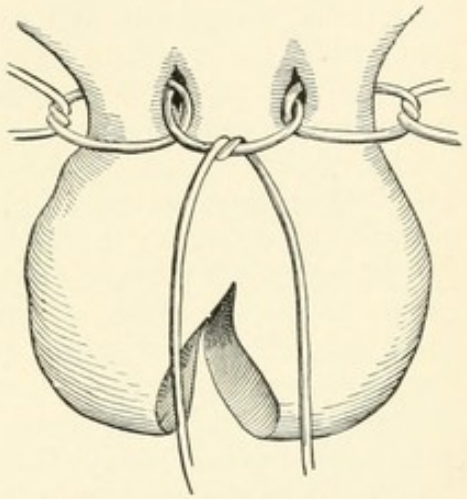


FIG. 123.—Sac closed by chain ligatures (Championnière).

Championnière's Operation.—First Step: Removal of the Sac.—The incision should be made where it best exposes the neck of the sac; it should not be too short, for the operator needs an abundance of room to make a complete dissection of the sac; it should be as far away as possible from the scrotum and penis, and especially from the labia, to guard against infection from the secretions of these parts. The sac, particularly if small, is often difficult to find; hence the advantage of making the incision as high as possible in the direction of the inguinal canal. No matter how thin the sac may be, an attempt should be made to dissect it out *in toto*. A pair of blunt-pointed scissors is the best instrument. The sac must not be too strongly drawn upon, for it will either be too firmly adherent to be separated from the other tissues, or it will be too thin to stand the strain and will tear.

Whatever the hernia operated upon, the layers must be separated one by one, and the serous membrane isolated as much as possible from the neighboring parts, in order to carry dissection as far up as possible. In an acquired hernia the adhesions may be just as firm as those of a congenital hernia. In the latter variety the sac is generally very thin. Having reached the highest point, a strong ligature is applied and the sac cut off. When the sac is large it should be tied off with a chain ligature, as seen in Fig. 123.

Second Step: Treatment of the Organs contained in the Hernia.—The intestine, if healthy, is returned to the abdomen, and requires no further

consideration. The omentum is a structure requiring the most careful management. It is a dreaded agent in the formation, maintenance, and recurrence of hernia, and should be reduced to the smallest possible dimensions. Not only should the protruding omentum be removed, but all that can be drawn out. And when none presents at the opening, the finger should be passed up in search of it with a view of drawing it down and resecting all that can be pulled out. The removal of omentum has three advantages:

1. It empties the abdomen of part of its contents and makes room for other viscera.

2. It suppresses an organ which is an active agency in the formation of hernia.

3. This procedure allows us to discover adhesions at or above the neck of the sac whenever they exist. These adhesions are often the cause of the return of the hernia and the persistence of pain.

Having broken up adhesions and brought down the omentum, it should be laid upon a sterilized towel and spread out until it is in a single layer, with every vessel of any size plainly visible. De Garmo urges the importance of numerous ligatures, instead of the older method of tying off in one or two masses. He begins at one edge of the fan-shaped omentum as it is spread out in a single layer, and places a row of silk ligatures across to a corresponding point on the opposite side. No piece of fat larger than a lead pencil is included within one ligature, and every vessel that can be seen is tied separately. The ligatures are cut off close to the knots, except those at the edges, which are clamped with forceps to control the stump. The omentum is then cut away, the surface of the proximal portion is dusted with aristol, the end ligatures are cut off, and the stump dropped back into the abdomen.[1]

Third Step: Closure of the Wound to Secure a Firm Cicatrix.—The third fundamental condition of the radical cure is the formation of a strong barrier extending along the whole hernial region. To secure this the incision must be long and high up along the inguinal canal, without sparing the lax muscular fibers stretched by the passage of the viscera. One of the most potent factors in the formation of a strong cicatrix is asepsis, for the cicatrices which are really strong, truly resisting, are those that heal by first intention.

For the deep suturing the best material is kangaroo tendon. It is strong, easily tied, and is absorbed in about three months, the time generally required for the completion of cicatrization. The soft parts which formed the wall of the canal are first brought together, and when the hernia has been large one side of the canal should be made to overlap the other. This row of sutures should include the aponeurosis and muscles. The next row can be of catgut, and it unites the cellular tissue in front of the muscle and extends downward along the cord. The last row is made with silkworm gut and closes the wound in the skin. A drainage-tube is placed in the position farthest from infection, an antiseptic dressing applied, and strong and steady pressure maintained for three or four days.

Treatment of the Testicle.—The testicle may occupy any of the following positions:

[1] *Annals of Surgery*, June, 1895.

First: It may be in the bottom of the sac, as in congenital hernia. In this case it is normally located, and all we have to do is to provide from the hernial sac a serous membrane to cover it. The membrane may be sutured or it may be allowed to roll up around the testicle.

Second: The testicle may be in the vicinity of the inguinal canal or in the canal itself. This condition is more serious. If the patient is not young and the testicle painful, it may be sacrificed, but most patients, even with atrophied testicles, object to this measure. The testicle and epididymis may be so firmly adherent to the hernial sac that it may be very difficult to separate them. The testicle held by fibrous bands is drawn upward, and held there in spite of our efforts to bring it down. If the bands be divided, the testicle will remain down, but there is no lodgement for it. Championnière is in the habit of making a new bed for it by tearing through the cellular tissue of the scrotum with his finger. When the vas deferens is shortened and atrophied, the testicle should be sacrificed. In his 266 cases he has only been compelled to perform castration 5 times.

Macewen's Operation.—The steps of Macewen's operation are as follows:

(1) He forms a pad on the abdominal surface of the internal ring, and (2) closes the inguinal canal.

(1) The formation of the pad. The bowel having been reduced in the ordinary way, the sac is thoroughly freed in its whole extent from the cord and from the walls of the inguinal canal. Then strip the peritoneum from the abdominal wall for about two inches round the internal ring and fix a stitch securely in the distal (*i. e.* the abdominal) extremity of the sac. This stitch is passed several times through the sac to its outer extremity, so that when drawn tightly the sac is folded up like a concertina (Figs. 124, 125). The free end of the suture is then threaded on a hernia needle, passed along the inguinal

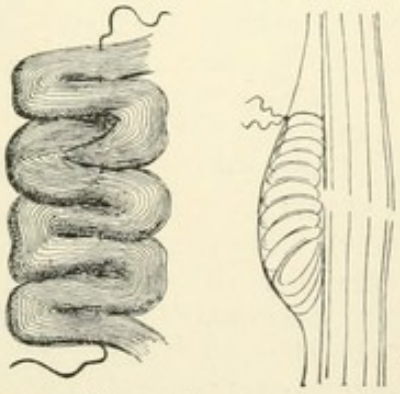


FIG. 124.—Macewen's operation: the sac transfixed and drawn into a fold.

FIG. 125.—The sac as a pad covering the abdominal aspect of the internal ring in Macewen's operation.

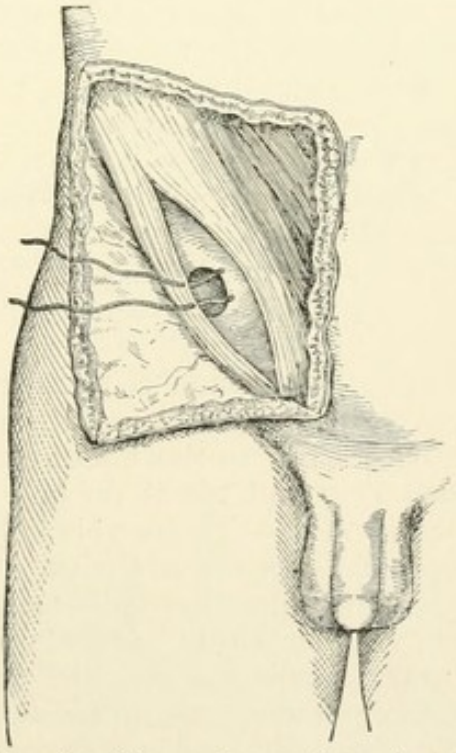


FIG. 126.—Macewen's operation: the threads ready for tying.

canal and through the structures of the abdominal wall, from within outward, one inch above the ring. The skin is to be drawn up out of the way while this suture is being passed. The end of the suture is then fixed by introducing it several times through the external oblique muscle.

In this way the sac is not only obliterated, but forms a pad which protects a weak point in the abdominal wall.

(2) The closure of the inguinal canal is accomplished in the following manner (Fig. 126): The conjoint tendon is penetrated in two places, at its upper and lower ends, by a single thread of catgut, so that a loop is made with its convexity on the abdominal aspect of the tendon. The lower freed end of this thread is passed from within outward through Poupart's ligament, and the upper end through the external oblique and transversalis muscles, each stitch maintaining the level it has at the conjoined tendon. The two free ends are then tied in a reef knot. The cord should be examined before tightening each stitch to avoid compression.

The pad is now considered an objectionable feature, and mainly on this account Macewen's operation has been supplanted by the methods of Bassini and Halsted.

Bassini's Operation.—First Step.—The incision extends from a point on a level with the anterior superior spinous process obliquely downward parallel to and about half an inch above Poupart's ligament, and ends at the center of the external abdominal ring. The dissection is continued until the aponeurosis of the external oblique is reached and exposed for a distance of about three inches. A director is then passed beneath the aponeurosis through the external ring, and the aponeurosis divided to a point half an inch or a little more above the internal ring. The edges of the aponeurosis are dissected backward toward the middle line as far as the edge of the rectus, and outward until the shelving portion of Poupart's ligament is fully exposed.

Second Step.—The sac and cord are isolated by the fingers and blunt-pointed curved scissors. The cord and its vessel are separated from the sac and the separation carried high up within the internal ring.

Third Step.—Open the sac, and, having separated adhesions and removed any thickened omentum that may be present, return the contents of the sac to the abdominal cavity. Ligate the sac above the internal ring and cut it off below the ligature.

Fourth Step.—The cord is held up by a hook and the edges of the aponeurosis kept out of the way. Buried sutures are then placed so as to close the abdominal wall beneath the cord. These sutures, three to five in number, should include on the inner side the internal oblique and transversalis muscles, the transversalis fascia, and in some cases the edge of the rectus, on the outer side the shelving portion of Poupart's ligament. Replace the cord and close the aponeurosis over it by a continuous suture. This suture should begin as near the pubes as possible without constricting the cord. The wound in the skin is closed by interrupted sutures. No drainage is necessary.

Halsted's Operation.—In Halsted's operation for the radical cure of inguinal hernia an incision is made through the skin from a point 5 cm. above and external to the internal abdominal ring, as far as the

spine of the pubis. Then, the aponeurosis of the external oblique, the internal oblique, transversalis muscles, and transversalis fascia having been divided along a line extending from the external ring to a point 2 cm. above and external to the internal ring, the cord is isolated and reduced in size by excising all the veins except one or two. The sac of the hernia is next isolated and opened, and, its contents having been replaced in the abdomen, the peritoneal cavity is closed by a few fine silk mattress sutures, and the remainder of the sac cut off close to the sutures. The isolated cord is now raised on a hook (Fig. 127), whilst

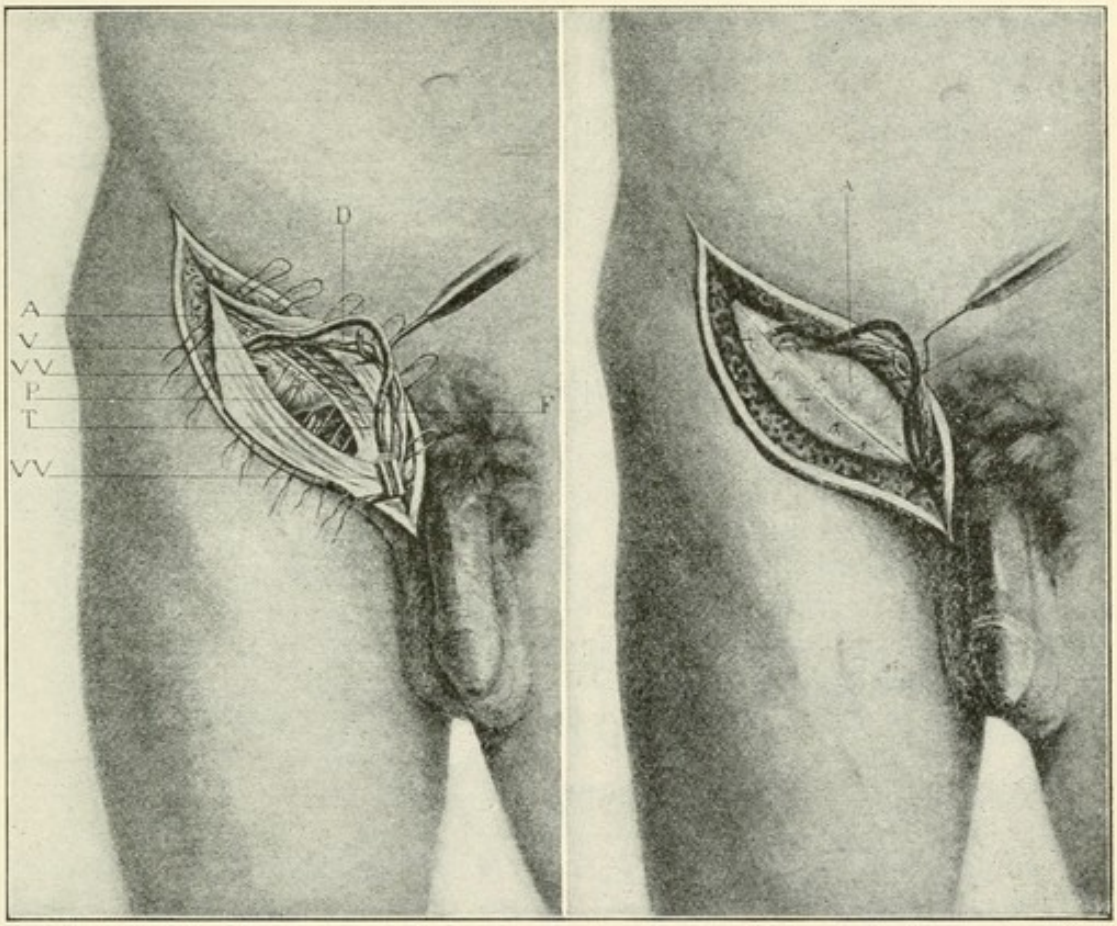


FIG. 127.—Inguinal canal laid open; sac cut away after suture of the peritoneum; elements of cord isolated and lifted up; deep mattress sutures introduced: *A*, aponeurosis of the external oblique muscle; *D*, vas deferens; *F*, fascia transversalis; *P*, peritoneum; *T*, conjoined tendon; *V*, vein; *VV*, stumps of excised veins (Halsted).

FIG. 128.—Deep sutures tied (Halsted).

the cut edges of the incision through the aponeurosis of the external oblique, internal oblique, and transversalis muscles, and transversalis fascia are again brought together by six or eight deep mattress sutures. The cord passes between the two outermost sutures, and care must be taken that the distance between them is such that the cord is embraced without danger to its circulation. The cord will now lie on the surface of the external oblique muscle under the skin (Fig. 128). The skin-wound is closed by silver-wire sutures.

Halsted's operation is sometimes spoken of as a modification of Bassini's, but this is not correct, as our famous American confrère not only arrived at his conclusions independently of the distinguished

Italian surgeon, but claims priority of publication. The two operations differ in several important particulars. In Bassini's method the cord is placed under the aponeurosis of the external oblique; in Halsted's operation the cord is placed outside the aponeurosis. Bassini's operation does not interfere with the veins of the cord; Halsted removes all superfluous veins, thus diminishing the size of the cord—a very important consideration. In Bassini's operation the obliquity of the inguinal canal is not restored; it is restored by Halsted's method.

The Radical Cure of Femoral Hernia.—The operation of Bassini of Padua is probably the best. He makes an incision parallel to Poupart's ligament and over the center of the tumor; he ligates the sac high up and removes it. He unites Poupart's ligament with the pectineal fascia by three silk sutures which he inserts with a curved needle. The first is placed near the spine of the pubes, the second half a centimeter externally, and the third one centimeter from the femoral vein. These sutures are not tied until four other sutures are passed through the edges of the falciform fascia, and then the pectoneal fascia, the lower suture entering just above the saphenous vein; the upper sutures draw Poupart's ligament backward to the pectoneal line and close the mouth of the canal. The other sutures bring together the anterior and posterior walls of the canal. The wound in the skin is then closed, and no drainage is employed.

Palliative Treatment of Hernia.—As the radical operation comes nearer and nearer to perfection fewer cases will require treatment of a palliative kind. There are many persons whose natural abhorrence of a cutting operation will lead them to go through life with the annoyance of a hernia and the inconvenience of a truss. Besides, there are certain cases already stated which are not amenable to the radical cure, as old men and children below six years of age, persons suffering from albuminuria, diabetes, etc., and those who are predisposed to hernia.

In young children a truss not only retains the hernia within the abdomen, but in many cases effects a permanent cure. Hence in them this treatment should always be adopted, with the radical cure held in reserve to be brought into requisition if the hernia remains after the child has reached the age of six years.

Persons who are the subjects of hernia should avoid violent exercise, sudden strains, and should prevent constipation of the bowels. For retaining a hernia in the abdominal cavity a truss is necessary, and a great variety of appliances in this direction have been invented. For slight or incomplete hernia, or in persons who are not obliged to engage in laborious occupations, an elastic truss is sufficient, but in others trusses having a steel spring and a pad composed of hard wood or rubber are essential. The wearing of a truss is attended with difficulty in the case of fat people, in a hernia which contains a portion of irreducible omentum, and in femoral hernia. In oblique inguinal hernia the pad is made to fit over the internal inguinal ring; in direct inguinal hernia it fits over the external ring; in femoral hernia over the femoral ring at the level of Gimbernat's ligament.

Before applying a truss it is necessary to reduce the hernia. This is done by placing the patient upon his back with the pelvis elevated. The sac is first emptied as described in the employment of taxis. The

direction of pressure will vary according to the form of hernia. In indirect inguinal hernia this will be upward and inward. For the measurement of a truss a few points must be considered: the size of the aperture, the circumference of the pelvis one inch below the crest of the ilium, the circumference of the body below the level of the aperture, the distance of the hernial opening from the anterior superior process, the direction in which pressure is to be applied, and whether the hernia is single or double.

Umbilical Hernia.—This variety of hernia is found under three conditions:

1. **Congenital.**—Both male and female infants are found at birth to be the subjects of umbilical hernia, but female children are in the majority. The hernia is due to imperfect closure of the abdominal wall, the visceral plates failing to meet in the middle line. The covering is often exceedingly thin, consisting only of the peritoneum and tissues of the cord, and allowing the contents of the sac to be plainly seen. These herniæ are often of immense size, and may even contain all the abdominal organs. The cecum is a frequent constituent.

The *treatment* consists in reducing the hernia as soon as possible after birth, and retaining it by the use of strong strips of adhesive plaster over which a broad bandage is applied. In small herniæ a small pad is useful under the strapping.

The radical operation in mild cases is seldom necessary, as with proper care spontaneous cure is the rule.

2. **Infantile umbilical hernia** is the result of stretching of the cicatrix shortly after birth. The tumor is easily reduced, and can be kept in position by a pad about the size of a dollar and retained by an easy-fitting belt. Tight bandaging and conical or button-shaped pads which fill the opening are to be condemned. A piece of adhesive plaster which is brought across the hernia in such a way as to fold the skin up into a roll at each side of the umbilicus is often satisfactory. The tendency of this form of rupture is to get well as the child grows.

3. **Umbilical hernia in adults** is most frequently met with in females who have borne numerous children. The covering is generally peritoneum and skin, and the size of the tumor may be enormous. It may at first escape observation, and one of its first indications may be severe neuralgic pains radiating from the umbilicus. Two features characterize these herniæ: they increase rapidly, and they readily form adhesions. In addition, the subjects are inclined to obesity and are liable to emphysema of the lungs; consequently the cough and difficulty of respiration react upon the hernia, causing its more rapid increase in size (Championnière).

Treatment.—Bandages here are of little value. The radical cure affords the best prospect of a satisfactory result. The operation is to be conducted on the general principles already laid down, consideration being given to differences in anatomical structure and physiological action. The incision may be straight or curved, the latter being chosen when it is desirable to lay open a larger space. One end of the incision must be over the hernial aperture. In view of the frequency of intestinal adhesions the sac must be cautiously opened and care taken to

avoid perforating the bowel. In dealing with the omentum the hernial opening should be freely enlarged and a free portion of the omentum found in the abdomen. From this point it must be traced down into the sac and freed from its adhesions. The omentum is drawn gently out, so that not only the part which was adherent to the sac, but a portion that lay above the hernia, is drawn down, spread out upon sterilized gauze, ligated off by chain ligatures, and removed (Championnière). The sac is next dealt with. It is freed from all adhesions, laid open, ligated by two, three, or more chain ligatures (as seen in Fig. 123), and cut off. In closing the abdominal wound interrupted sutures of kangaroo tendon are placed in the muscular wall. A continuous catgut suture closes the cellular tissue and fascia, and lastly a row of superficial and deep sutures, alternating, are employed to close the opening in the skin. Drainage is useful when the abdominal wall is very much thickened with fat, otherwise it is not indicated.

Ventral Hernia.—A hernia in the linea alba, above or below, but not at, the umbilicus, in the linea semilunaris, or in any other part of the abdominal wall which is not a common position of rupture, is spoken of as ventral hernia. Many of the cases occur after laparotomies (Fig. 129). When of considerable size these herniæ are readily diagnosticated, and their treatment is practically that of umbilical hernia. The tumor may be very small and escape observation, and yet produce very urgent symptoms. This is especially the case when the hernia contains omentum, which, forming adhesions, is retained in the sac. Sometimes the omentum forms a narrow band between the stomach and the hernia. In such cases the pain and gastric disturbances are such as to lead to a suspicion of cancer of the stomach. The band usually goes to the great curvature, and as a consequence intense suffering results from movements of the stomach or when the organ is distended with food or gas.

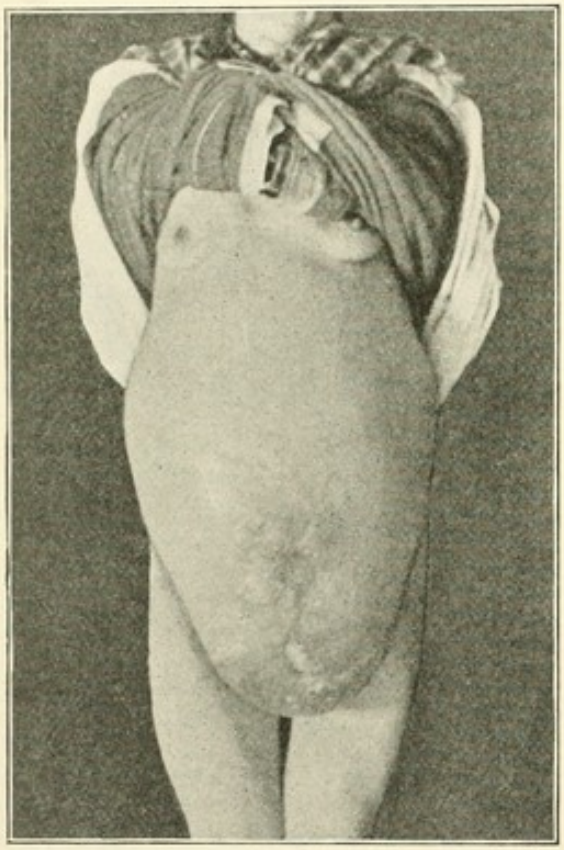


FIG. 129.—Large ventral hernia forming in the cicatrix made for removal of an ovarian cyst. The patient bore two children, after which a cyst formed in the remaining ovary, burst through the cicatrix, and filled the hernia (from a photograph in the collection of Dr. W. J. Mayo, Rochester, Minn.).

The *diagnosis* must rest upon the presence of a tumor, however small, which may or may not be attended with an impulse on coughing. Sometimes the presence of a band may be determined by a drawing in of the abdominal wall at that point. Violent attacks of gastric pain and vomiting are also common consequences.

The *treatment* consists in the radical operation for the hernia and division of the omental band.

Lumbar Hernia.—A weak point in females who have rapidly lost flesh is the triangle of Petit, formed by the lower margin of the external oblique, the latissimus dorsi, and the crest of the ilium. Its floor is formed by the internal oblique. The course of a hernia in this locality is through the lumbar fascia, near the outer edge of the quadratus lumborum muscle. Its interest from a diagnostic point of view lies in the danger of mistaking the hernia for tumor or abscess—an error which has more than once led to incision and disappointment. The history of the case, the occurrence of a reducible tumor in an emaciated female or its connection with a traumatism, the presence of an impulse on coughing, and the absence of symptoms of suppuration should make the diagnosis reasonably clear. The only *treatment* required, as a rule, is a comfortably fitting elastic abdominal belt.

Other rare forms of hernia are the following:

Obturator hernia, a very rare form. The subjects are generally above the age of fifty. It is seldom diagnosed during life unless it becomes strangulated. The symptoms resemble femoral hernia. The tumor is situated to the inner side of the femoral vessels in both forms. The most characteristic symptoms are pain along the course of the obturator nerve—that is to say, along the inner side of the thigh as far as the knee—and the presence of a hard and tender swelling on the inner side of the thigh, which in certain cases can be felt on vaginal examination.

Treatment.—When there is strangulation, as is generally the case before the hernia is recognized, attempts at reduction by taxis should be made, which, if unsuccessful, should be followed by herniotomy. The constriction is at the obturator foramen.

Perineal hernia is very rare, and is generally due to weakness of the levator ani muscle. The tumor is formed in front of the rectum, and in the case of females it may appear in the vagina or labium. The tumor is always reducible, which distinguishes it from cysts or other growths.

Diaphragmatic hernia is generally the result of a severe traumatism, as the passing of a cart-wheel over the abdomen or the wound of a spear or saber. The symptoms are those of internal strangulation, but in the majority of cases death occurs from the severity of the traumatism and a diagnosis can seldom be made. If under circumstances which would lead us to suspect rupture of the diaphragm we find tympanitic resonance in the precordial region, with interference with the heart's action, or over the pleura, with impaired respiration, a diagnosis of diaphragmatic hernia will probably prove to be correct.

VI. APPENDICITIS.

Arising from the lower and posterior part of the cecum is the appendix vermiformis, a rudimentary form of the elongated cecum of herbivorous animals. Its length varies from three to six inches, its diameter is about half an inch. Dr. C. J. Ringnell in 200 autopsies found the length to vary from two and a half to nine and three-quarter inches.

By a mesentery of its own it is bound loosely to the back of the cecum, in some cases to both cecum and ileum; hence it is easily stretched or twisted when these portions of the intestines are distended (White). It is supplied by a single artery whose caliber is so small that stretching or twisting readily produces occlusion.

The position of the appendix is not constant.

1. It is generally directed upward toward the termination of the duodenum, and lies to the inner side of the cecum.

2. It is directed downward to the inner side of the cecum and into the right iliac fossa.

3. It lies to the outside of the cecum, directed upward toward the right kidney.

Much more rarely it is directed downward below the cecum, or it enters the sac of a hernia, or runs directly inward to form an attachment at the linea alba, as I once saw in the case of a young man who had suffered many recurrences of appendicitis.

Inflammation in the appendix is a disease of common occurrence, and of late years has received a great deal of attention. The terms typhlitis, perityphlitis, paratyphlitis, and appendicular abscess have almost become obsolete, since a constantly accumulating mass of evidence goes to show that nearly all of the cases formerly classed under these names are due to inflammation of the appendix with or without suppuration. To say that there is no such thing as typhlitis without appendicitis is to disregard clinical facts. Lanphear operated on a case of supposed appendicitis, and found ulcer of the cecum with perforation and perityphlitic abscess. The appendix was normal.[1] It would probably be correct to say that 98 per cent. of cases of perityphlitis are due to inflammation of the appendix.

The appendix is composed of a serous peritoneal covering, a muscular coat, and a mucous lining with a large proportion of lymphoid tissue. To the presence of this lymphoid tissue is perhaps due the clinical fact that so many cases of appendicitis occur in childhood and youth.

The starting-point of appendicitis is from within, commencing as a simple catarrh, and producing no local changes beyond a thickening of the mucous membrane, and perhaps an accumulation of mucus. From this point the disease may recede, pain, tenderness, and all other symptoms disappearing. These are the mild cases which are often pointed to as being successfully treated without operation. When the inflammation results in suppuration, abscess, and peritonitis, we have the disease presenting a variety of features, which will be spoken of presently (see Fig. 130).

Causes.—1. The presence of a hard foreign body in the appendix, such as a fecal concretion, the small seeds of fruit, fragments of bone, etc. Although the presence of a foreign body is spoken of as the most frequent cause, it is not a common thing to find such a body in cases operated upon. Probably this cause has been over-estimated.

2. Catarrhal inflammation of the cecum and ascending colon. In this class of cases the inflammation spreads by continuity of tissue. As the mucous membrane becomes swollen the orifice becomes more

[1] *Ann. of Univ. Med. Sciences*, 1895, C. 35.

FIG. 130.—ILLUSTRATING SOME OF THE CHANGES OBSERVED IN ACUTE APPENDICITIS (FOWLER).[1]

FIG. 1.—Appendix removed twenty-nine hours after commencement of the attack; gangrenous and perforated at the distal extremity. The dark body in the cavity at the tip is a fresh blood-clot resulting from the involvement of one of the branches of the appendicular artery in the gangrenous and perforating process. The appendix in this case was unusually free from surrounding inflammatory conditions, adhesions, etc. The perforation had taken place into the unprotected peritoneal cavity, and a violent septic general peritonitis was under way. No foreign body, or even inspissated fecal matter, was present.

FIG. 2.—Appendix removed twelve hours after the commencement of the attack. The appendicular artery in this case extended to the distal extremity of the organ before giving off any branches. It was then reflected in the submucosa, and gave off its branches in a direction toward the base of the organ. The vessel is seen to be occluded by a thrombostasis a short distance from its tip.

FIG. 3.—External surface of an appendix imbedded in inflammatory material and perforated about half an inch from its distal extremity.

FIG. 4.—The same appendix incised longitudinally, the line of incision crossing the point of perforation. The wall of the appendix is shown, thickened at its upper or proximal extremity and about five-eighths of an inch from the latter. A stenosis exists, the cavity beyond which had undergone some dilatation. The mucous membrane is seen to be gangrenous (green) and necrotic (yellowish-white) in spots. The larger perforation is shown in the broken line of the edge of the incised mucous membrane; another and smaller perforation is present upon the opposite side and nearer the tip. This was a chronic relapsing case, operated upon in an acute relapse.

[1] These colored sketches were made by the artist from the fresh specimens immediately after removal.

Fig I.

Fig II.

Fig III.

Fig IV.

and more obstructed, causing retention of the natural secretion of the appendix.

3. As this secretion always contains putrefactive and pathogenic organisms, the simple catarrhal inflammation readily becomes an infective one (Barling).

Once suppuration begins, ulceration is a natural consequence. Ulceration soon leads to perforation, and perforation to peritonitis. Fortunately, against the effects of perforation Nature sets up her safeguards. As the infective inflammation reaches the outer coverings of the appendix, adhesions begin to form, and the accumulating pus is enclosed within strong walls, which prevent the bursting of an abscess into the peritoneal cavity. Sometimes the adhesions occur so promptly that the perforation is sealed, and a return to health takes place without the formation of an abscess. In cases still more rare the inflammation spreads so rapidly that no barriers can be raised, and the consequence is a general peritonitis. Instead of ulceration of the appendix, the inflammatory action may result in gangrene. Pressure of the exudates on the vessels from without and thrombosis from within can speedily cut off the blood-supply to the whole or a part of this functionless structure, which, at best, is endowed only with low vitality, and with its blood-supply cut off quickly becomes gangrenous. As predisposing causes typhoid fever and rheumatism have been mentioned. Age has a decided influence, and about 50 per cent. of all cases occur between the ages of ten and twenty-five. It is more common in males than females.

Symptoms.—The leading symptoms around which many others group themselves are the following:

1. Severe localized abdominal pain, generally felt in the right iliac fossa, sometimes over the whole abdomen.

2. Tenderness over the position of the appendix midway between the umbilicus and the anterior superior spine of the ilium. We have seen that the length and position of the appendix are subject to variations. It is only natural, therefore, that corresponding varieties should be observed in the location of the symptoms. For instance, in 3 cases reported by Fowler pain was more marked on the left side of the abdomen, especially at the outer border of the left rectus. At the operation the appendix was found to the left of the rectus.[1] Too much reliance must not be placed upon the presence or absence of tenderness at McBurney's point, for there is no single point that can be definitely named as the position of the appendix, or, for that matter, of the cecum itself.

3. A rise of temperature to 101° or 102° F. and a rapid pulse. This temperature is reached in the first twenty-four hours and seldom goes beyond. A temperature of 103° is very rare.

4. Nausea and vomiting.

These four symptoms we expect to find in every case of appendicitis. Severe pain is present because there is inflammation in a structure whose walls are dense and resisting. By reflex action this pain is distributed widely over the abdomen through the sympathetic plexuses. This widespread pain continues for from one to twelve hours, after which it becomes localized in the right iliac fossa.

[1] *Ann. of Univ. Med. Sci.*, c. 37, 1895.

Now comes tenderness on pressure over the appendix. There are the rapid pulse and high temperature peculiar to hectic fever, for suppuration is going on. Vomiting is present in most cases. It may occur only once, and in any case it consists of the food last taken and of bile. Persistent vomiting or persistent hiccough is a very unfavorable sign.

The patient generally lies in the dorsal position, with the lower limbs extended, or the right may be drawn up to relieve tension in the iliac fossa. Where there is general peritonitis both limbs are drawn up and the abdominal walls are rigid.

5. Constipation is the rule, although diarrhea has been noted in a few instances.

6. In about two-thirds of the cases a tumor is found in the right iliac fossa. This does not necessarily prove the existence of an abscess. In some cases it is the thickened appendix, the omentum, and intestine matted together, or it may be the infiltration of the abdominal muscles and fascia. Care must be taken not to mistake rigidity of the muscles for a tumor. Anesthesia is a valuable aid in the examination, especially in children, in nervous subjects, and in those whose abdominal walls are thick.

It is customary to mention palpation by the rectum as a means of detecting the presence of a tumor. I have never been able to derive any information from this method, and have long ceased to employ it. The cases in which such an examination proves of any service are probably those in which the appendix takes a direction downward into the pelvis.

Neither can we expect much help from palpation of the appendix itself, for, while it may be possible to detect it in the healthy subject, the extreme tenderness and swelling which attend appendicitis will render such a measure impossible during an acute attack. In relapsing cases it has proved valuable when employed during the interval between attacks; and Ewald reports several cases in which palpitation enabled him to settle the diagnosis. The pressure must be deep enough to recognize the posterior abdominal wall and the brim of the pelvis against which the appendix is felt. The beginning of the appendix is found a little outside of a line drawn from the umbilicus to the middle of Poupart's ligament.

7. Movements of the bladder may produce pain, as in the act of micturition.

Differential Diagnosis.—Of the diseases from which appendicitis must be distinguished I shall mention:

1. Pelvic inflammation in females. When a mistake is made, it is because the surgeon has neglected the imperative duty of making a vaginal examination. A diagnosis of appendicitis in a female should never be entertained until pelvic inflammation, especially of the ovaries and tubes, has been excluded. This, as a rule, is very simple: A fixed uterus, hardness and infiltration of the pelvic floor, or enlargement of tube or ovary leaves no room for doubt.

2. Intestinal obstruction. Appendicitis shows a rise of temperature from the beginning; intestinal obstruction of any kind has a normal temperature until peritonitis has set in.

3. Typhlitis from accumulation of feces occurs in patients well advanced in years; there is a doughy, sausage-shaped tumor which retains an indentation made by the finger. The local tenderness is not so marked as in appendicitis.

4. Hepatic colic. The pain in hepatic colic is most intense at the position of the gall-bladder, and radiates to the shoulder and the angle of the scapula. In appendicitis the tenderness may at the outset be widely diffused, but in a day or two it becomes localized in the right iliac fossa. A history of repeated attacks, one or more of which have been attended with jaundice, is strong evidence of hepatic colic. Vomiting is more persistent in the latter disease.

5. Renal calculus on the right side. Only when the examination of the urine is negative and the pain is not localized, or when the pain in appendicitis radiates toward the os pubis, scrotum, and testicles, with tenesmus and dysuria, should there be room for doubt. In such cases a little time will make the symptoms clearer, for the pain will become localized in the right iliac fossa, proving appendicitis, or tenderness will be manifested over the kidney posteriorly, pointing to the kidney as the seat of the affection. Fowler gives the following diagnostic points in a tabular form:

Appendicitis.	Hepatic Colic.	Renal Colic.
Pain around the umbilicus and in the epigastric region, not radiating from these points; fixed painful point in the iliac fossa.	Pain in the epigastric region, radiating to shoulder and angle of scapula, arising from the gall-bladder as the fixed point.	Pain radiating to inguinal region and testicle, occasionally to the rectum when at stool; also tenesmus.
Greatest tenderness in the right iliac fossa, particularly at McBurney's point.	Great tenderness below the arch of the ribs; slight tenderness over gall-bladder.	Greatest tenderness behind, over the pelvis of the kidney; in front the maximum point of tenderness is over Poupart's ligament.
Vomiting may be present, but is usually not continuous.	Vomiting frequent, and not to be suppressed.	Vomiting is not a frequent nor prominent symptom.
The bladder and testicles are very rarely symptomatically tender or painful.	Bladder and testicles give no symptoms.	Bladder irritable; dysuria and tenesmus of the bladder; occasionally hematuria; testicle retracted.

All cases of appendicitis may be divided into four classes:

First class, mild appendicitis, in which neither abscess nor perforation takes place. To this class probably belongs a majority of all cases. They are not regarded as surgical cases, and form the basis of the belief that appendicitis gets well without operation. The disease runs a mild course; the pain, local tenderness, vomiting, nausea, and fever are not severe. The tumor, if present, is small, and all the symptoms abate in three or four days.

Second class, appendicitis attended with suppuration and the formation of an abscess. This class belongs to the surgeon, and affords him support for the argument that the proper treatment for appendicitis is an operation. The pain is severe, the local tenderness is marked, there is fulness in the right lower quadrant of the abdomen, and sooner or later a tumor appears at the point of tenderness.

There are special indications that suppuration is taking place. The temperature goes up to 101° or 102° or 103° F. at night, and has a

morning remission. In some cases there is a pronounced chill. If, after continuing several days, the temperature should go still higher, it is an indication that the septic infection is spreading to new localities. The pulse gives still more valuable information. If at the end of three or four days it continues to rise, reaching 110 or 120, the presumption of abscess is very strong. The tumor becomes more prominent, and, if allowed to take its course, redness of the skin, bogginess, and fluctuation may appear, leaving no doubt that an abscess has formed.

Third class, perforating appendicitis presents some of the most perplexing problems which can confront the surgeon. Its symptoms are often obscure, and, although operation is acknowledged to be the only treatment of any avail, the decision to operate will often tax the judgment of the most experienced. Much depends upon the position of the appendix. If it happens to lie to the inner side of the cecum, perforation is speedily followed by symptoms that might be called explosive in their character—sudden, unremitting pain, tenderness, and tympanitic distention over the whole abdomen; intense and persistent vomiting with a pulse running up to 110 or 120, and a temperature that suddenly bounds to 102° or 103°. When a case belonging to another class assumes this character, we may strongly suspect that perforation has taken place.

When the appendix, by good fortune, lies to the outside of or behind the cecum or in a peritoneal pouch, adhesive inflammation plays an important part. As soon as a drop or two of the contents of the appendix escape through a perforation the vicious fluid is fenced in by adhesions, and the danger of general infection is greatly lessened.

Those who advocate operative treatment for every case of appendicitis find in this class their strongest argument. No matter how mild a case may be at its outset, there always hangs over it three terrible risks—*perforation*, *rupture*, and *relapse*. In the hands of a good operator an incision which would reach the appendix is practically free from danger. On the other hand, perforation or rupture is almost certainly followed by death. Would it not be wisdom to anticipate these risks and choose the course which affords the best prospect of immediate cure and the only safeguard against recurrence?

The operation in perforating appendicitis is practically the same as in the suppurative form, except that when there is evidence of general infection of the peritoneum an incision in the middle line will give a better outlet. The fluid is often a milk-like serum rather than pus, and here irrigation is not open to the same objection as in other classes.

Fourth class, relapsing appendicitis. The appendix, even after a mild attack, as well as the surrounding tissues, is more or less changed. Adhesions take place, the tube may become narrow at one or more places, or it may become kinked or twisted upon itself; all of which may lead to retention of its secretions and render it liable to future outbreaks of inflammation. The question of the most opportune time to operate in relapsing cases is a difficult one. Generally the patient settles the point by appealing to us only during an attack. This is probably the best time, but operations during intervals are, on the whole, satisfactory.

Bull has collected 480 operations of this kind with 8 deaths, or a mortality of 1.77 per cent. He estimates that 5 or 6 per cent. would be more nearly correct.[1]

Appendicitis obliterans has been described by Prof. Senn as forming a class of cases in which the lumen of the appendix becomes gradually obliterated by relapsing disease. This classification seems unnecessary. In a functionless and rudimentary structure like the appendix obliteration would, *a priori*, be a natural process. This assumption is borne out by the result of 400 autopsies made by Ribbert (death being due to other causes than appendicitis) in which partial or complete obliteration was found in 25 per cent.

Prognosis.—In a total of 364 cases Wyeth calculates the mortality of appendicitis at 18 per cent. The mortality from operations made in the interval between attacks is probably 5 or 6 per cent. (Bull).

Treatment.—The treatment of the first class of cases is debatable ground. Granted that the majority of all cases are of this kind, and that they get well under medical care in three or four days, there is still the question of recurrence. An appendix which has been the subject of one attack is a perpetual menace.

According to the statistics of Sahli, Hollander, Fürbringer, Leyden, Renvers, Guttman, and Rotter, 90 to 91 per cent. of all cases of perityphlitis get well without an operation. On the other hand, many surgeons resort to operation as soon as they make a diagnosis, no matter how early in the disease or how mild the symptoms. Between these two extremes we must endeavor to find a golden mean.

The operation in the hands of a skilful operator has a low mortality; but another consequence of surgical interference must be taken into account, and that is the risk of hernia. On the other hand, every case treated without operation has to run the risk of possible rupture during the attack and of relapse after the patient recovers.

The third day, at the latest, should decide the question. If by that time the symptoms are abating, do not operate, but watch the case closely. If on the third day the case continues to grow worse or shows no signs of improvement, operate. In spite of every care there are cases in which grave doubts must exist as to the propriety of operation; but, as Helfrich tersely expresses it, "It is always better to say, 'The patient might have recovered without operation,' than to say, 'The patient might have been saved by operation.'"

There are certain indications for operation which the most conservative physicians will admit: *First.* When there is perforation followed by peritonitis. Many of these cases are the penalty of ultra-conservatism. *Second.* When there is evidence of a collection of pus. *Third.* When there are the current attacks increasing in frequency and severity.

In the early stages of all classes of cases the first essential is perfect rest in bed. The horizontal position should be persistently maintained, the patient not being allowed to get up for micturition, defecation, or for any other cause. The diet should be easily digested fluids. The practice of giving a purgative should be condemned. Fecal impaction in the cecum is not so common as was formerly supposed; hence

[1] *Ann. of Univ. Med. Sciences*, 1895.

a purgative to remove impaction is unnecessary. The better course is to relieve the bowel by enemata without causing much distention. Warm fomentations locally afford great relief. When, in spite of these measures, pain is very severe, the indication is not to give opium, but to operate.

In the second class of cases (those attended with suppuration and abscess) the proper course is undoubtedly to operate. Wyeth states that in his entire experience he has yet to see a death which could not be properly ascribed to delay in timely and skilful surgical interference. The diagnosis of pus may be confidently made when the tumor begins to increase, the temperature showing morning remissions and the local tenderness persistent. Fluctuation and edema should not be waited for.

The operation for appendicitis is performed as follows: An incision is made in an oblique direction through the skin, crossing a line drawn from the antero-iliac spine to the umbilicus, nearly at a right angle and one inch from the iliac spine (McBurney). This is in the direction of the fibers of the external oblique, which can be separated without cutting. The wound is now held open by retractors, and divisions of the internal oblique and transversalis effected in a similar manner along the direction of their fibers. The advantage of this mode of dividing the abdominal wall is that the action of the muscles tends to close rather than retract the edges of the wound; hence the chances of subsequent hernia are greatly lessened. It is only suitable, however, in simple cases without suppuration.

The position of the incision in suppurative cases must depend upon circumstances. It should be oblique and over the most prominent part of the tumor. Two inches in length is sufficient in most cases, though others will require three or four inches. Pus wells up as soon as the abscess is reached. The patient should be turned on to his right side, and the abscess-cavity mopped out with gauze. Irrigation should not be employed, lest septic matter be carried into the general peritoneal cavity. Having evacuated the pus, the finger is passed into the wound, and search made for the appendix and for foreign bodies. The anatomical guide to the appendix is the anterior longitudinal band of muscle in the cecum which leads to the base of the appendix. When the appendix is found, it should be ligated near the cecum and removed. If it does not appear readily, no lengthened search should be made for it, as drainage of the abscess-cavity will be sufficient to dispose of all necrotic tissue, including the diseased appendix. The cavity should be drained from the bottom, either by strips of iodoform gauze or by a good-sized drainage-tube, around which gauze should be packed. The wound can be materially reduced in size by inserting a few silkworm-gut sutures, leaving sufficient room in the most convenient place for drainage.

In the after-treatment of cases operated for appendicitis I would draw attention to two points:

1. *Fecal Fistula.*—This is a complication which is likely to arise when the operation has been delayed till a large abscess has formed or when the drainage is not thorough. To the young or inexperienced operator the escape of intestinal gases from the wound or the appearance of fecal matter therein is perfectly appalling. Experience, however,

has proved that such fistulæ close of their own accord, and all that is needed is a little patience on the part of the surgeon and the afflicted one.

2. *Deficient Drainage.*—It may happen that after the operation the symptoms improve, and everything appears to point to a favorable issue, but at the end of a day or two the temperature rises, the pulse increases in frequency, pain returns, and the abdomen becomes tympanitic. These symptoms indicate either the retention of pus or the formation of an abscess in a new location. The proper course to follow under such circumstances is to pass the finger into the opening and break up any adhesions that may have formed since the operation. You will generally find one or more pus-cavities. In one case of appendicitis I opened up the wound three times in this manner, and saved the patient's life. Sometimes nature comes to the patient's relief by allowing the concealed abscess-cavity to discharge into the bowel, and thence *per viam naturalem.*

VII. DISEASES AND INJURIES OF THE PERITONEUM.

The peritoneum is a serous membrane almost equal to the skin in its extent. While the skin is an organ which throws off waste material, the peritoneum absorbs the fluids with which it comes in contact, readily disposing of large quantities, and showing no discrimination between poisonous and benign substances. Hence septic or poisonous fluids are readily taken up and carried to the general circulation. The free movements of the membrane have also an important clinical bearing. It slides over the abdominal organs, and its own surfaces glide smoothly over one another, so that an infection which at first is purely local is likely to become general in a short time. Another important characteristic of the peritoneum is the readiness with which it forms adhesions. Thanks to this power, septic foci are walled off and the success of many surgical operations is assured.

So closely is the peritoneum associated with many of the abdominal organs that disease of these viscera is almost certain to extend to the serous membrane.

Examination of the peritoneum is very satisfactorily conducted by inspection, palpation, and percussion.. In a systematic examination the following questions should be settled:

1. Is the peritoneum distended?

Two conditions can produce distention of the peritoneum—viz. escape of gas from the stomach or intestine and a collection of fluid—ascites. Escape of gas into the peritoneal cavity, technically named meteorismus peritonei, is always to be regarded as a very serious matter, and always leads to peritonitis. The abdomen is distended and tympanitic, the pitch varying according to the degree of tension. This, however, can be said of tympanites from gas within the intestine. How, then, are we to decide the question as to whether the gas is contained in the intestine or free in the peritoneal cavity? *By percussion over the liver and spleen.* If the gas be free in the peritoneal cavity, it will come in front of these solid organs, and there will be no liver or splenic dulness. If it is contained within the bowels, liver and splenic dulness will be present. The liver may be displaced upward by the

distended intestines, but it will nevertheless be recognized by dulness.

When free fluid in the cavity is the cause of distention it gravitates to the most dependent parts. At the beginning it is confined to the pelvis (while the patient is standing), and gradually rises until it gives a dull area and produces bulging in the lower part of the abdomen. When the patient lies upon his back the fluid, gravitating to the most dependent parts, causes the sides to bulge outward, while the intestines and stomach float like air-balloons upon the water, and give a tympanitic note in the anterior portion of the abdomen. Ask the patient to lie upon one side and then on the other, and in each case the fluid will settle to the lowest part, and give a dull percussion-note, while the intestines as promptly float and give a hollow sound.

Fluctuation or undulation is another important feature of ascites. Place one hand flat upon the abdomen, and with the fingers of the other hand gently tap the abdominal wall at a distant point, and the waves of fluid can be felt and even seen. In people whose abdominal walls and omentum are loaded with fat there is a tremulous movement which may be mistaken for true fluctuation. When, owing to a large amount of fluid, there is much distention, it may be impossible to elicit fluctuation.

If fluid be present, it is either free or encysted. When free the ease with which it gravitates to the dependent parts is very characteristic. When encysted there is a feeling as if a ball were grasped within the hand, or the tumor formed by the encysted fluid may have an elongated form; tension is usually greater, and consequently fluctuation is indistinct. Cystic ovaries, the pregnant uterus, and a distended bladder all rise in front of the abdomen, pushing the intestines back, and when the patient lies on the back the front yields a dull sound (Fagge).

2. Is the peritoneum inflamed? Peritonitis, or inflammation of the peritoneum, is generally described as primary and secondary, but the opinion is gaining ground that most if not all cases are of secondary origin. That is to say, there are no cases of idiopathic peritonitis, there being an exciting cause in every instance, the recognition of which is essential to a rational line of treatment. The disease is also divided into acute and chronic varieties.

Surgically, we are deeply interested in peritonitis on account of its frequency after many operations, such as celiotomy, lithotomy, lithotrity, and litholapaxy. We also meet with it as an extension of disease or injury from the abdominal viscera. A perforation of the stomach or intestines with escape of contents is with certainty followed by general peritonitis. Septic infection can travel up the uterine canal and by way of the Fallopian tubes gain access to the peritoneum. A perforating appendicitis is responsible for many cases of peritonitis.

Plastic Peritonitis.—A very interesting feature about the peritoneum is its power to protect itself and other structures by throwing out plastic material which acts as a barrier to advancing disease or infection. This should not be classed as an inflammation, but rather as a regenerative process. Should the peritoneum be wounded or bruised or irritated by chemical substances, without the presence of septic infection, the result is generally purely local. The action of the peri-

toneum is at once changed, so that, instead of absorbing, it secretes, and its secretion is fibrinous material, which becomes organized and forms adhesions between portions of the peritoneum itself or serves to bind the membrane to neighboring organs. These adhesions may afterward be absorbed or they may remain as permanent structures.

Examples of non-septic peritonitis are met with in aseptic wounds or other traumæ of the peritoneum, the application of chemical irritants, the twisting of the pedicle of a tumor, the escape of aseptic contents of an ovarian tumor, and the strangulation of a hernia.

This form of peritonitis being generally localized, the symptoms which manifest its presence are localized pain and tenderness, *rigidity of the abdominal wall at that point*, and the presence of more or less fever. The rise of temperature is due to resorption, the fermentative fever so commonly seen after operations, and in no way connected with suppuration. The symptoms appear in from six to thirty-six hours after the receipt of an injury. Collapse may at first mask the symptoms of peritonitis, but they become apparent when reaction sets in.

The *treatment* of non-septic peritonitis consists in perfect rest in the recumbent posture, the use of hot fomentations and, if necessary, opiates.

Septic Peritonitis.—Two things are necessary to produce septic peritonitis: first, the entrance of bacteria, and second, the peritoneum must have lost its absorptive power. The *healthy* peritoneum has a marvellous power of absorbing and disposing of bacteria, so that considerable numbers of germs can enter the peritoneal cavity without producing septic inflammation; but let the membrane once lose its power of absorption, and infection readily takes place.

The bacteria which are generally found in such infections are the pyogenic germs, but the common colon bacillus is so frequently present in cases of intestinal origin that some have thought it of diagnostic importance. Bacteria which produce peritonitis are sometimes spoken of as specific and non-specific. Of the specific germs, the tubercle bacillus occupies a most important position. The infection of syphilis seldom figures as a cause of peritonitis. Of the non-specific organisms, the pyogenic germs are most commonly found. Even they cannot produce peritonitis except when the amount of fluid which they contain is so great and the germs are produced so rapidly that the tissues cannot deal with them (Grawitz). This comes back to the second essential already stated, an inadequacy of the absorptive power of the peritoneum. The bacteria reach the peritoneal cavity, either directly through an opening in the abdominal wall, as in celiotomy, or from parts which are covered by peritoneum and communicate with the exterior of the body, as the intestinal canal and the genito-urinary tract; or they may find their way upward through the open mouths of the Fallopian tubes, as is demonstrated in that terrible disease, puerperal peritonitis; or it is possible that they may come from remote points of the body, carried through one or more of the innumerable blood- or lymph-channels.

The peritoneum may lose its power of absorption, and thus supply the second essential—(*a*) by being bruised or wounded, (*b*) by being the

seat of a pre-existing disease, or (*c*) by disease spreading from an organ to the peritoneum which covers that organ. Both of the essentials are well illustrated in perforation of the intestine; numberless bacteria are admitted to the peritoneal cavity, and the rupture which lacerates the peritoneum deprives it of its absorptive power.

Symptoms.—Pain is the most prominent of all the evidences of peritonitis. In cases due to perforation of the stomach or intestine the patient may declare that the pain set in with a tearing sensation. It is nearly always sudden, and in most cases intense, cutting, or griping. The slightest motion aggravates it, and the unhappy sufferer guards against even such innocent movements as coughing or breathing, while vomiting is perfect torture. To guard against the slight motion of the abdominal muscles he draws his limbs up in bed, flexing the thighs upon the abdomen. So tender is he to pressure that the weight of his bed-clothes is unbearable, and the idea of examining his belly by manipulation fills his soul with horror. The fixation of his abdominal muscles causes him to resort entirely to thoracic respiration, and the chest rises and falls while the abdomen is perfectly still. The diaphragm cannot descend without producing pain; consequently the breathing is rapid and shallow, reaching as high as forty, fifty, or even sixty, instead of eighteen or twenty, in the minute. It is scarcely necessary to press upon the abdominal wall to look for tenderness. If you need to do so, lay the hand gently upon the abdomen and watch the expression of the patient's face, which will indicate pain before he can express his sensations in words. Sooner or later the abdomen begins to swell and becomes tympanitic; hiccough is not uncommon; quantities of dark-colored liquid are raised from the stomach without effort or, it may be, expelled by distressing vomiting. Pinched and anxious from the first, the face assumes a ghastly appearance; the eyes become sunken; the pulse becomes more and more feeble, and may be imperceptible at the wrist for twenty-four hours before the end. The condition of collapse supervenes and death closes the scene, the mind in many cases remaining clear until the last.

When the body is examined after death little change is seen in the appearance of the peritoneum, and a small amount of serous fluid is all that is found in the cavity. But this fluid is intensely poisonous. Shun it as you would the venom of a rattlesnake. Such is the form of peritonitis seen in that awful disorder puerperal fever, and also after some abdominal operations.

When fully developed, septic peritonitis is almost absolutely certain to prove fatal, and the most we can do is to palliate the patient's sufferings. In the universal rush to the operating-table these cases have not been made an exception, but, so far as my experience and observation have gone, abdominal section and unlimited flushings have proved of little avail. In the way of prevention, however, which is so much better than cure, there is everything to be hoped for. As accoucheurs form the habit of attending confinements with as strictly aseptic precautions as they would conduct a major operation, as nurses abandon filthy syringes and learn to be *surgically clean*, septic peritonitis will gradually but surely disappear.

After abdominal section it is not uncommon to find tympanites set-

ting in, which may possibly be the beginning of septic peritonitis. Experience has shown that the best treatment in such a case is the administration of a saline cathartic, such as a Seidlitz powder or a one-grain pill of calomel, every three hours till the bowels move. Such a course is often rewarded by finding at the next visit a perfectly flat abdomen and a happy patient.

Suppurative peritonitis is practically the same disease as septic peritonitis, the only difference being that in the suppurative form the process is less rapid, and pus has time to form either in localized abscesses, walled off by adhesions, or in one large collection in the general peritoneal cavity. Septic peritonitis is general, and results in death before suppuration has time to declare itself. Suppurative peritonitis is more likely to be localized, and is therefore more amenable to surgical treatment. Pain is very severe; there is usually a chill to usher in the disease; and the temperature rises to 102° or 104° F. In perforative cases gases in large quantities collect in the cavity, causing distention of the peritoneum, and are recognized by absence of liver and splenic dulness, as already mentioned. When pus collects in considerable quantity, its presence can be detected by dulness on percussion in the most dependent portions, just as in the case of ascites. Vomiting and constipation are the most characteristic symptoms, and so pronounced are they that we often have to decide the question as to whether the case is suppurative peritonitis or intestinal obstruction. To do so we must remember that in obstruction a tumor may be felt, the movements of the intestinal coils can be seen through the abdominal walls, the temperature is not high from the beginning, and as time goes on the vomiting becomes fecal in character. Temperature is not an infallible guide, for while the rule is that in peritonitis it is high and in obstruction not raised above normal (except there be complications), some of the worst cases of peritonitis are free from a rise of temperature throughout their course.

Treatment.—To guard against suppurative peritonitis the greatest care must be observed in the details of all abdominal operations. Asepsis must be observed most scrupulously, the peritoneal toilet must not be lost sight of, complete arrest of hemorrhage must be ensured, and the cavity dried with aseptic sponges. Should there be infection already established or a likelihood of a collection of serous or sanguineous fluid, a drainage-tube must be employed. At the slightest indication of peritonitis a saline cathartic should be given, the action of which is increased by the use of turpentine enemata. Opium in such cases is to be avoided.

Perforative peritonitis requires a somewhat different line of treatment. It would make matters worse were we to increase the peristaltic action; consequently, purgatives of every kind must be avoided and a judicious use of opium resorted to. If a diagnosis of perforation be made, the repair of the perforation by operative measures should be attempted. With this object in view an incision is made in the linea alba, unless the point of the disease can be located elsewhere. If the opening in the intestine cannot be readily found, recourse should be had to the hydrogen-gas test. The rent is to be closed by sutures, as already described under Rupture of the Bowel, the abdominal cavity

thoroughly flushed with Thiersch's solution, a drainage-tube inserted, and the wound closed and dressed.

Fibro-plastic peritonitis is a variety characterized by a tendency to numerous adhesions. The disease is probably identical with septic peritonitis, except that there is not a general intoxication of the system by ptomaïns, owing to a less violent character of the bacteria or a greater resisting power of the system. It commonly terminates in localized suppuration.

Tubercular Peritonitis.—Tuberculosis may attack the peritoneum simultaneously with other structures, such as the lungs, the bones, or the joints. These cases are not of surgical interest. It is also a fact that the peritoneum may be attacked primarily, and remain the only seat of the disease. In this form it is of the greatest interest to the surgeon, since it has been found amenable to treatment in a very satisfactory degree.

The disease is not limited to any particular period of life, but follows pretty much the same law as tuberculosis of the lungs, the majority of cases occurring between the ages of twenty and forty. In the diagnosis of tubercular peritonitis we must not expect to find the disease following a uniform course in every case. Osler makes the following classification :

1. Acute miliary tuberculosis, characterized by a sudden onset, a rapid development, and a serous or sero-sanguineous exudation.

2. Chronic, caseous, and ulcerating tuberculosis, characterized by larger tuberculous growths which tend to caseate and ulcerate, leading often to perforation between the intestinal coils, and by a purulent or sero-purulent exudation, often sacculated.

3. Chronic fibro-tuberculosis, which may be subacute from the outset, or it may be the termination of the miliary form. This variety is attended with slight exudation if any. The tubercles are hard and pigmented. Although this classification is based on a correct pathology, we have no means by which we can differentiate from a clinical standpoint.

The *diagnosis* of tubercular peritonitis is not always easy. Bearing in mind the manner in which tuberculosis acts elsewhere, we are prepared to find it following a slow and chronic course. There are cases, however, in which its development is rapid. We may reasonably look for the leading symptoms by which we detect ordinary peritonitis—viz. pain, tenderness, tympanites, fever, etc.—but these have not here the significance which attaches to them in the other varieties of peritonitis. They may be sudden in their onset, or they may come on so slowly that distention of the abdomen is the first symptom to attract attention. All the symptoms may be apparent at one time, and then subside. This is just like tuberculosis, for do we not find in pulmonary phthisis that a patient has his periods of improvement and decadence? Pain is usually slight, but in exceptional cases very severe, and tenderness to pressure is in direct proportion. The temperature is also variable. As a rule, there is little elevation, and generally we find it in proportion to the pain and tenderness. Enlargement of the abdomen may be due to ascites or to meteorism or both. Should peritoneal adhesions take place, collections of fluid may thus be encapsulated, giving the appear-



FIG. 131.—Periumbilical erythema in a case of tubercular peritonitis (F. P. Henry).

ance of cystic tumors. Even when the distention is due to meteorism, round elastic tumors can be felt, which do not change their position when the patient is moved to one side or the other. These tumors are formed in a variety of ways. Coils of intestine may become adherent and form a mass resembling a solid abdominal tumor; the omentum may become thickened and curled upon itself; mesenteric glands, especially in children, are liable to be the seat of tubercular enlargement and attain considerable size, and circumscribed collections of fluid walled in by strong adhesions constitute the last class of these deceptive tumors. The abdominal wall is frequently found to have more than a normal resistance, due to a thickening of the peritoneum. Vaginal or rectal examinations will also demonstrate a thickening of the membrane.

A sign of great importance in the diagnosis of tubercular peritonitis is an erythema which in some cases surrounds the umbilicus. This is regarded by Dr. Henry[1] as pathognomonic, and is shown in Fig. 131.

Many diseased conditions may be mistaken for tubercular peritonitis. In fact, a large proportion of the cases which have been operated upon have been incorrectly diagnosed. The errors have been fortunate ones, for by them surgeons have stumbled on a treatment which is very successful. In 1864, Spencer Wells, operating upon what he supposed to be an ovarian tumor, found on opening the abdomen that the fluid was free in the peritoneum, while the membrane itself was studded with miliary tuberculosis. The patient recovered, and was free from disease twenty-six years afterward.

Against tubercular peritonitis the following must be carefully differentiated:

1. Abdominal tumors. An ovarian cyst has many points in common. In it, however, there is generally a freedom from pain, tenderness, and fever until the tumor has attained to a larger growth. Bimanual examination will also prove of value in the majority of cases. Pyosalpinx or hydrosalpinx has its characteristic attacks of localized pain, a history of disordered menstruation, and the characteristic tumor felt on examination. Pyonephrosis and hydronephrosis have their renal manifestations. An enlarged gall-bladder is connected with the liver, and ascends and descends with respiration. Malignant tumors in the abdominal cavity are usually more rapid in their progress than tubercular peritonitis, and frequently are but extensions of the disease from other parts.

2. Ascites of non-tubercular origin. This may be excluded by taking into consideration the etiology of ascites. The condition of the liver, the existence of jaundice, and a careful examination of the urine will generally settle the point.

3. Typhoid fever. Acute tubercular peritonitis may closely simulate typhoid fever. The points which aid in differentiation are—the absence of typhoid spots, the less constant diarrhea, the absence of the typical remissions of temperature, and the non-limitation of the point of tenderness to the cecal region.

In spite of every precaution the case may puzzle the most expe-

[1] *International Clinics*, vol. iv. 5th series.

rienced, and the real state of matters be only found after opening the abdomen.

Treatment.—Why it should be so no one has yet been able clearly to explain, but experience has shown that celiotomy with drainage has not only given immediate relief in tubercular peritonitis, but in many cases has effected a permanent cure. This is more particularly the case when the ascites is circumscribed. The incision is made in the middle line midway between the umbilicus and pubis, except where localized collections of fluid demand special incisions. Care must be taken to avoid wounding the intestine, as there is a likelihood of its being adherent to the abdominal wall at the point operated on. The peritoneum should be carefully sought and divided, the bowel separated if adherent. Caseous matter should be scraped away with a sharp spoon and iodoform thoroughly rubbed into the raw surfaces. After allowing the fluid to escape and washing the cavity with Thiersch's solution or a very weak solution of iodin, a glass drainage-tube is inserted, around which is packed strips of iodoform gauze. Some operators dust iodoform over the whole peritoneal surface. The drainage-tube must not be removed as long as there is any fluid escaping, a process which may continue for weeks or even months.

Carcinoma of the peritoneum is rarely primary in its origin. It is quite common, however, for malignant disease to spread from one of the abdominal organs to the peritoneum covering that organ, and thence to various parts of the serous membrane. The peritoneum covering the stomach, the large intestine, and especially the cecum, are the most common seats of the disease. Less frequently it is found in the membrane covering ovaries, the kidneys, the liver and gall-bladder, the pancreas, and the suprarenal capsules. After its extension to the peritoneum cancer seems to show a preference for the omentum, and masses of malignant growth are sometimes found in it which weigh as much as ten or twelve pounds. The peritoneum in Douglas's pouch and that near the umbilicus are also common seats of the disease. The presence of carcinoma leads to inflammation of the peritoneum; consequently an exudation of plastic material or an effusion of fluid is commonly associated with peritoneal cancer. The liquid exudation is frequently hemorrhagic, and the ascites of a milky character due to the breaking down of cancerous tissue by fatty degeneration (Fitz).

Symptoms.—Since many of the cases of peritoneal cancer have been discovered only after death, it is evident that there are no very definite symptoms by which the disease can be recognized. The primary organic cancer, as a rule, overshadows the peritoneal complication, and by the time the peritoneum becomes involved the case is usually beyond hope. Generally speaking, the symptoms indicating cancer of the peritoneum are peritonitis and ascites. Pressure upon the intestine produces constipation, and possibly meteorism. A considerable collection of fluid causes dyspnea and disturbances of the circulation. There is generally fever, very similar in character to that observed in tubercular peritonitis. After the disease has far advanced the cancerous pallor and cachexia become apparent.

Two serious complications are likely to arise in the course of the disease. One is hemorrhage, due to erosion of vessels in the cancer-

ous mass; the other is perforation of the bowel, due to the cancerous process destroying the wall of an affected portion of the intestine. In the one case we would have a sudden onset of symptoms which point to hemorrhage, and in the other the sudden pain and peritonitis which follow perforation.

In view of the fact that the pelvic peritoneum is so frequently the seat of cancer a vaginal or rectal examination should never be neglected in any suspicious case.

Sarcoma of the Omentum.—When a malignant tumor has its primary seat in the omentum, it is always a sarcoma, as carcinoma does not occur here. When the tumor has reached a considerable size, it is readily recognized, for it lies just within the abdominal wall, and has a feeling which has been compared to the back of a turtle. This turtle-like tumor is freely movable, and remains free from adhesions until an advanced stage of the disease. Early recognition of the tumor is of great importance, for at this period it is free from complications, and if removed the prospects are favorable. The operation of removal consists in making a free abdominal incision, drawing down the omentum, and by multiple ligatures tying it off at a safe distance from the tumor.

Benign tumors of the peritoneum are found between the folds of the membrane; that is, in the mesentery and omentum. They are lipomata, fibromata, myxomata, hemangiomata, chylangiomata, and serous cysts. Rarely are benign tumors found to arise from the free surface of the peritoneum. The diagnosis of these is generally difficult and uncertain. Given a tumor lying deeply in the abdominal cavity, the closest scrutiny should be made to ascertain whether any organ or any part of the intestine has been involved. The kidney can be excluded by changes in the character or amount of the urine; the intestine, by the presence of diarrhea or obstruction; and the stomach, by evidence of constriction or vomiting. If in this manner all the organs can be excluded, it is reasonable to infer that the tumor is in the mesentery. The most common cause of error in the case of cysts is their resemblance to ovarian tumors. From these they must be differentiated by the train of symptoms which characterize cysts of the ovaries.

Treatment.—A patient was presented to the Paris Academy of Medicine from whom Terrillon removed a fatty tumor weighing fifty-seven pounds, and which lay between the folds of the mesentery. Sir Spencer Wells, Homans of Boston, Brookhouse of Nottingham, and others have reported cases of a similar nature.

Rupture of the peritoneum is a rare accident. The most common situation is in the peritoneum covering the uterus. The membrane over the stomach, intestine, the mesentery, and omentum has also been ruptured by blows or by over-distention. The dangers of such a lesion are two in number—viz. peritonitis and hemorrhage. Diagnosis must rest upon the symptoms of these as already described.

Wounds of the Peritoneum.—The peritoneum was long misunderstood. Until recent years a wound of this membrane was looked upon with horror, and the surgeon who fearlessly amputated limbs, removed tumors, and ligated arteries stood aghast when he reached the peritoneum, as if Dante had written upon that delicate parchment,

"Abandon hope, all ye who enter here." When no note was taken of septic germs, and the abdominal cavity was entered with unclean hands, germ-laden sponges, and unsterilized instruments, peritonitis and death followed as an almost universal rule.

Aseptic surgery has demonstrated the true position of the peritoneum. It is a membrane of great absorbing power. It can be incised with perfect safety, provided the wound is kept aseptic. It has a greater power to resist disease-germs than have most of the other tissues. A wound of the peritoneum heals readily, provided the surfaces be kept in apposition. Firm adhesions take place between the serous surfaces even in a few hours, and the healing process is complete in a week or ten days. In treating a wound of this membrane the cut edges should be brought together by sutures.

Serous surfaces readily unite to serous surfaces, and the discovery of this fact lies at the bottom of all the methods for closing intestinal wounds or making anastomoses. Union is made more certain if the serous surfaces are first scarified and then approximated. An opening in the peritoneum should always be closed in order to prevent adhesions of the membrane to internal organs and to guard against ventral hernia. A slit in the mesentery should be carefully closed, lest a loop of intestine slip through the opening and become strangulated.

VIII. INJURIES AND DISEASES OF THE LIVER.

Before considering the diseased or injured liver let us briefly review a few anatomical points in the normal condition of the organ.

The lower border of the fourth rib on the right side corresponds to the upper border of the liver. The highest point is at the junction of the fourth rib with its cartilage. On the left side the junction of the sixth rib with its cartilage corresponds with the upper portion of the left lobe. The lower border of the liver follows the lower limit of the ribs posteriorly and as far forward as the cartilage of the tenth rib. From this point it runs toward the junction of the fifth left rib with its cartilage. While these points indicate the normal position, percussion will not always verify them. The lung may overlap the liver from above, giving resonant sounds, and the distended intestines below may limit the dulness in that direction.

The lower border may be felt by the palpating fingers, and a notch in its sharp edges detected near the middle line. It corresponds with the attachment of the broad ligament, and from this point to the umbilicus runs the suspensory ligament composed of two layers of peritoneum. In this fold is contained the obliterated umbilical vein. Should the vein happen to be not totally obliterated, an incision in this region might result in serious hemorrhage.

An important feature in diagnosis about the liver is that the organ rises and falls to a certain extent with the movements of respiration, carrying the gall-bladder with it. This movement is useful in differentiating an enlarged gall-bladder from other tumors in the abdomen.

The liver-substance is vascular and bleeds freely when incised. It is also brittle and easily torn, but in either case the hemorrhage is a sluggish oozing which can be readily stopped by pressure or sutures.

Examination of the Liver.—On palpation the liver in thin persons may be felt below the border of the ribs and in the epigastrium. In passing the finger over the organ we note any enlargement by the extent to which it is pressed downward into the abdomen. The fingers can detect any nodules indicative of carcinoma or the bogginess suggestive of abscess or the hepatic fremitus which attends hydatids or perihepatitis. It is rarely that we can feel the gall-bladder, but when over-distended or enlarged by the pressure of calculi it can occasionally be felt without difficulty.

Percussion.—It must be remembered that when the patient lies down the liver rotates upon its transverse axis. This causes the anterior margin to slip up under the ribs, so that the area of dulness is not the same as when the patient is standing. The upper limit is always covered with lung, and cannot be accurately defined by percussion. In the normal liver absolute dulness along the upper border should occur as follows:

Posteriorly, the tenth rib.

In the axillary line, the eighth rib.

In the mammillary line, the lower border of the sixth rib.

In the parasternal, just above the sixth rib.

In the mid-sternal, the base of the ensiform cartilage.

Beginning posteriorly, it may help the memory to recall the number 1086.

The lower border cannot be found posteriorly, owing to the thickness of the lumbar muscles.

The other limits are as follows:

In the axillary line, between the tenth and eleventh ribs.

In the mammillary line, the free margin of the ribs.

In the mid-sternal, midway between the base of the ensiform cartilage and the umbilicus.

Rupture of the Liver.—The liver is apt to be ruptured by crushing forces, such as the passage over the body of heavy wagons. It may also be ruptured by the ends of broken ribs or by the abdomen being jumped upon. In some cases the organ has been completely broken through; in some it has been ruptured at its lower or upper border; in others a portion has been broken off and found lying loose in the abdomen.

The *symptoms* of rupture of the liver are summed up in two words —internal hemorrhage and shock. The immediate result of rupture is copious hemorrhage; this is recognized by extreme pallor and coldness of the skin; the pulse is small and feeble; the respiration short and sighing; the abdomen becomes swollen and tympanitic; possibly dulness at the most dependent parts will show where the blood is collecting. There is often vomiting, thirst, and syncope. When the patient survives the first twenty-four hours jaundice is likely to set in. When death does not take place directly from the shock and hemorrhage, peritonitis is sure to follow, with abscess of the liver or adjoining parts.

The *treatment* must be expectant.

Wounds of the Liver.—Wounds of the parenchyma made during the course of operations bleed freely, but packing with sponges

or gauze for a few minutes readily controls the flow, and a row of catgut sutures permanently closes the bleeding vessels. Accidental wounds are not common. The symptoms of penetrating wounds are hemorrhage and, in some cases, a discharge of bile. A pain in the right shoulder is indicative of an injury to the liver, and may accompany a wound of the viscus. If the upper surface be wounded, the pain is felt at the larynx and shoulder; if the under surface, the pain is felt at the ensiform cartilage. Vomiting, hiccough, dyspnea, and delirium are also symptoms. Common sense must be employed to determine the direction taken by the penetrating instrument. If it enters the lower intercostal spaces and goes through the thoracic wall, the liver must suffer; if it enter below the ribs and take a direction upward, the result is the same. If it enter the chest above the points already mentioned as forming the upper border of the liver, then the lung is the organ to suffer, and we must look for pulmonary symptoms.

Treatment.—If bile and blood escape from the external wound, the latter should not be closed, but be kept open and gently packed with iodoform gauze. If, however, it is evident that this is insufficient, the abdomen should be opened and the wound in the liver closed by sutures.

Abscess of the Liver.—Although it has been customary in text-books to describe this disease as if it were confined to tropical climates, I am convinced that it is much more frequently met with in the temperate zone than is generally supposed. It presents a great variety of phases, and no definite typical symptoms can be laid down for its diagnosis. In 1881, I operated on a child eight months old, and evacuated about six ounces of pus mixed with bile, after which a rapid recovery took place. In this case the symptoms were fever, with a bulging and fluctuation in the right mammillary line over the liver. In the case of a boy aged fifteen symptoms resembling typhoid fever, which disease was then prevalent, continued for three weeks, when a large quantity of pus was discharged into a bronchial tube and expelled by coughing. This was followed by rapid improvement for about two weeks, when a relapse occurred. After collecting again, the abscess found its way into the intestine, and a large quantity of pus was discharged per rectum. This did not end the matter. A recurrence of the same symptoms was followed by a third and last escape of pus. This time it was voided with the urine, the abscess having no doubt discharged into the ureter.

Causes.—Wounds and contusions may end in abscess of the liver, provided septic germs find an entrance to the tissues at the time of or subsequent to the traumatism. Besides this direct infection, pyogenic or other germs may find a portal of entrance by the bile- or blood-channels. In this manner the inflammatory and ulcerative processes which attend dysentery, appendicitis, hemorrhoids, and uterine phlebitis may be the precursors of hepatic abscess. A very important point for the surgeon to remember is that operations for hemorrhoids, fistula in ano, or prolapsus of the rectum have been followed by abscess of the liver. Embolism of the hepatic artery, gall-stones, parasites, and foreign bodies in the bile-ducts, such as pins, needles, or nails, may also be set down as causes.

Symptoms.—A small abscess may produce no special symptoms, and even a large collection of pus may take place, and be recognized for the first time in the post-mortem room or when evacuated by some other channel, as the bronchi or intestine.

A small abscess near the surface is attended with severe pain, high fever, and rapid pulse, while a deep-seated abscess, even if large, may produce only slight disturbance. The general effect of an hepatic abscess is to produce in the patient a progressive wasting of flesh and failure of strength, with loss of appetite, nausea, vomiting, and a feeling of weight at the epigastrium. If the upper surface of the liver is inflamed, the pleura and base of the lung may participate, causing cough and hectic fever and leading to an erroneous diagnosis of pulmonary phthisis. It would be natural to expect that jaundice would be a prominent symptom, but experience proves that it is rare, and in fact its presence argues against rather than for hepatic abscess. In forming an opinion we must weigh well the following symptoms:

(*a*) Temperature. Although the disease may exist with little or no fever, the rule is that there is a well-marked rise of temperature, often reaching 104° or 105° F. When this is attended with chills the suspicion of suppuration is strong. Sometimes the chill is followed by sweats and a sudden fall of temperature, and there is a danger of mistaking the disease for malaria. But this can be excluded by remembering that the chills do not come at regular periods, as they do in intermittent fever. Sometimes the temperature follows a steady course with a slight evening increase, as happens in typhoid fever. Then we must look for typhoid spots, enlarged spleen, and other symptoms of enteric fever.

(*b*) Local evidence of the presence of pus. Palpation will generally prove that the whole liver is enlarged. The lower border can be felt under the ribs, and pressure there produces pain. Carcinoma of the liver can generally be distinguished by feeling the hard nodules of that disease. In the advanced stages fluctuation can perhaps be felt and a swelling observed in the abdominal wall. We are not usually so fortunate as to have the case so clear. If, however, we have tenderness and enlargement of the liver, with some of the other symptoms already mentioned, we should proceed to use the exploring needle. Although exploratory puncture is not to be recommended in the examination of the abdomen generally, this condition must be considered an exception, for if the liver be enlarged and bulging against the abdominal wall, there is little danger of the escape of pus into the peritoneal cavity. The skin and needle should of course be well disinfected. It is better to use the exploring needle than wait for the abscess to burst into the bowel or bronchus. When it opens into the intestine, a copious liquid evacuation containing pus reveals the fact, while a free expectoration of chocolate-colored material announces that the abscess has ruptured into a bronchial tube. In rare cases the kidney or ureter is ulcerated into, and the pus evacuated by the urethra, or it may rupture into the pleural or peritoneal cavity, the pericardium, or externally through the abdominal wall. There is a peculiar muddy countenance which is indicative of hepatic abscess.

Diagnosis.—The disease most closely resembling hepatic abscess is

perihepatitis. This is an inflammation of the capsule of the liver, and may occur as a primary disease or be simply an extension of inflammation from the liver to its capsule. It is often the result of abscess of the liver. While perihepatitis causes pain, tenderness, and fever, it is a disease of short duration (several days), while abscess is slow in its development and may be a disease of months. Hydatid cysts have led to errors in diagnosis. In the case of uncomplicated hydatids there is no pain or fever. Hydatid cysts, however, may suppurate, and then the symptoms are practically those of liver-abscess. The so-called hydatid fremitus is of very little value in aiding the diagnosis.

To sum up: Abscess of the liver is recognized by wasting and loss of strength, a muddy complexion, enlargement, pain and tenderness of the organ, bulging and fluctuation in rare instances, and the discovery of pus by the exploring needle.

Can we determine the portion of the liver which is the seat of abscess? Sometimes we can. If cough and dyspnea are present in addition to the general symptoms, the abscess is at the upper surface. If vomiting and nausea are prominent, the lower surface is the seat of the abscess. If situated in the posterior portion of the right lobe, there may be bulging and bogginess posteriorly near the spine. A superficial abscess produces acute symptoms; a deep abscess is slow in progress, and its symptoms are indefinite.

Treatment.—Following the broad principle that wherever pus exists it should be evacuated and drained, there should be only one opinion regarding treatment of abscess of the liver. There are several methods by which hepatic abscess can be treated; they are briefly as follows:

1. Aspiration. This is more valuable as a diagnostic than as a curative procedure. A good-sized needle should be employed, and after careful disinfection it should be filled with a solution of carbolic acid (1 : 20). The skin should not only be sterilized, but a small opening should be made with a knife through the outer skin. This disposes of the epithelium and everts the danger of carrying any germs into the interior. Repeated aspirations have been recommended, but with the discovery of pus the usefulness of the aspirating needle may be said to end. It can be left in position as a guide for the incision. Care should be taken to allow the needle to move with the liver as it rises and falls during respiration. If held too firmly the instrument is liable to tear the liver substance, which is always pliable and easily lacerated.

2. Puncture by trocar. In this method a large-sized trocar is introduced and withdrawn, leaving the cannula in position. Through the cannula the pus escapes and frequent washings of the cavity are effected. The objection to this method is that it does not give free enough drainage and prolongs the suppurative process.

3. Free incision and drainage. This is the only thorough and trustworthy method of dealing with the abscess. If we have positive assurance that firm adhesions exist between the liver and the abdominal wall, a dissection through the tissues one by one until the abscess is reached is all that is required. The cavity is then well washed out, and packed with iodoform gauze or drained by rubber tubes.

Rarely can we have the assurance that adhesions exist. The opera-

tion which will meet every demand is one usually designated hepatotomy, and is performed as follows:

1. Over the most prominent part of the tumor, or at the point where the exploring needle has demonstrated the presence of an abscess, an incision is made through the abdominal wall, as in an ordinary celiotomy. Both the longitudinal and the transverse incisions have their advocates. The opening should be four or five inches in length.

2. Examine the surface of the liver, and if at any part adhesions are found, open into the liver at that point, even if it does not correspond to the abdominal opening. If there are no adhesions, the opening is made directly into the liver in the following manner: Pack several flat sponges or gauze pads around the spot to be opened on the liver, so as to catch any pus that may escape and prevent its getting into the peritoneal cavity. If not yet satisfied of the existence of an abscess, pass a large exploring needle into the liver, and, using the needle as a guide, make an incision large enough to admit the fore finger. The finger is then used as a hook to draw the liver up against the abdominal wound, while an assistant presses upon the walls and keeps them in close apposition to the liver. Having thus guarded against the escape of pus into the peritoneum, the blade of a long, slender knife is passed along the finger and the opening enlarged to the required extent. The edges of the opening in the liver are now caught in the blades of several pairs of forceps and kept well up into the abdominal wound, while the abscess-cavity is being thoroughly irrigated. The finger is again inserted and made to sweep around the cavity in search of secondary abscesses, which, if present, can be torn open by the finger or by forceps, and the irrigation continued or the pus mopped out with soft sponges.

3. The cavity being now empty and wiped clean, and any fluid that escaped into the peritoneal cavity wiped up, the edges of the liver-wound are stitched to the opening in the abdominal wall. The soft sponge is used to plug the abscess-cavity, the sponges packed around the opening are removed, and with a continuous suture of stout catgut the lips of the wound in the liver are secured to the abdominal wall. The sponge is removed from the abscess-cavity, and a drainage-tube or strips of iodoform gauze inserted, to be changed as often as the discharge shall demand. A copious antiseptic dressing completes the operation.

4. Incision in two stages. To ensure greater safety, and particularly to guard against the risk of infecting the peritoneal cavity, the operation can be done in two stages. As a rule, the case is too urgent to admit of the necessary delay. In the first stage the abdominal opening is made down to, but not through, the peritoneum, and into this wound a packing of sterilized gauze is placed, a dressing applied, and the patient sent back to bed. At the end of forty-eight or seventy-two hours the operation is completed by making the incision into the liver. Firm adhesions have had time to take place and the peritoneal cavity is saved.

Barwell recommends opening the peritoneum at the first operation, lest omentum or intestine should happen to lie beneath and be incised when the opening is made into the liver.

5. Opening by caustics or the thermo-cautery is falling into disuse, and it is not likely that so antiquated and barbarous a procedure will be revived.

Hydatids of the Liver.—In the intestine of the dog, the wolf, and other animals abounds the echinococcus which is the cestode or larval stage of the tape-worm. Human beings living in too close companionship with dogs are liable to swallow the eggs of these parasites. In the north-western portions of Canada and the United States Icelanders form the majority of the people thus affected. The eggs, once in the alimentary canal, are capable of passing through the intestinal wall into the liver. Here the embryo becomes a cyst and may grow to an enormous size. In the liver the unilocular variety of echinococcus is most frequently met with. It may occupy either lobe of the liver, but is most frequent in the right. When situated near the surface it usually forms a well-marked rounded tumor, easily palpated and fluctuating. When deeply situated in the hepatic substance it causes a more diffuse swelling, with the liver-tissues expanded over it. As the tumor grows



FIG. 132.—Tumor and area of dulness in hydatids of the liver (side view).



FIG. 133.—Tumor and area of dulness in hydatids of the liver (front view).

(From photographs in the collection of Dr. Strickler, New Ulm, Minn.)

pressure-symptoms are likely to appear. If the upper surface be the seat of the cyst, the diaphragm is pressed upward, causing dyspnea and cough. When the pressure is downward the bile-ducts may suffer pressure and jaundice is the result.

Symptoms.—In the liver the single echinococcus is the rule, and we

have to deal with a slowly-growing cystic tumor free from inflammation and producing only such symptoms as are due to growth and pressure (Figs. 132, 133). It sometimes happens, however, that the cyst suppurates, and then there is a condition closely resembling abscess of the liver. A small cyst is devoid of any symptoms which are characteristic. The first symptom to attract attention is usually a painless, slowly-growing tumor in the epigastrium or right hypochondrium. Fluctuation can usually be detected. The tendency of the growth is downward, and as it comes into the region of the kidney it is liable to be mistaken for hydronephrosis. It may appear singular that any great difficulty should exist in the diagnosis between a disease in the liver and in the kidney, but it is a clinical fact that some of the most difficult questions in surgery arise on these very points. Hydronephrosis has usually a history of chronic kidney disease, such as renal calculus or a movable kidney whose ureter becomes twisted. As the hydatid tumor descends still farther it is apt to be confounded with ovarian cyst. The resemblance to ovarian cyst is increased by the presence of fluctuation all over the abdomen, while the flanks are resonant as in ovarian tumors. Bimanual examination is an excellent aid in the determination of ovarian cyst, but if the tumor should happen to have a long pedicle, we are at a loss. The exploring needle is to be condemned in the diagnosis of ovarian cysts. In view of all these discouraging features our main reliance must be placed on the history and the direction in which the tumor has developed. From pleurisy on the right side hydatids are distinguished by the absence of fever and the physical signs of inflammation of the pleura. The pain felt in the right shoulder in liver-affections may be of some value. Given a smooth, painless fluctuating tumor making its first appearance in the epigastrium or right hypochondrium, we may strongly suspect hydatids, and should seek to settle the question by the exploring needle. The fluid of hydatid cysts is different from any other fluid in the body. It is albuminous, contains a large quantity of chlorid of sodium, and has a specific gravity below 1015. Under the microscope the hooklets on the laminated echinococcus membrane may be found, and then there can be no possible room for doubt.

Diagnosis is sometimes settled by rupture of the cyst into the lung, as shown by the expectoration of the fluid containing hooklets. Sometimes the rupture takes place into the intestine, and a few cases have been reported in which the opening was into the pericardium. In any case rupture is always attended with danger and may prove suddenly fatal.

Treatment.—Simple puncture and aspiration have been long employed in the treatment of hydatids of the liver, and many cures have resulted, but the method has many drawbacks, among which may be mentioned escape of hydatid fluid into the peritoneal cavity and return of the tumor from failure to destroy the mother-cyst. Injection of chemical substances and the use of electrolysis may be placed in the same category.

The success and slight danger attending hepatotomy have made it the favorite method of treatment with most of the leading surgeons. The operation should be resorted to as soon as a diagnosis of a hydatid

cyst can be confidently arrived at. It is true that such a cyst may go on for years without producing much discomfort, but it is equally true that rupture may take place at any time and produce fatal results, or suppuration may supervene and place the patient in a critical position. It is much safer to operate upon a small than a large tumor, and this should have its influence in determining an early operation. The operation can be performed in either one or two stages:

Operation in One Stage.—Make an incision over the most prominent part of the tumor and divide all the tissues down to the peritoneum. Next make an opening in this membrane and pack the space around it with antiseptic sponges. The tumor is then opened and its contents allowed to escape, after which the edges of the sac are stitched to the abdominal wound, a drainage-tube inserted, and a copious dressing applied.

Operation in two stages is safer than the preceding, and should be chosen except under special circumstances which demand the immediate evacuation of the cyst. The first stage consists in making an incision down to and through the peritoneum. Just below the lower margin of the ribs is a favorite position for this incision when it corresponds with the position of the tumor. Having opened the peritoneum, a tampon of iodoform gauze is placed in the wound, a dressing applied, and the patient sent back to bed for five or six days. At the end of this time the adhesions between the peritoneum and tumor are so firm that the cyst can be opened into without risk of infecting the peritoneal cavity. The second stage consists in opening the cyst, which can be done without an anesthetic. The cavity is thoroughly washed out with an antiseptic solution, a drainage-tube inserted as before, and a dressing applied.

Floating Liver.—This is a rare affection, found, like floating kidney, in women who have rapidly borne children and suffered loss of flesh. The diagnosis must rest upon the presence of a large abdominal tumor which moves about as the patient changes her position. The absence of the normal hepatic dulness and the existence of this movable body are very suggestive. The pressure of the liver upon the aorta causes pulsations to be transmitted to the tumor which must not be mistaken for the pulsations of an aneurysm.

The only *treatment* to be considered is the wearing of a suitable belt.

IX. INJURIES AND DISEASES OF THE GALL-BLADDER.

Anatomy.—The gall-bladder is lodged on the under surface of the right lobe of the liver. Its length is about four inches and its breadth about one and a quarter inches. It consists of a fundus, a body, and a neck. The fundus only is covered with peritoneum. It projects just below the anterior edge of the liver at the position of the cartilage of the ninth rib. The body of the gall-bladder lies in such relation to the right flexure of the colon that the intestine at this point is bile-stained when examined post-mortem. It also lies over the pyloric end of the stomach and the first portion of the duodenum. These relations help to explain the frequency with which vomiting and pain in the stomach attend attacks of hepatic colic. The neck curves upon itself like the

letter S, and empties into the cystic duct at the transverse fissure of the liver. The cystic duct at its juncture with the hepatic duct forms an acute angle, from which point the common duct is continued to empty into the duodenum. During the intervals of digestion the bile naturally gravitates into the fundus, which is the lowest part of the gall-bladder. Here, too, lodge gall-stones, which are the source of so much suffering, and the removal of which has claimed so much attention of late years (see Fig. 134).

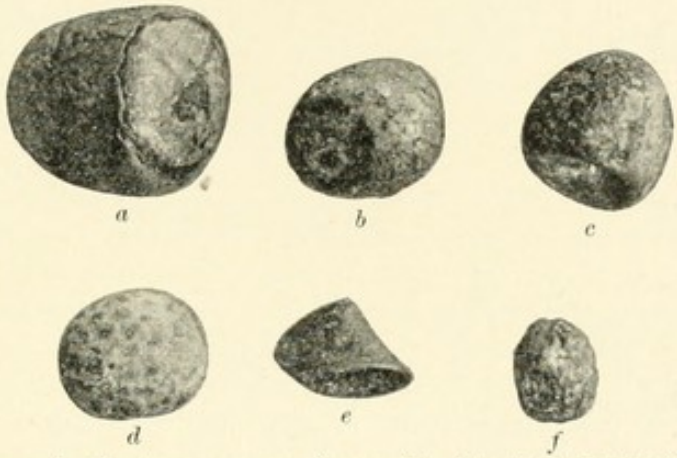


FIG. 134.—Types of gall-stones: *a* caused complete intestinal obstruction for eight days; *b* and *c* were removed from the gall-bladder, and show points of attrition; *d*, solitary stone removed from gall-bladder; no point of attrition; *e*, gall-stone of irregular shape, due to compression or moulding; *f*, solitary stone from common duct (from a photograph in the collection of Dr. Jepson, Sioux City, Ia.).

The bile, in common with the blood and nervous tissues, contains cholesterin. In the liver this highly carbonaceous substance is held in solution by the fatty acids so long as the bile is alkaline. It has been demonstrated that the presence of calcium in any fluid containing cholesterin causes precipitation of that substance. It is also found that when any of the organic acids occur in excess in the solids or liquids of the body they cause the calcium of the anatomical elements to be liberated. Precipitation of cholesterin follows. Concentration of the bile and stagnation in the bile-ducts favor precipitation.

Another important factor in the formation of gall-stones is catarrhal inflammation, which extends from the intestine up the ducts, and in which the bacterium coli commune is an active agent. The mucus deposited in the gall-bladder forms a ready nucleus for the precipitation of bile-crystals. If there happen to be some small particles of solid matter to serve as a nucleus around which the precipitated cholesterin can collect, a concretion is formed which is called a gall-stone.

Gall-stones may be divided into the following classes:

1. Those containing cholesterin with or without pigment;

2. Those composed of bilirubin in combination with calcium: they are dark colored and amorphous;

3. Small dark-colored stones having a mulberry shape, consisting not of bilirubin itself, but of one or another derivative of bilirubin;

4. Gall-stones consisting almost entirely of inorganic salts; calcic carbonates and phosphates are also occasionally met with (Foster).

Clinically, we find gall-stones most frequently in persons of seden-

tary habits who are given to excessive eating and drinking. Females are more liable to the affection than males, possibly owing to a tendency to osteomalacia, a disease which tends to the liberation of calcium, and hence to the precipitation of cholesterin, as suggested by some authors, but more likely on account of their sedentary habits and changes in abdominal pressure resulting from tight-lacing, pregnancy, etc. The number of stones which may be found in a gall-bladder varies from a single one to seven thousand. A law which seems to prevail is that when few stones exist these are of large size; when they are numerous their size is always small. They generally have facets, which are the result of the pressure of the stones against each other, and this feature is important in the operation of cholelithotomy, for if a single stone be removed which has one or more facets, we may be sure others are near at hand.

Symptoms.—The symptom which plays the leading rôle in a typical case of gall-stones is *paroxysmal pain*, which, from its resemblance to the spasmodic pain so common in the colon, has been named gall-stone or hepatic colic. This pain is due in part to inflammation produced in the gall-bladder, the ducts, and adjacent parts by the irritation of the stones; also to the obstruction of the ducts during the passage of the calculi, and to the strong contraction of the gall-bladder in its efforts to overcome obstruction. The pain is paroxysmal in character, and may last for a period varying from several hours to two or three days. It is referred to the region of the gall-bladder, to the epigastrium and right hypochondrium, and it is also felt in the shoulders and back. It is attended by fever, and the patient will probably tell you that he is "subject to such attacks."

The second symptom is the existence of a *tumor*, which is identified as the gall bladder. The normal position of this reservoir is at the anterior sharp edge of the liver in close relation with the ninth costal cartilage. Definitely to localize it, the best landmark is the tip of the cartilage of the tenth rib. Immediately beneath this lies the fundus of the gall-bladder.

What causes enlargement of the gall-bladder? It is the permanent occlusion of the ducts. So long as the cystic and common ducts are free no enlargement of the gall-bladder takes place, unless it be permanently enlarged from the enormous size of its contained calculi. But let either of these ducts become occluded and the bladder will soon enlarge. This enlargement follows a definite line, which is of great diagnostic importance—that is to say, from the normal position of the cyst *toward the umbilicus*. If not too large, the tumor rises and falls with the liver in the movements of respiration.

The third symptom is *jaundice*. This symptom is not present in every case, and the reason is very clear. If the cystic duct be obstructed, the flow of bile from the gall-bladder is stopped, the cyst becomes over-distended, but the flow of bile from the liver passes down the hepatic and common ducts without hindrance, *and there is no jaundice*. There is a possible exception to this rule, as pointed out by Fenger—viz. that obstruction in the lower or distal half of the cystic duct may cause icterus from compression of the hepatic duct. When the hepatic duct or the common duct is obstructed, the bile is

unable to escape from either the liver or gall-bladder; it is reabsorbed and jaundice is the result. Jaundice, then, is an indication that either the hepatic or the common duct is obstructed. Fenger was able to prove by a post-mortem experiment that a small stone in the common duct acting as a ball valve can stop the flow of bile into the duodenum. This accounts for the remittent icterus and the frequently recurring attacks of icterus and colic.

It may at first thought appear a very easy matter to settle the question as to whether the gall-bladder or the kidney is the seat of the symptoms just described, but in actual experience I know of no diagnostic point that is more difficult. Take the first symptom, pain. In many cases this is not referred to the position of the gall-bladder, but to the epigastrium, and if it is accompanied by severe vomiting, the stomach is apt to receive attention and the gall-bladder may be overlooked. The pain may be felt in the back, and sometimes the patient finds difficulty in localizing the pain. Pressure over the gall-bladder usually elicits tenderness, but the same amount of tenderness may be experienced when pressure is made over the right kidney.

When we come to consider the second symptom—the presence of a tumor—still greater difficulties meet us. A movable kidney has many points of resemblance to a distended gall-bladder. These points are summarized by Morris as follows:

"1. Both may be felt in the loin or in the right hypochondrium.

"2. Either tumor may be capable of being pushed back into the loin or over to the left of the median line.

"3. In both cases the tumor is more or less firm, elastic, and smooth—either very tender or not at all so.

"4. In either case it may be round or oval, or shaped like an egg, a pear, an orange, or a sausage.

"5. Each may present a smooth, firm, and rounded projection on its surface—in the case of the kidney due to a cyst beneath the front of the capsule; in the case of the gall-bladder, to a calculus in a pouch in its anterior wall.

"6. Both may have either a resonant or a dull note on percussion in front.

"7. Both may give rise to various dyspeptic symptoms—nausea, flatulence, and constipation.

"8. Either may give rise to paroxysmal attacks of severe colic, the maximum intensity of which is referred to the situation below the ribs on the right side of the abdomen. In enlarged gall-bladder these attacks are due to the sudden impaction of a gall-stone in the cystic duct—in movable kidney, to kinking or rotation of the ureter or renal vessels.

"9. Either may give rise to jaundice, gastric and intestinal catarrh.

"10. With either there may be considerable displacement of the colon and small intestine, or adhesions and matting together of the intestines and omentum in front of the intestine may occur.

"11. In neither case does the condition of the urine help us, as there may be albumin with distended gall-bladder or bile in the case of movable kidney."

Further to increase the difficulty which attends the diagnosis of

these cases, a gall-bladder may be elongated and curved in such a way that it has a kidney shape, or the liver, being pushed downward, causes the elongated gall-bladder to turn backward, giving the appearance of a tumor in the right lumbar region. The kidney, on the other hand, may simulate the gall-bladder. It may be adherent to the liver, so that when pushed toward the left and back again to the loin, its connection with the liver is still maintained, and the resemblance to a distended, elongated gall-bladder be perfect.

When we look for help in other directions, we meet with disappointment. Movable kidney occurs seven to nine times more frequently in women than in men; gall-stones have a preference for the sex in about the same proportion. Both affections often coexist in the same individual, and both are most frequently found in women who have large families. It is a fact not to be lost sight of that a movable kidney may be a cause of gall-stones.

These statements are rather discouraging, and yet a careful investigation will usually lead us to a correct conclusion.

The following points will help us:

1. A gall-bladder if enlarged is inclined to grow in the direction of the umbilicus, and on careful palpation it can be traced to its connection with the liver. Tracing it up to the liver and holding two fingers of the left hand on this point, move the lower end of the tumor with the right. The point at the junction with the liver is a fixed point, while the rest of the tumor moves as a pendulum.

2. On deep inspiration the tumor moves downward with the liver and rises with expiration.

3. Jaundice, either attending or following paroxysmal attacks of pain, is very strong evidence of gall-stones.

4. While a sudden diminution of the size of the tumor may occur in either case, we may consider it positive evidence that the tumor is a kidney if the decrease in size is attended with a sudden and copious flow of urine, or that it is a gall-bladder if the stool, previously clay-colored, suddenly shows an excess of bile.

5. A gall-bladder filled with calculi is much harder than a movable kidney. It is more tender, and in rare instances a grating of the stones can be felt on palpation.

A very difficult problem arises when a distended gall-bladder rests upon the anterior surface of a slightly displaced kidney in such a way that on double palpation a tumor is felt to extend from the lumbar region to the anterior abdominal wall. If the history of jaundice and other symptoms pointing to the gall-bladder fail us, we can sometimes settle the question by finding on palpation that the gall-bladder has an independent movement.

Stone in the kidney is another condition which is frequently difficult to distinguish from gall-stones. Our main reliance must be placed upon two points:

1. A microscopic examination of the urine is almost sure to reveal the presence of blood- and pus-corpuscles, which is strong evidence that the kidney is the affected organ.

2. Tenderness over the kidney. This tender point is found by making deep pressure inward at the outer edge of the erector spinæ

muscle at the lower border of the twelfth rib. The edge of the muscle is about two inches from the spines of the vertebræ. It must, however, be remembered that the kidney and gall-bladder are close together, and that in the case of a gall-stone inflammation of the peritoneum and other tissues in its vicinity is common. Hence pressure from the loin is a source of pain, even in gall-stones.

A tongue-shaped elongation of the right lobe of the liver, produced by tight lacing, may simulate an enlarged gall-bladder. The direction in which the tumor points and the breadth of its attachment to the liver should be sufficient to differentiate them.

Gastric ulcer may be confounded with gall-stones. The diagnosis must rest upon the presence of blood in the vomited matter, vomiting coming on almost immediately after taking food, and the existence of a tender spot in the stomach. In every case of this kind a test-breakfast should be given and the stomach-contents examined.

Carcinoma of the stomach should not cause much confusion, for here we have the coffee-ground vomiting, the presence of a tumor, and the absence of hydrochloric acid in the stomach-contents. Disease of the pancreas frequently simulates gall-stones, and especially when a tumor presses upon the common bile-duct—a condition which may render the diagnosis impossible.

Sounding for gall-stones by exploratory puncture, although advocated from time to time, is a proceeding which is attended with risk, and cannot be spoken of with any favor.

Diagnosis of the Position of the Stone.—1. *In the Gall-bladder.*—Judging from the number of cases in which stones are found in the gall-bladder post-mortem, it is evident that they can exist for an indefinite time without producing symptoms. According to Fürbringer, their presence can only be manifested when they become displaced by violent movements of the body, by contractions of the abdominal wall, or by increased secretion of the mucous walls of the gall-bladder induced by the irritation of the stones.

While the stones are confined to the gall-bladder, it is doubtful if we ever find pronounced hepatic colic. There is pain, but not of the severe paroxysmal type. It is only when obstruction of the cystic duct takes place that the typical colic occurs. The diagnosis of stones in the gall-bladder must rest upon the following points: pain in the epigastrium and the right hypochondrium, gradually increasing in severity, and often radiating to the angle and inner margin of the scapula. There is a slight rise in temperature, not exceeding 99.5° F.; the stomach is disturbed, but vomiting may be slight or absent.

On palpating the position of the gall-bladder a sensitive spot is felt, especially on deep inspiration. There is no jaundice, for the bile is not impeded in its flow from the liver through the hepatic and common ducts to the duodenum. If, however, a stone escapes from the gall-bladder and passes through the cystic and common ducts into the intestine, temporary jaundice will result, depending upon the transient obstruction in the common duct. In every case of supposed gall-stones the feces should be examined for stones that may have passed.

No tumor can be felt unless the gall-bladder is enlarged by the immense size and number of the stones or by the presence of pericystitis.

2. *In the Cystic Duct.*—There is hepatic colic, which reaches its height in two or three hours, and stops suddenly, provided the stone falls back into the gall-bladder. Nausea and vomiting are nearly always present. On palpation the muscles over the hypochondrium are found to be rigid, and the movements of the diaphragm are restricted, causing rapid and shallow respiration. The gall-bladder may or may not be distended, and there is no jaundice unless the stone occupies the lower half of the cystic duct, in which case it may press upon the hepatic duct, and, preventing the flow of bile from the liver, result in jaundice.

3. *In the Common Duct.*—There is no tumor, abscess, or local tenderness in the position of the gall-bladder, unless coincident inflammation is present (Fenger). The pain is in the epigastrium or in the back. Sometimes the stone acts as a ball valve (Osler, Fenger), the evidence of which may be inferred when a change of position causes relief of pain, or when there is remittence of pain with sudden subsidence, attended with flow of bile and without discharge of stone.[1] Icterus is the leading symptom, and is always inseparable from obstruction. It is either intermittent or remittent in character.

Colic is an almost constant symptom, varying in character and duration. If a stone becomes impacted, colic is continuous, but this is relatively rare. When the stone floats in the dilated duct, the attacks of colic are remittent. If it passes into the duodenum, the attack of colic is transient. Pain may come on slowly or suddenly. It may last for a considerable time, and disappear abruptly. Nor is it always felt in the region of the gall-bladder, unless that viscus is inflamed, but is found in the lower dorsal region, in both hypochondriac regions, and in both lumbar regions, and may be relieved or ended by change of position. Vomiting is common from the absorption of bile; fever, either of an intermittent or a remittent type, is a common symptom. Rapid and extreme loss of weight is due to the same cause.

Exploratory Incision.—There are cases in which a positive diagnosis is impossible in spite of the most searching inquiry, and nothing short of bringing the parts under ocular inspection will clear up the mystery. In many of these obscure cases the diagnosis lies between stone in the gall-bladder or ducts and stone in the kidney. Unfortunately, the incision which will reach the gall-bladder is not the best to explore the kidney. If we operate for gall-stones and find that none exist, it then becomes necessary to close the wound, turn the patient over, and get to the kidney by the lumbar incision. This I believe is the wisest programme to adopt. The gall-bladder can be exposed to view; it can be examined for stones by the sense of touch without opening into it; evidences of inflammation, recent or remote, will be regarded as strong evidence of gall-stones; in the vicinity of the gall-bladder the cystic and common ducts can pass under the same review, and should no stones be found the only cutting has been in the abdominal wall. It is not so with the kidney. We may manipulate it, perforate it with needles, and find that nothing short of laying the organ open will reveal the calculi.

Pathological Changes produced by Gall-stones.—In a very practical and able paper on gall-stone diseases read before the Minnesota Acad-

[1] *American Year-Book of Medicine and Surgery*, 1897, p. 182.

emy of Medicine, Dr. Hoegh sums up the pathological changes as follows:

"1. *The gall-bladder* is usually the primary seat of stones. Exceptionally, they are developed in the liver gall-ducts when there is stagnation of bile. But the gall-bladder is usually, even then, the primary seat of the illness, and its epithelium is always diseased—sometimes certainly in a very mild degree, only some desquamation with rapid regeneration of epithelium. In such cases no symptoms appear during life. But in other cases there are changes in the form, size, and thickness of the walls of the gall-bladder. The contents may be more or less changed. In other cases the disease has progressed to the cystic duct, where the pathological changes are the same as those in the bladder. When the disease stops here we have only local symptoms; the constitution suffers but little. The gall-bladder may be very much changed in form; it may contain diverticula, the seat of concrements; it may assume an hour-glass shape; it may flop over to the cystic duct and obstruct or obliterate it; it may be atrophic, barely of the size of the last phalanx of the little finger, or it may be large enough to hold a pint; the thickness of its wall may be nearly an inch; it may be encrusted with salts of bilirubin-lime, so that a chisel may be necessary to open it; it may be obliterated, but that is mostly after suppuration and operations. In more than half the cases the contents will be found changed; it may be filled with serum, mucus, pus, or any mixture of these. When there are adhesions to the colon it may even be putrescent, and probably highly infectious for the peritoneum. In about one-half the cases the stones are found only in the gall-bladder.

"2. The *cystic duct* is usually not seen during the operation on account of its depth. If the cystic duct is pervious, the contents of the gall-bladder are bilious; if the bile is inspissated or if the contents are pus, mucus, or serum, it is evident that the duct is closed. This closure may be due to an impacted stone, more often to inflammatory swelling, a simple continuation of the inflammation of the gall-bladder produced by the presence of stones or bacteria; when the stones are removed from the gall-bladder and the latter drained so that its epithelium becomes healthy, this concomitant swelling of the cystic duct disappears; when the bandage is changed after a couple of days, it is found full of bile, but no stone is found to account for the established communication between the ductus communis and the gall-bladder.

"Dilatation of the cystic duct is the result of impaction of stones, sometimes in this duct alone, sometimes also in the bladder, ductus choledochus, or liver; a whole row of stones may be found in the cystic duct arranged as beads on a string; a stone may be forced into the duct with such violence that it becomes arrested at its mouth, which it dilates; gravity may then pull it down into the gall-bladder, and it hangs down into it as a polypus from a dilated os uteri hangs down into the vagina.

"Obliteration of the cystic duct is found alone or with obliteration of the gall-bladder.

"3. The *ductus choledochus* next demands our attention. This duct is obliterated only when cancerous infiltration of its walls or of the

portal glands is present; otherwise the constant flow of bile prevents this taking place. Dilatations are, on the other hand, common from stones, especially when they become arrested at the papilla. This dilatation has been so great that the duct has been mistaken for the gall-bladder, and has been sewed into the abdominal wall. Stones may be found only in the ductus choledochus, or at the same time also in the other bile-ducts. The contents of this duct do not, like those of the bladder, become changed to pus, serum, or mucus. They are always bilious, but may be more or less inspissated in case of impacted stones.

"4. *The Liver.*—After death this organ is always found smaller than was supposed during life when its distention depends upon engorgement by blood or bile. It must also be remembered that the liver frequently is rotated upon its transverse axis, and thus offers an abnormally large surface to the examining hand; this takes place, for instance, when the right kidney draws or pushes it down. It may be very difficult to establish the lower border of the right lobe of the liver, especially when it is soft and the abdominal wall thick from fat. Palpation with a light hand yields usually a better result than percussion, which only rarely can demonstrate a thin, atrophic, and wedge-shaped liver margin or an elongated process of the right lobe, which is not uncommonly associated with chronic gall-stone disease. By pressing from the lumbar region with the left hand and gently feeling with the right one laid flat upon the abdomen the sharp lower margin may be felt. Inspection will sometimes give valuable information. It is to be expected that enlargements of the liver are most common where the deeper bile-ducts are inflamed and impervious; a tongue-shaped process over the gall-bladder in an almost vertical direction is frequently found; in extreme cases this process reaches as low and even lower than a line from the navel to the anterior iliac spine. The form of the liver shows many anomalies which seem to be connected with the gall-stone disease; for instance, hypertrophy of the anterior lobe, a deep notch instead of the usually rather shallow incisura vesicalis, striking development in the vertical dimensions of the liver at the expense of its transverse diameter. The consistency of the liver is occasionally changed, sometimes harder, sometimes softer, than in health. In exceptional cases we must be prepared to find thrombosis of a branch of a portal vein which may lead to great swelling, to enlargement of the hepatic ducts, even with formation of concrements within the same. The liver may be partly atrophic, especially where it is overlying a gall-bladder filled with stones. Like the other biliary organs and the adjacent viscera, the liver-surface may show signs of inflammation, new or old; there may be deposits of fibrin and more or less firm adhesions to the omentum, the adjacent abdominal wall, the duodenum, or the stomach, thus producing changes in these organs and interfering with their functions; thus in a case reported by Kehr adhesion to the stomach had produced dilatation of this organ, with all its disastrous symptoms, which, however, were relieved by successful operation.

"This leads us to the consideration of—

"5. *The adjacent intestines*, which frequently (nay, perhaps, more frequently than the regular gall-stone colics) give rise to those disturbances

that we have learned to consider as depending upon the presence of gall-stones in the biliary organs. While the adhesions usually are so slight that they may be easily broken up by the mere pressure of the tips of the fingers, they are at other times so firm that they must be dissected out; sometimes they are stronger than the walls of the hollow viscera, which may be torn. Under such circumstances careful suture has saved the patient in cases reported by Riedel and Lauenstein. Adhesions have been formed to the abdominal wall and to the pleura. By the breaking through of a circumscribed pleuritic empyema into a bronchus gall-stones have been known to be coughed up. Such cases are of course exceedingly rare, but common are adhesions to omentum, colon transversum, duodenum, and abdominal wall."

Treatment.—Considering the frequency with which gall-stones are found post-mortem, and which cause no symptoms during life, there must be a large number of cases in which no ill effects are produced. Such cases, even if diagnosticated, require no treatment. Medicinal remedies can be of value only in palliating the suffering during attacks of gall-stone colic. No remedy has been discovered which will prevent the formation of stones, much less dissolve them after they have been formed. More satisfaction can be expected from remedies which are given with the object of propelling the stones along the ducts. For this purpose phosphite of soda, turpentine, rhubarb, and the salicylates have been commended. Could we determine the size of the stones and the possibility of their passing through the ducts, this line of treatment would be rational. But, as a rule, we are entirely in the dark as regards the size of a stone which is causing colic, and should we force it onward we may be doing the patient absolute harm by causing it to lodge in the common bile-duct, where it is infinitely more troublesome and dangerous than in the gall-bladder. On this point Dr. Hoegh, in the paper already referred to, says: "Where there has been no icterus I can see no justification in trying to push the stones through, for they must yet be in the gall-bladder or cystic duct, and thence they can be removed safely by surgical means. To subject a patient with stones confined to the gall-bladder to the risk of having them arrested in the ductus choledochus seems almost a criminal act. In fact, the only condition that I think of that would justify the use of cholagogues would be that group of cases in which the disease begins suddenly and is complicated with jaundice, without such prodromes as epigastric oppression, occasional cardiac pain, or nausea. The absence of these symptoms would indicate that the disease was recent and the stones small, and that the jaundice was the result of impaction of a small stone, for if it were caused by a concomitant inflammation of the ductus choledochus, we ought to have had a train of inflammatory symptoms preceding it."

Surgical Treatment.—Before deciding that an operation is required we should endeavor to determine the position of the stone. In the vast majority of cases gall-stones are formed in the gall-bladder, and the operation for their removal from this position is safe and satisfactory in the hands of experienced operators. We can come to the conclusion that the stone is still in the gall-bladder if there are the cha-

racteristic attacks of hepatic colic, no permanent distention of the gall-bladder, and no persistent jaundice.

We can say that it is in the cystic duct if the gall-bladder be permanently distended, without persistent jaundice, notwithstanding that every attack of hepatic colic is followed by jaundice which is transitory. This is due to inflammation in the ducts.

It is in the ductus communis choledochus if there is persistent jaundice, with attacks of colic and with no permanent distention of the gall-bladder. "Attacks of severe pain in the epigastrium and right hypochondrium, accompanied by vomiting and shivering, and followed by sweating, complete relief, and transient jaundice, are due to the passage of a gall-stone from the gall-bladder through the ducts into the duodenum."

"Careful washing of the feces (best performed on a wire sieve) will rarely fail to discover the stone or stones in such a case" (Rutherford Morison).

High fever is most frequently found in connection with colic when the stone is in the common duct, and this pyrexia may assume an intermittent type, the rigors and fever recurring every two, four, seven, or fourteen days.

A long-standing case may show a history of a stone in each of these positions, or a single case may have mixed symptoms due to the circumstance of two or more stones occupying different positions. Of these positions the gall-bladder is the most favorable, and the aim of the surgeon should be to operate before the stone shall have been forced into either the cystic or the common duct.

The operation of incising the gall-bladder is called cholecystotomy. For the removal of stone from the gall-bladder cholelithotomy is the more correct term.

Operation.—An incision is made over the most prominent part of the tumor if one be present, or, if not, then over the situation of the gall-bladder. To find the gall-bladder the tip of the cartilage of the tenth rib is a good landmark. From this point the incision can be made downward and inward toward the umbilicus. John B. Hamilton gives the following landmarks for the fundus of the gall-bladder: Draw a line from the anterior superior spinous process of the ilium to the center of the xiphoid cartilage. Intersect this with a line from the umbilicus to the tenth costo-cartilaginous juncture. In the right upper triangle near the apex, but nearer the right oblique line, the fundus of the gall-bladder will be found.

Other directions for the incision are—the vertical, employed by Lawson Tait; the transverse, by Kocher; and one parallel with the line of the ribs, by Keen. I prefer the oblique incision of Greig Smith, separating the fibers of the internal oblique, thus lessening the risk of ventral hernia. If additional space is required in dealing with a stone in the ducts, this incision can be supplemented with one that is transverse, thus allowing the flap to turn inward. When the peritoneum is reached and all bleeding points stopped the membrane is pinched up in the usual way and divided. The edges of the opening are held apart with retractors while the operator finds and examines the gall-bladder. When the cyst is small it can readily be explored with the

fore finger and stones detected if present. If the bladder is greatly distended, the contents should be drawn off with an aspirator, the cyst at the same time being drawn up into, and if possible partly outside, the wound. Sponges are packed around the bladder to catch any fluid which escapes by the side of the trocar. When the fluid has drained away sufficiently the bladder is opened, and the manner of opening it must depend upon the size to which it is distended. A pair of catch-forceps is applied on each side of the trocar and an opening made large enough to admit the fore finger. It must be borne in mind that as the bladder is emptied it is drawn upward by the contraction of its walls. The opening in it must be made low down, so that it will not be drawn above the parietal opening. The finger in the bladder searches for stones, and directs forceps or spoons which are used for their removal. When the calculi are confined to the gall-bladder their removal is generally an easy task, but when the cystic duct is the seat of a stone its removal is often exceedingly troublesome.

Removal of Stones from the Cystic Duct.—The fact that a gall-bladder is distended may be taken as proof that its neck or the cystic duct is obstructed by a stone. With the fore finger of one hand held upon the duct at the site of the stone, a narrow-bladed dressing-forceps can be passed into the duct and guided to the obstructing calculus. The forceps is then made to chip off pieces of the stone while the finger pushes it toward the bladder or into the jaws of the instrument. Should this measure fail, the duct should be incised, the stone removed, and the opening in the duct treated as in the case of the common duct presently to be described. Crushing the stone by padded forceps outside the duct-walls, as first advocated by Tait, is not now considered good practice. Stones which could not be removed from the cystic duct or neck of the gall-bladder have, in a few instances, been dissolved by injections of hot water or olive oil through the fistulous opening in the bladder, but such treatment is not to be relied upon. After all stones have been removed, the next step is to stitch the bladder to the abdominal wound. In my first operation I followed the teaching then in vogue, and united the edges of the bladder-incision to the skin by a continuous silk suture. The skin was inverted, and the result was a biliary fistula which gave no end of trouble. Since that time some operators appear to have gone to the other extreme, and are satisfied with stitching the edges of the bladder opening to the edges of the incision in the peritoneum only. This is unsafe. The peritoneum is too thin and delicate a structure to prevent the contents of the gall-bladder from getting into the abdominal cavity. Were we sure that the flow consisted of pure bile (an aseptic fluid), it might matter little if some of it trickled through, but if pus or other infectious fluids are present, even a stitch-hole is sufficient to afford entrance and result fatally. *The stitches which secure the gall-bladder to the parietal wound should include gall-bladder, peritoneum, conjoined tendon, and some muscular tissue.* This will effectually shut off the peritoneal cavity and give a good granulating surface for the closing of the fistula. A drainage-tube is now placed in the gall-bladder and held in position by a stitch to the skin, the parietal wound shortened by several silk-worm-gut stitches, and a dressing applied. The dressing is changed as

often as necessary, and the stitches are removed about the fifth day. The drainage-tube is left till the discharge is greatly diminished; it is then withdrawn and the fistulous opening allowed to heal up.

Cholelithotomy in Two Stages.—When circumstances permit, much risk will be averted by operating in two stages:

1. The abdomen is opened as before, the peritoneum incised, and a thorough examination made of the bladder and both cystic and common ducts. If satisfied that the stones are confined to the bladder and both ducts free, the gall-bladder is stitched by a row of sutures, as in the former operation, and left unopened. A piece of gauze is placed in the wound, and the patient sent back to bed for four or five days, at the end of which time the bladder is firmly adherent to the abdominal wound and the peritoneal cavity completely shut off.

2. The gall-bladder is now incised, the stones removed, a drainage-tube inserted, and the wound treated as before.

Removal of the Stones from the Common Duct.—Three different procedures have been advocated for the relief of this condition:

I. *Crushing* the stone by padded forceps outside the duct (Tait). This method is incomplete and attended with danger. It cannot be considered a rational treatment.

II. *Cholecystenterostomy*, or the establishment of an opening between the gall-bladder and the intestine. This diverting of the bile was supposed to serve every purpose, and with the aid of Murphy's button the operation can be so quickly performed that it found favor in the eyes of many operators. It is open, however, to very serious objections, which McGraw of Detroit classifies as follows:

1. Although relief may follow the operation, the cause of the disease has not been removed, and the stone which obstructs the duct remains as a menace, causing irritation by its presence and even leading to suppuration and abscess. The inflammation may spread even beyond the duct and produce peritonitis and adhesions.

2. A firm adhesion is established between the gall-bladder and the bowel. This must at times produce great traction on one or the other of these organs, interfering with their movement and with the performance of their functions. These unyielding adhesions between bowel and gall-bladder may cause frequent attacks of pain, flatulence, distress during digestion, and finally render the patient liable to attacks of obstruction of the bowel.

3. After this operation the stream of bile is diverted through the cystic duct and gall-bladder into the bowel. The gall-bladder takes upon itself the function of the common duct, and the common duct becomes to all intents and purposes an abnormal gall-bladder, and receives a certain amount of bile which stagnates or crystallizes.

If, then, the operation is attended with the dangers just mentioned, and if we only convert the common duct into a gall-bladder (a gall-bladder containing a stone), the procedure cannot be compared with an operation that removes all cause of the disease and leaves the parts in perfect condition. This operation is—

III. *Incision of the duct, removal of the stone, and drainage.* The views of surgeons have undergone some change in regard to the danger of incising the gall-ducts. Leakage of bile is now regarded as of little

importance, provided it be in its normal state and free from pus. Drainage is a safeguard against the consequences of sepsis.

Operation.—The oblique incision, beginning over the ninth costal cartilage and extending downward and outward with the splitting of the internal oblique muscle, is the most suitable. The peritoneum is opened in the usual manner. The duct is then exposed and incised longitudinally over the stone. After the removal of the calculus a sound can be gently passed along the duct in search of other stones, which, if present, may be pushed along to the incision, or a new opening can be made in the duct for their removal. The opening in the duct is now closed by two rows of fine silk sutures. This part of the operation is much facilitated if the stitches are placed before the stone is removed (see Fig. 135), as recommended by Dr. J. Wheelock Elliot

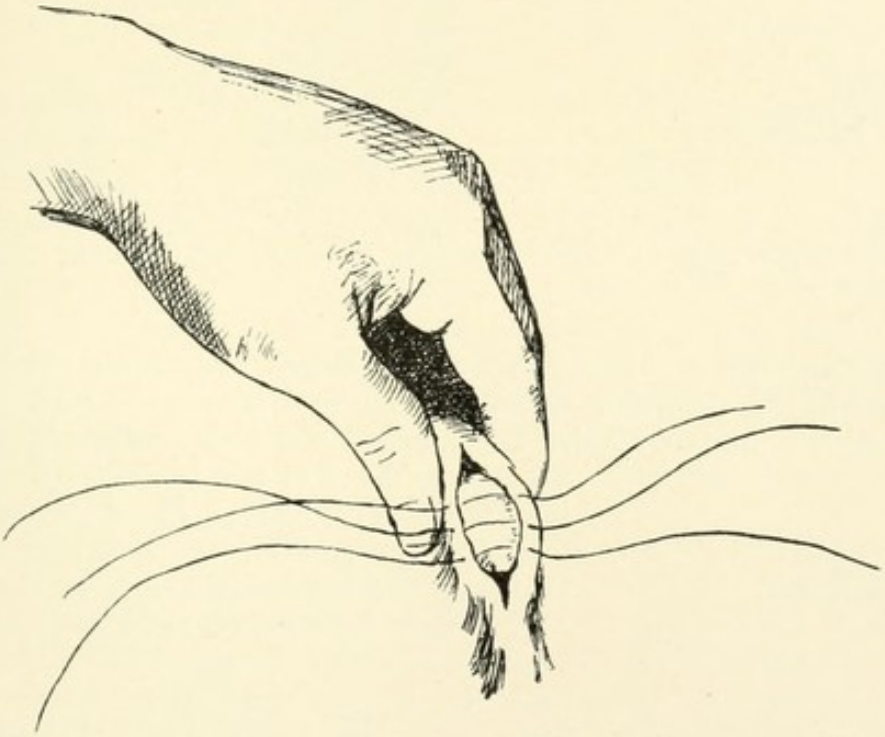


FIG. 135.—The duct is held by thumb and finger of left hand. The stitches are placed before the stone is removed (Elliot).

of Boston. If the gall-bladder has not been opened at a previous stage of the operation, this should next be done, and a careful search made for stones both in the cyst itself and in the cystic duct. The bladder is then stitched to the abdominal wound, a drainage-tube inserted, and a copious dressing applied. It is not uncommon to find on the dressings small stones or fragments which have come away and which escaped notice at the time of the operation, proving the value of this method of drainage.

Operation with Drainage of the Right Hypochondrium.—Dr. Rutherford Morison has described a pouch behind the right lobe of the liver which has natural barricades separating it from the general peritoneal cavity, and he has demonstrated that efficient drainage of this pouch serves a useful purpose in gall-stone operations. The space is exposed

by a transverse incision commencing over the rectus muscle an inch below the tip of the ninth rib, and extending back into the loin midway between the lower costal margin and the iliac crest. A tube in the lower angle of this wound effectually drains this space.

The boundaries of the space are as follows: The floor is formed by

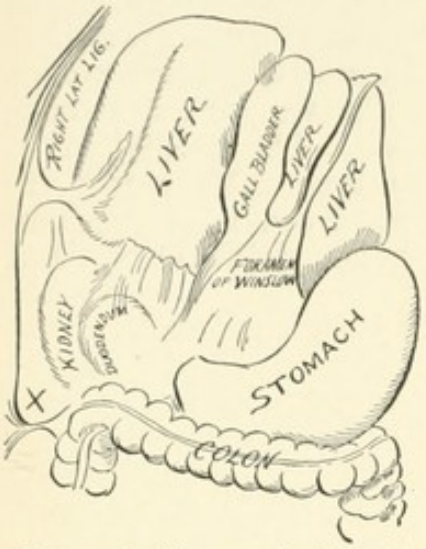


FIG. 136.—The pouch shown by drawing liver upward; × in all the figures marks points for drainage (Morison).

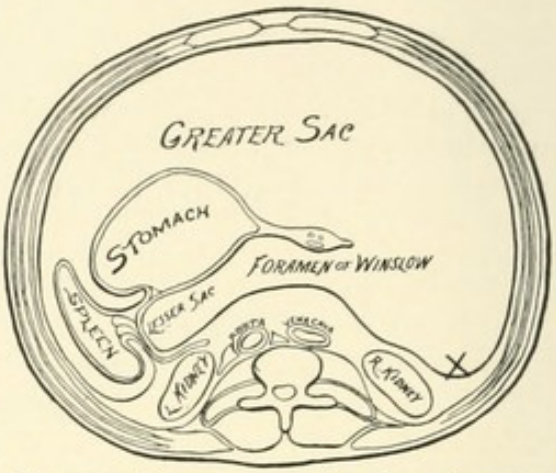


FIG. 137.—Transverse section through center of pouch (Morison),

the ascending mesocolon covering the kidney, duodenum, and other structures in the posterior abdominal parietes (Fig. 136). Superiorly, the space is bounded by the left lobe of the liver; inferiorly, by the ascending layer of the transverse mesocolon (Fig. 137) covering the duodenum internally; externally, by the peritoneum, bringing the lumbar parietes as far down as the iliac crest; internally, by the peritoneum covering the spine behind, the free edge of the gastro-hepatic omentum in front, and the foramen of Winslow between the two (Fig. 138). A varying quantity of fluid, roughly estimated a pint, may be introduced into the pouch from below before any overflow into the general peritoneal cavity can take place (Morison).

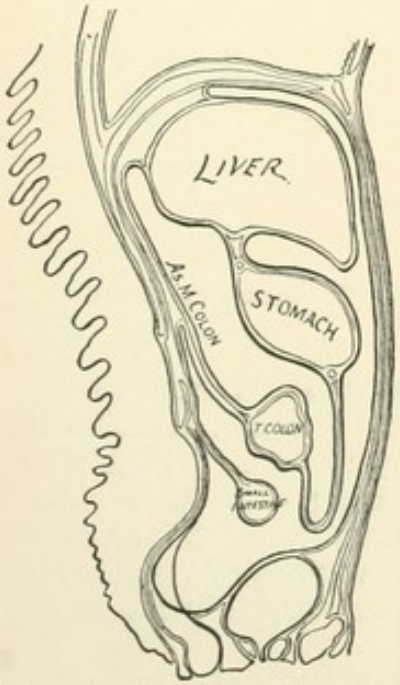


FIG. 138.—Vertical mesial section (Morison).

It is perhaps premature to condemn this method of treatment, but it appears to me open to some objections:

1. The length of the incision must be considerable to obtain the drainage, and, as it is a transverse incision, the risk of ventral hernia is too great.

2. There is no evidence to show that suppuration, once established in the pouch, would not spread to the general peritoneal cavity.

3. Drainage through the gall-bladder, as already described, is secured by a much smaller incision, and appears to answer all purposes.

The method of operating is as follows:

Operation.—An incision beginning at the outer border of the right rectus muscle, an inch below the ninth costal cartilage, is extended outward and downward toward a point midway between the costal margins and the iliac crest. After arresting all bleeding points the peritoneum is opened and the duct found. The portion of the tube which contains the stone is steadied on the fore finger of the operator or his assistant, and a longitudinal incision made in the wall of the duct. The stone having been extracted, the opening is closed by a double row of fine silk sutures. Dr. Morison does not suture the duct or gall-bladder, but places one end of the drainage-tube in contact with the incision. An examination of the remaining portions of the common and of the cystic duct is then made, and if no further obstruction is found a drainage-tube is so placed that one extremity is in contact with the incision in the duct and the other projecting from the posterior edge of the abdominal wound just below the right kidney. The abdomen is closed in the usual manner, beginning at the inner extremity of the incision and going outward to the drainage-tube. Gauze is not a suitable material for drainage, as it does not absorb bile readily. When bile no longer escapes through the tube, the latter can be removed and the opening allowed to close by granulation.

Cholecystectomy, or excision of the gall-bladder, is indicated (1) where the gall-bladder containing one or more calculi is so contracted that its fundus cannot be sutured to the abdominal wall; (2) where there have been perforations or ulceration and empyema, and the tissues are so thin or so much inflamed that they will not bear suturing (Greig Smith).

The operation usually requires a longer incision than cholecystotomy. The edge of the liver is held up by a retractor and sponges are packed around the seat of the operation. The gall-bladder is separated from the liver, beginning at the fundus and going toward the cystic duct. The bleeding may be free, but is easily arrested by pressure or a few ligatures. The cystic duct is divided between two ligatures and the gall-bladder removed.

Wounds of the Gall-bladder.—The gall-bladder may be wounded by cutting instruments or projectiles, or it may be perforated by ulceration, or ruptured by over-distention or by a blow. Although the escape of pure bile is not necessarily harmful, the fluid being aseptic and readily absorbed, wounds of the gall-bladder are very fatal. The quantity of bile found in the abdominal cavity after death in this manner is sometimes enormous. When rupture of an empyema occurs death is inevitable.

Diagnosis of a stab-wound of the gall-bladder must rest upon the position and direction of the wound and upon the escape of bile.

Treatment.—If the wound is small, adhesions to neighboring parts may wall in the escaping bile, which is soon absorbed and the wound heals. Large wounds are very serious and require immediate operation, the steps of which are the same as for the removal of gall-stones. Should there prove to be a wound of the portal vein, this vessel must

not be tied, as ligation has always been followed by death. The edges of the wound in the vein must be united by suture.

Dropsy of the Gall-bladder.—When the gall-bladder is distended it is nearly always the result of obstruction by gall-stones. Much more rarely the cause is a neoplasm of a neighboring structure, causing pressure on the cystic duct, or parasites, hydatids, or worms. The contents of the cyst soon become altered, changing to a colorless fluid consisting largely of mucus. The distention is generally toward the umbilicus, and a tumor may form almost large enough to fill the abdomen. The walls of the bladder become tense; the surface is smooth and uniform, and generally painful to the touch.

Empyema of the Gall-bladder.—Suppuration of the gall-bladder is an occasional result of gall-stones, and, according to Tait, it is more likely to occur when only a few stones are present. The tumor is not usually large. The walls are thickened in some parts, thinned in others, and adhesions to neighboring structures are the rule. Pus may perforate the walls of the bladder and rupture into the peritoneal cavity, or if adhesions have formed in favorable positions the pus may burrow through the parietes and discharge externally.

The *diagnosis* of empyema is always difficult. A history of acute cholangitis, followed by chills and other evidences of suppuration, with the formation of a moderate-sized tumor of the gall-bladder, would be reasonable grounds for asserting that the gall-bladder contained pus.

Treatment.—The only treatment to be considered is cholecystotomy with drainage. The greatest care must be taken to prevent escape of the cystic contents into the peritoneal cavity. For this purpose sponges should be carefully packed around the bladder before opening it, the bladder should be stitched to the abdominal wound, and a rubber drainage-tube inserted and retained until all suppuration shall have ceased.

X. DISEASES AND INJURIES OF THE PANCREAS.

The pancreas is deeply seated in the abdomen, and is the most inaccessible of all the organs. Its diseases are obscure and their diagnosis sometimes impossible, yet the pancreas is by no means beyond the reach of surgical interference. Many cases have been successfully operated, and with increased knowledge of morbid conditions a much wider field may open up for surgical procedure in this organ.

The functions of the pancreas are—

(1) To emulsify fat;
(2) To saponify fat;
(3) To peptonize albuminoids;
(4) To convert starch into sugar.

The appearance of fat in the feces is an evidence that the organ is not performing the first two of its functions, and from a remote period to the present time the appearance of fat in the stools has been considered one of the most prominent of symptoms of pancreatic disease. This, however, has lost its significance of late years, since it has been shown that free or saponified fat in the feces may be absent when there is obstruction or failure of the pancreatic secretion, and may be present

when there is no disease of the organ in question. Diabetes has a closer relation to pancreatic disease. Mering and Minkowski have shown that complete removal of the pancreas from dogs is followed by all the characteristic symptoms of diabetes mellitus, while incomplete removal of the organ produces no such result. Yet we find, clinically, that diabetes occurs without disease of the pancreas, and not every case of pancreatic disease is followed by diabetes.

A like uncertainty attends other symptoms that physicians have been wont to rely upon in the diagnosis of pancreatic disease. Lipuria, or fat in the urine, has been observed in cancer of the pancreas, but the rarity of the symptom deprives us of its value. Emaciation is a concomitant of so many diseases that it indicates nothing. Bronzed skin, salivation, and watery diarrhea are now regarded as of little diagnostic importance.

Pancreatic Hemorrhage.—The etiology of this disease is obscure. Various causes have been suggested, as traumatism, the corrosive action of the pancreatic secretion, and certain nervous influences.

Symptoms.—Hemorrhage of the pancreas must be placed among the causes of sudden death in apparently healthy individuals. The diagnosis is not likely to be made until the profusion of the hemorrhage has produced collapse. The patient is generally a male, seldom under forty-five years of age, apparently in good health at the time, but who has been more or less intemperate (Fitz). The first symptom is generally pain, which may be severe or be simply felt as a constriction of the lower part of the chest or upper portion of the abdomen. There is a frequent desire to defecate or there may be frequent stools. Nausea and vomiting are commonly present. Death is the common termination, occurring sometimes in thirty minutes, at others times being delayed for thirty-six hours. The suddenness of the death is probably due to pressure on the solar plexus and semi-lunar ganglia, with which the pancreas is in immediate relation. If the amount of blood is small, recovery may take place in from half an hour to several hours. When the patient survives there is a possibility that the attack may be followed by localized peritonitis or inflammation in the cavity of the lesser omentum, or the hematoma may be the starting-point of a pancreatic cyst. It is only for the relief of the latter conditions that surgical interference is possible.

Suppuration and Abscess of the Pancreas.—Suppurative pancreatitis is ushered in by severe pain in the epigastrium or abdomen, with vomiting and great prostration. About the third day of the disease chills and a rise of temperature occur, and the epigastrium becomes swollen, tympanitic, and tender to the touch. Jaundice is present in a small proportion of cases, and the liver and spleen may be enlarged. When an abscess forms, its presence may be diagnosticated by the existence of a growing tumor and the development of septic conditions. To distinguish between a tumor of the pancreas and one of the stomach the latter organ may be inflated. As the disease is fatal within a few weeks or months, an operation for the opening and drainage of the abscess is justifiable.

Cysts of the Pancreas.—Cysts of the pancreas are due to

obstruction of the duct of Wirsung or its branches by either contraction, obliteration, or the impaction of calculi. It has been suggested that many of these cysts are due to an extension of an inflammatory process from the duodenum into the duct of Wirsung, by which the latter is obstructed. Traumatism must also be recognized among the causes. Besides those confined to the ducts, the term "cyst of the pancreas" has been applied to all cysts occurring in the cavity of the lesser omentum, some of them probably due to localized peritonitis.

Men suffer from the disease more frequently than women, and the period of life most liable is from thirty to fifty.

Symptoms.—The tumor makes its appearance above the umbilicus and between the upper and middle zones of the abdominal cavity. It grows rapidly, and is often accompanied by gastro-intestinal symptoms, as vomiting and diarrhea. The tumor is tense and elastic on palpation. It projects forward, pushing the spleen to the left, the stomach to the right, and the colon downward. Sometimes the pulsation of the aorta is communicated to the neoplasm, suggesting aneurysm. In some cases it moves up and down with respiration. Fluctuation can be felt in favorable cases. Celiac neuralgia, diabetes, a muddy complexion, and salivation have been set down as symptoms, but their significance is doubtful. In making a diagnosis care must be taken to exclude distention of the gall-bladder, hydatids of the liver, aneurysm of the abdominal aorta, tumor of the kidney, and ovarian cyst.

Tapping and examination of the fluid will aid materially in determining the nature of the growth, but in the hands of a careful and experienced operator an exploratory incision is more satisfactory. When fluid is withdrawn, it will be found to have the following characters: It digests starch and emulsifies fat; it contains a large amount of sugar and of serum-albumin; and under the microscope leukocytes, fatty degenerated epithelial cells, cholesterin, free fat, and acicular crystals are common.

Treatment.—Three methods of treatment have been recommended—viz. tapping, total extirpation, and incision with drainage. Apart from the danger which attends tapping, it is at best only a palliative measure and not to be advocated. Total extirpation is unwarrantable from the fact that it is followed by diabetes, and, besides, is attended with terrible hemorrhage and serious danger. Incision with drainage is comparatively safe, and has proved very successful.

Operation.—The operation is very similar to that employed for a distended gall-bladder. An incision is made over the most prominent part of the tumor and the cyst exposed. The cyst is then sutured to the abdominal wall, the wound packed with gauze and left for four or five days, at the end of which time adhesions will have formed. The cyst is then opened with safety, washed out, and a double rubber drainage-tube inserted. When the operation is completed at one sitting, the sac, after exposure, is aspirated, pulled gently into the wound, and incised. Its edges are then stitched to the abdominal wound and the cavity drained.

Cancer of the pancreas calls for little consideration from a surgical standpoint. By the time the disease has so far progressed as to be recognized it has generally invaded other organs and is beyond

the reach of treatment. Billroth has removed the pancreas for carcinoma and the patient recovered, but this single case scarcely establishes a precedent. It is generally conceded that an attempt to remove the entire organ for any cause is unjustifiable. Partial removal is, however, another question. The following indications for operation are given by Senn: "Partial excision of the splenic portion in cases of circumscribed abscess and malignant tumors, in all cases where the pathological product can be removed completely without danger of compromising pancreatic digestion or inflicting abdominal injury upon important adjacent organs.

"Ligation of the pancreas at a point or points of section should precede extirpation as a prophylactic measure against troublesome hemorrhage and extravasation of pancreatic juice into the peritoneal cavity.

"The formation of an external pancreatic fistula by abdominal section is indicated in the treatment of cysts, abscesses, gangrene, and hemorrhage of the pancreas due to local causes.

"Abdominal section and lumbar drainage are indicated in cases of abscess or gangrene of the pancreas where it is found impossible to establish an anterior abdominal fistula.

"Thorough drainage is indicated in cases of abscess and gangrene of the pancreas with diffuse burrowing of pus in the retroperitoneal space.

"Removal of an impacted pancreatic calculus in the duodenal extremity of the duct of Wirsung, by taxis or incision and extraction, should be practised in all cases where the common bile-duct is compressed or obstructed by the calculus and death is threatened by cholemia."

XI. INJURIES AND DISEASES OF THE SPLEEN.

Examination.—The spleen lies in the left hypochondrium, and in the normal state of the organ its boundaries are as follows: From the upper border of the ninth rib to the lower border of the eleventh, and from the middle axillary line backward toward the spine. In the normal condition the organ cannot be palpated, lying as it does behind the ribs. When greatly enlarged it can be palpated and the sharp edge and rounded anterior surface clearly felt. The notch in its anterior border has long been considered a sort of distinguishing mark. When examined by percussion the spleen is found to be a solid body surrounded by resonant organs except on one side. Above is the lung, in front the stomach, and below is the intestine, while in the backward direction the dull sound is continued over the dorsal muscles.

Wounds of the Spleen.—Although the spleen is a very vascular organ, wounds of its substance are by no means always fatal. Guthrie has observed after death cicatrices in the spleen corresponding to former wounds. It is not so liable to injury as the liver, owing to its smaller size and greater depth. Sword-thrusts have been observed rarely, and it has been stated by Larrey that swordsmen who use the weapon with the left arm are in greater danger of sustaining wounds of the spleen, because they present to the adversary the side to which his hand is naturally directed. Protrusion appears to be a favorable com-

plication, as it tends to lessen the danger of internal hemorrhage and peritonitis.

The *diagnosis* of splenic wounds must at the onset rest upon the position, direction, and depth of the penetration. Hemorrhage must be judged of by the effect produced upon the pulse and the pallor of the face, lips, and gums, the sighing respiration, yawning, fainting, and possibly the presence of a steadily increasing area of dulness in the most dependent part of the abdomen. Should the hemorrhage be slight or the patient survive the immediate effects of the traumatism, peritonitis, splenitis, and abscess may appear at a later period.

Treatment.—If the position, direction, and depth of a wound should lead you to suspect a wound of the spleen, the injured side should be strapped as for fractured ribs; the patient should lie upon it and be kept perfectly at rest. Iced drinks are recommended to distend the stomach and cause pressure on the spleen. Should there be evidence that profuse hemorrhage is taking place, the abdominal cavity should be opened by an incision in the left linea semilunaris, and the wound in the spleen packed with iodoform gauze or the bleeding vessels ligatured. When the organ is seriously lacerated and other measures are of no avail the organ may be totally or partially removed. Splenectomy, or removal of the spleen, has been attended with a mortality of about 80 per cent. It is indicated in severe wounds of the organ, in certain tumors and cysts, and in cases of dislocated or movable spleen. For leukemia the operation is not justifiable. The great danger of splenectomy is hemorrhage. The incision is made in the upper part of the left lineæ semilunaris. After opening the peritoneum in the usual manner the hand is inserted and passed around the spleen, separating all adhesions. The organ is then brought out through the abdominal wound, care being taken to avoid twisting or dragging on the pedicle; the lower extremity must be the first to come through the wound. Traction on the pedicle is attended with shock and must be carefully avoided. With this object in view the abdominal parietes should be pressed inward by an assistant, and the pedicle kept in as slight a state of tension as possible. Sponges are packed around the abdominal end of the pedicle. The most important part of the operation is the securing of the vessels of the pedicle. They are exceedingly apt to slip through the ligature, and in spite of the most painstaking and skilful ligation hemorrhage has followed many of these operations. Dr. Greig Smith gives the following directions: "No absolute rule can be laid down as to the management of the pedicle, but a few guiding principles may safely be enunciated. Every divided vessel, artery, or vein should be efficiently and, as far as possible, separately ligatured. The ligature should be tied while the pedicle is in a state of relaxation; the tendency of a small branch to retract after being forcibly elongated is thereby obviated. The veins should be ligatured as well as the arteries, because considerable branches communicate with the splenic vein close to the site of ligation. If the splenic branches spread out considerably before entering the hilum, if they are numerous and intermingled with veins and not easily isolated, and if the pedicle is not short, the placing of a broad temporary clamp before cutting away the tumor may be found advantageous. In many cases it will be found a good plan to

apply pressure-forceps in pairs—one pair after another—to each portion of the pedicle which contains a vessel, and divide between them till the whole pedicle has been cut through. Then one forceps after another is picked up, and the vessel or vessels which it grasps are deliberately tied at a safe distance from the forceps. When each vessel has been secured the whole may be surrounded with a single ligature, tied with moderate force, so as to lessen the shock of the arterial pulse on the distal ligatures. Finally, the ligatures are all cut short and the pedicle dropped into the cavity. Sponging, if it is necessary, should avoid the pedicle, which may be kept out of the way by a catch-forceps attached to its extremity.

"The gastro-splenic and diaphragmatic ligaments are dealt with in the same fashion by separate ligatures; the same minute care need not be observed, however. Adhesions are treated according to ordinary principles."

Gunshot wounds of the spleen, if not extensive, are not necessarily fatal, even when the bullet lodges in the organ. In warfare this form of wounds is observed much more frequently than in the incised or punctured variety, as the American Civil War afforded only a single instance of incised, while thirty gunshot wounds are recorded. The symptoms are obscure, and the diagnosis must rest upon the evidence of hemorrhage.



FIG. 139.—Anterior view of tumor of the spleen, showing lines of dulness (Abbe).

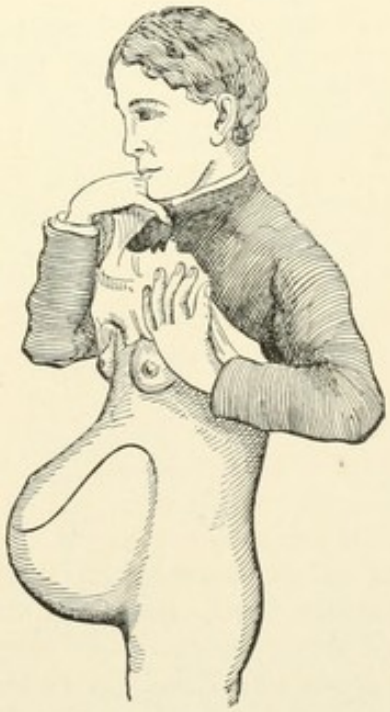


FIG. 140.—Lateral view of site and lines of dulness of a tumor of the spleen (Abbe).

Protrusion of the spleen through a wound may require total or partial splenectomy.

Abscess of the spleen probably occurs more frequently than is generally supposed, owing to the difficulty with which the condition is recognized. The cause is traumatism or septic infection. The treatment is practically the same as for abscess of the liver.

Rupture of the spleen may be produced by violent blows or kicks. The accident is usually fatal unless the organ protrudes through a wound and the protruding portion is ligated or removed.

Cysts of the spleen are simple, hydatid, or dermoid, and are almost beyond the possibility of diagnosis except by exploratory puncture or incision. The treatment consists of incision or drainage, as in the case of a similar condition in the liver.

Carcinoma and **sarcoma** of the spleen may be considered as beyond the pale of surgical treatment.

The areas of dulness in tumors of the spleen are shown in Figs. 139 and 140.

XII. DISEASES AND INJURIES OF THE RECTUM AND ANUS.

The history of a rectal disease, as related by the patient, is generally unsatisfactory and unreliable. One disease is uppermost in his mind, and that is "piles." If he has pruritus, he speaks of "itching piles." If there is hemorrhage from the rectum due to any condition, he speaks of "bleeding piles." There is no class of diseases in which so little reliance can be placed upon the patient's own statements as in diseases of the rectum. On this account a systematic examination should be made in every case and the diagnosis settled by the surgeon's personal observation.

Mathews advises that the first question put to the patient should be, Does the bowel protrude at stool? This practically settles the question of piles; for if there is no protrusion, there are no internal hemorrhoids that require a surgical operation. It also settles the question of polypi, for these growths usually protrude during the act of defecation.

Examination.—For purposes of examination the patient should lie on his left side, and, where it is at all possible, he should be prepared by having had the bowels previously cleared out by a purgative and the rectum washed by an enema. The knees should be drawn up, the body placed in Sims' position with the back to the light, and the pelvis elevated.

Inspection.—The condition of the anus should be noted; external hemorrhoids or protruding internal piles, the opening of fistulæ, ulceration, eczema, pruritus, fissures, abscesses, and condylomata can be detected with the eye.

Digital Examination.—No instrument has ever been invented that can compare with the finger as an aid to the examination of the interior of the rectum. The examining digit should be well lubricated with vaselin and passed through the sphincter with great gentleness. If the patient offers no resistance and the surgeon makes use of a boring motion with his finger, the pain of this examination is trifling, except where there is serious disease. Having passed the finger through the sphincter, any undue contraction of that muscle is to be noted, and before the digit is withdrawn the following questions must be answered:

1. Is there stricture? In the healthy rectum the finger can be made to sweep around a considerable space, and there is nothing to impede its progress when pushed in an upward direction. In the case of stric-

ture a narrowed portion is reached through which the finger may be freely passed or passed with difficulty; in any case where stricture exists the finger can readily detect it if within reach.

2. Is there a tumor? Cancerous tumors are readily detected when they are hard and lobulated; polypi are often attached by long pedicles and may reach up to the sigmoid flexure, although the insertion of the pedicle is easily within reach. The patient should therefore be directed to "strain down," so as to avoid this source of error.

3. Is there an ulcer? Chronic ulcers in the rectum have indurated edges and a good deal of inflammatory thickening which the examining finger readily detects.

4. In the male the prostate, and in the female the uterus, should be carefully palpated in this examination. The prostate, even in health, can be felt and its lobes accurately defined. If the gland is found enlarged or painful to touch, this fact should be carefully noted. The uterus may be felt to be retroverted, and symptoms which were referred to the rectum thus accounted for.

Examination with the Speculum.—Many different forms of specula have been invented, few of which are of any value. The best instruments are those which contain least surface of metal and permit a view of an extensive bowel surface. Mathews' self-retaining rectal speculum (Fig. 141) seems to answer all purposes. For illumination direct sun-

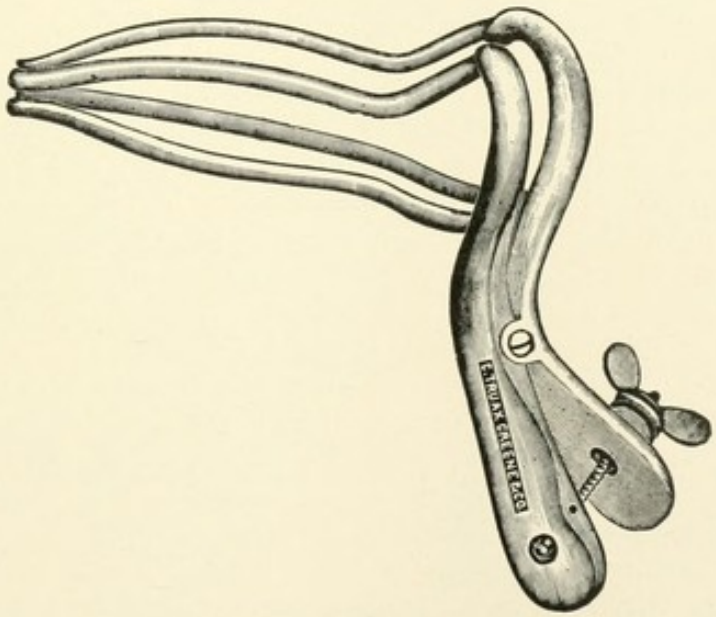


FIG. 141.—Mathews' self-retaining rectal speculum.

light is the best, but a forehead mirror and any of the reflectors used by eye or throat specialists will be useful when natural light is not obtainable. By the aid of the speculum the diagnosis made by the finger can be corroborated, ulcers, simple, malignant, or syphilitic, can be studied, and the condition of the mucous membrane of the rectum ascertained.

Manual Examination.—Although this method of examining the rectum has been advocated by eminent authorities, notably by Simon, it must be considered a dangerous procedure, seldom necessary. and

not affording benefit commensurate with the risk. In exceptional cases, however, it is justifiable. The hand of the examiner should not exceed eight inches in its greatest circumference. The patient having been anesthetized, two fingers are inserted, then three, and finally the five digits. With a boring motion the whole hand is finally passed within the sphincter and up toward the sigmoid flexure. It is only in exploring the upper portion of the rectum and lower end of the sigmoid flexure that the hand possesses any advantage over the finger.

Bougies and rectal sounds are dangerous and of very doubtful utility. In passing them up the bowel they are almost sure to be stopped by a fold of mucous membrane or they impinge against the sacrum.

Wounds and Other Injuries of the Rectum.—The commonest cause of wound of the rectum is rupture of the perineum during parturition. The laceration extends through the sphincter ani, and seldom involves the higher portions of the bowel. One case is recorded (Busche) in which the child's head was passed through the anus. Falls upon sharp or pointed instruments and the rough use of a bougie or the enema syringe have been known to cause death by wounding the rectum and perforating the peritoneum. Such wounds are generally septic, and are more dangerous when punctured than when incised and well drained. A violent effort to expel a mass of hardened feces has been known to rupture the bowel, but it is doubtful if this has ever taken place in a healthy rectum. The accident is attended with sharp pain at the moment of the rupture, and followed by a discharge of blood.

Wounds of the rectum, however produced, are liable to serious complications. The hemorrhage is often profuse, and may be either primary or secondary. If the wound be high up, the peritoneum is perforated, and septic peritonitis is an almost inevitable consequence. Fecal matter infiltrates the surrounding tissues, invagination or hernia may occur, and at a later period stricture and fistula. When emphysema follows such a wound, as it frequently does, the putrid nature of the gas leads to diffuse inflammation and septicemia.

Treatment.—Uncomplicated wounds of the rectum may heal readily, and an effort should always be made to obtain prompt healing by disinfecting the parts as well as possible, by accurate approximation of the lacerated tissues, by frequent irrigation with mild antiseptic solutions, and by keeping the bowels at rest. Opiates serve this latter purpose, and lessen the danger of fecal infiltration by solidifying the stools. When there is fecal infiltration or imperfect drainage the sphincter ani may require free dilatation or incision.

Foreign Bodies in the Rectum.—All sorts of bodies have been found in the rectum, from nails, screws, and knitting-needles swallowed by lunatics to the military despatches discovered by Napoleon's officers in the bowel of the German soldier. These bodies are either swallowed, and, passing through the entire alimentary canal, are arrested in the rectum, or they are pushed into the bowel by the patient. They produce irritation and ulceration of the bowel which may lead to perforation and death by peritonitis. For their removal the patient should be anesthetized, the sphincter dilated, and, if need be, an incision made through the posterior part of the anus to the tip

of the coccyx. This incision gives free access to the rectum and admits the whole hand or instruments for the removal of large objects. In the case of bottles or cups great care should be taken to avoid breaking them, as in such an event the sharp fragments would produce serious injury before they could be removed.

Hemorrhoids, or Piles.—Hemorrhoids are dilatations of the veins of the rectum, with more or less infiltration of the connective tissue. The branches of the superior hemorrhoidal vein in their course upward pass through little slits in the muscular wall. When the muscle contracts upon them it causes obstruction of the caliber of the vessel, and hence dilatation below that point. Verneuil asserts that man is liable to this varicose condition, owing to his upright position and to the absence of valves in these veins. Persons are predisposed to the condition who are hearty eaters and lead sedentary lives. The chief exciting causes are—1. Conditions which obstruct the return circulation of the rectum, as pregnancy, constipation, straining at stool (as in dysentery), pelvic tumors, etc.; 2. Portal obstruction due to diseases of the heart, lungs, or liver.

Two classes of hemorrhoids are recognized, one class being inside, the other outside, the sphincter muscle. If the veins inside the sphincter are affected and protrude at stool, either remaining outside or capable of being pushed back above the sphincter, they are called *internal* piles. If the affected veins are in the submucous tissue outside the sphincter, they are *external.* In some cases the external hemorrhoids are partially covered by skin and partly with mucous membrane, forming a sort of mixed variety, which when inflamed becomes edematous, infiltrated, and very painful.

External piles occur in two forms:

(*a*) *Venous piles*, which are dilated veins of a purplish or reddish color, in some cases causing little or no trouble; in others they are inflamed, tender, and produce excessive pain during defecation. Sometimes a clot of blood is found which may be a thrombus in the lumen of the vein, or a slight hemorrhage into the surrounding tissues due to the rupture of the vein (Mathews).

(*b*) *Cutaneous Piles.*—These are hypertrophied folds or tags of skin produced by inflammatory thickening around the affected veins. They are often exceedingly painful, but when free from inflammation give no trouble. They are usually a result of the venous variety of hemorrhoids.

Treatment.—Although operative treatment affords the only permanent relief, patients are not always willing to submit to it, and palliative measures must be employed. Errors in diet must be corrected, highly-seasoned foods and stimulants being forbidden. Hot or cold applications, combined with rest in bed, are useful to allay inflammation. Ointments of belladonna and opium have long been favorite remedies. Lotions containing carbolic acid or acetate of lead are recommended. Poultices may be employed. Constipation should be remedied by mild laxatives, such as cascara, confection of senna and sulphur, or the compound licorice powder, and when possible the exciting causes should be removed. Regular habits of going to stool must be cultivated.

Operative treatment aims at a radical cure of the condition. For the cutaneous variety excision is the proper remedy. The following is the operation recommended by Mathews: A half-grain of the muriate of cocain is injected under the growth and five or ten minutes allowed for its complete absorption. The tumor is then caught up at its base with a pair of four-pronged forceps and drawn firmly out. With a sharp knife the skin is next divided all around it, up to the mucous membrane on each side. A silk suture is then thrown around the base, tightly tied, and the tumor cut off close to the thread. Many operators are content to snip off the protuberant skin with scissors, controlling the resulting hemorrhage by pressure and leaving the wound to heal by granulation. A neater operation, and one more in accordance with the surgery of to-day, is to treat the growth as a simple tumor, disinfect the part, excise the growth by a clean incision, stop all bleeding, close the wound by a continuous catgut suture, and dress it with iodoformized collodion.

The common method of treating venous external piles is as follows: "Pinch up the tumor gently between the finger and thumb of the left hand, transfix its base with a curved bistoury, and cut out; at the same moment, by pressure of the finger and thumb, the clot may be extruded. Place a piece of cotton wool at the bottom of the sac and the operation is completed. The pain soon subsides, and the patient makes a speedy convalescence. The incision should be made in the direction of the radiating folds of the anus, and this allows more completely of the contraction of the skin" (Allingham).

Internal hemorrhoids are usually described as varicosities of the middle and superior hemorrhoidal veins. This definition does not fully describe them. Besides the dilated vein there is always more or less infiltration of the surrounding connective tissue. The vascular tissue need not necessarily be venous, for an artery as large as the radial is sometimes found entering the base of an internal pile.

Allingham makes three classes of internal hemorrhoids—viz. capillary, arterial, and venous.

Capillary hemorrhoids partake of the character of nevi or erectile tumors, being slightly elevated above the surface of the mucous membrane, of a granular appearance, and bleeding freely on the slightest irritation. They bleed if touched during an examination: they bleed during defecation. "Bleeding piles" is a term which is well applied to them. They never protrude through the anus. The chief symptom of this variety is hemorrhage, which occurs during every act of defecation, often without the patient's knowledge, for the piles are painless. Bleeding daily for weeks or even months, the patient becomes anemic. the heart is disturbed in its action, the digestion suffers, and in females menstruation ceases.

By natural changes the arterial hemorrhoid merges into one of the other varieties. Constant irritation leads to inflammation; inflammation is followed by thickening of the adjacent connective tissue; as this increases it obliterates the capillaries by pressure, and there is produced the second variety—viz.:

The *arterial* hemorrhoid, which is a freely anastomosing mass of arteries and veins bound together by connective tissue. The veins are

varicose, the arteries tortuous, and their pulsations can be felt by the examining finger. As the tumor increases in size it drops farther and farther from the rectum, and at last is protruded every time the patient goes to stool. It is smooth and firm to the touch, easily inflamed, and subject to erosion. The patient learns to push it back after each movement of the bowel, and all goes fairly well until some day it comes out and becomes strangulated by the action of the sphincter ani.

The *venous* hemorrhoid may be a sequel of either of the two preceding, or its venous character may be present from the first. A vein beneath the mucous membrane becomes dilated; inflammatory changes thicken the membrane and the connective tissue. A tumor results, bluish and hard, which protrudes in defecation, and is covered by a

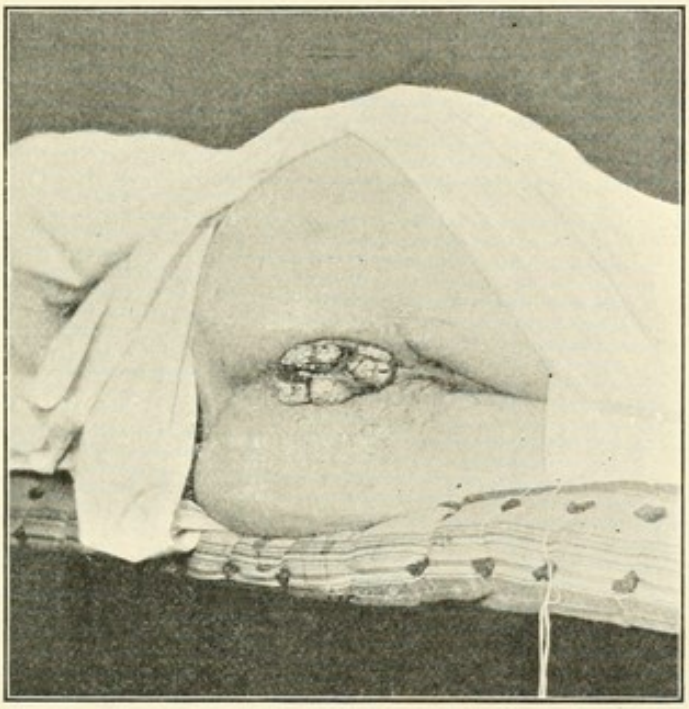


FIG. 142.—Hemorrhoids (from a photograph in the collection of Dr. Lincoln, Wabasha, Minn.).

mucous membrane which by gradual thickening from exposure assumes the appearance of skin (Fig. 142).

All three varieties may exist in the same patient at the same time, each bearing its own distinctive characteristic or merging the one into the other.

Symptoms.—The leading symptom, as a rule, is hemorrhage, and in the capillary variety it may be the only evidence. Pain is not present until protrusion takes place and the tumors are irritated either by friction or the grasp of the sphincter. In making an examination the finger should first be used. If the tumor be hard it will be readily felt, but if soft and not over-distended, it may escape detection, even though it bleed occasionally. The speculum should next be employed and an inspection made of the whole rectal surface. "An examination in the case of internal hemorrhoids should never end with the finding of a tumor. An inch or so higher up there may be stricture, malignant or simple, which has given no sign of its presence except the hemorrhoids; and this is not a good thing to overlook" (Kelsey).

Treatment.—The palliative treatment is the same as in external piles, and is equally unsatisfactory. Rarely a spontaneous cure takes place. The hemorrhoids protrude and become strangulated by the action of the sphincter ani; ulceration and sloughing follow, causing the tumor to drop off, after which the part heals over. The operative procedures are as follows:

Removal by the Clamp and Cautery.—I prefer this to any other method, as it is just as safe as the ligature, and is free from the tedious sloughing which attends the tying of masses of tissue. The choice of operation should, however, be determined by the nature of the case. If the anus is patulous and the sphincter relaxed, and especially if the hemorrhoids are of the capillary variety, the treatment by clamp and cautery is the best. The cicatricial contraction which follows the burns produced by the cautery is here utilized to remedy the laxity about the anus. In many other cases such contraction would prove an injury, and in these cases the ligature would be preferable.

The patient should be prepared for this or any of the other operations for hemorrhoids by taking a brisk purgative the previous evening and having one or more enemata of soap and water on the morning of the operation. Under an anesthetic the sphincter is stretched by both thumbs or by a speculum, and the tension maintained until the muscle is felt to give way. This gives a clear view of the rectum for about three inches, it allows you to check hemorrhage should any occur, and it is the best safeguard against the pain which follows the operation. The lithotomy position is the most convenient, the knees being held apart and flexed by the aid of a Clover's crutch. Each of the tumors brought down separately by a pair of forceps is placed within the blades of a clamp and the instrument tightly screwed up, and so placed that the scar will radiate from the anus as a centre. The pile is now cut off with scissors to within one-eighth of an inch of the clamp (Fig. 143). The Paquelin cautery-knife at a dull red heat is applied to the stump and all the tissue burned away down to the clamp. The instrument is removed and each remaining pile similarly dealt with. For a dressing an ointment of iodoform and vaselin is as good as any. The parts are first irrigated with an antiseptic, the ointment spread over the cauterized parts and covered with absorbent cotton held in place by a T-bandage. A morphia suppository or a hypodermic injection prevents pain and should not be neglected. The bowels are kept con-

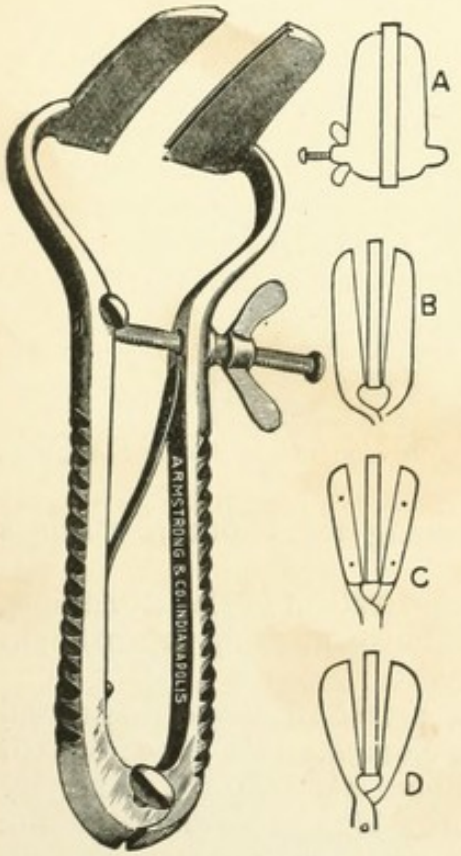


FIG. 143.—Gant's pile-and-polypus clamp. The letters show the different clamps and their clamping power: A, Gant's; B, Kelsey's; C, Smith's; D, Langenbeck's.

fined by the opiates for three days, after which a dose of castor oil is given and the bowels caused to move daily thereafter. Difficult urination, which is common after all operations on the rectum, is relieved by hot fomentations over the bladder and by the use of the catheter.

Ligature.—The preparation of the patient is the same us in the preceding. The tumor is grasped by forceps or volsella and drawn down. With sharp scissors the mucous membrane or skin around the base of the tumor is divided, and a silk ligature thrown around the pedicle and tied as tightly as possible. The pile is cut off with scissors close to the ligature and the ends of the thread cut short. When the pedicle is large it is best to transfix it with a needle carrying a double thread. The muco-cutaneous border is divided as before and each half tied off.

Whitehead's operation is excision of the tumors, and is thus performed: An incision at the junction of the skin and mucous membrane separates the membranes from the muscular tissue. The mucous membrane containing all the hemorrhoids and veins is dissected off throughout its whole circumference and brought down below the anal orifice. On a line above the piles this membrane is divided transversely and attached by a row of sutures to the skin surrounding the anus. The operation is very radical, but is open to several objections: It is more dangerous than either ligature or cautery, and there is a risk of stricture of the rectum in the event of failure of the wound to heal by first intention.

Other methods which have been advocated for the cure of hemorrhoids are crushing, injection with carbolic or chromic acid, ignipuncture, dilatation of the sphincter muscle, application of chemical caustics, and submucous ligation. But these cannot be regarded as trustworthy.

Prolapsus Ani.—This is a common accident in childhood and old age, and consists of a protrusion of the mucous membrane of the rectum through the sphincter ani. It is frequently the result of straining at stool due to phimosis, constipation, diarrhea, or stone in the bladder, and especially when connected with a feeble constitution. It also occurs in elderly people, especially those who have enlarged prostates and difficult urination. It frequently complicates pregnancy, and also hemorrhoids and polypi of the rectum. It might seem strange that errors should occur in the diagnosis of prolapsus ani, but such is the case.

The *symptoms* will depend largely upon the condition of the sphincter, whether or not there is constriction of the protruding mass. If the condition has existed for some time and the sphincter is relaxed, the patient will complain of inconvenience and discomfort or an offensive discharge of blood, not rarely appearing in the stools, and pain upon walking or sitting. Where the constriction of the protruding mass results in more or less obstruction to the blood-supply, the symptoms are a sensation of a foreign body in the rectum associated with hot, burning pain, a fetid discharge, and rarely an elevation of the body-temperature. The mass may become ulcerated and sloughing, and stricture of the rectum may result. The gut will be of a bright-red color, and its folds can be easily pressed together when placed between the fingers. Hemorrhoids are irregular in shape, of a purplish or dark-red color, and when grasped by the finger and thumb are felt

as firm organized tumors. Polypus is not so smooth to the eye and to the touch, and has a pedicle.

Prolapsus recti is a protrusion of all the coats of the rectum, and is to be distinguished from the prolapsus in which only the mucous membrane protrudes. The tumor in prolapsed rectum is usually much longer and thicker than in the former case. It may be several inches in length. Cases have been recorded in which the tumor was as large as a fetal head. Symptoms are the same as those of prolapsus ani, greatly intensified, with incontinence of feces.

Treatment.—A child subject to prolapsus should be prevented from straining at stool. He should have an attendant who will remove him from the commode as soon as the bowels are evacuated. When the bowel protrudes it should be wiped with a soft cloth wrung out of cold water, gently pushed back, and retained by a T-bandage or by broad strips of adhesive plaster applied so as to keep the buttocks together. I have found great benefit from the use of astringent injections given once a day. Alum, gallic acid, or hydrastis serves the purpose.

These children are usually debilitated, and require iron tonics and cod-liver oil to build them up and improve their general health. Constipation should be prevented by the judicious use of a mild laxative. When the prolapsed bowel remains down in spite of the ordinary efforts of the nurse or mother to return it, the aid of the physician is sought. The best position for reduction is on the knees and elbows. The bowel, having been washed with cold water, is anointed with vaselin. The surgeon then inserts his finger into the rectum, and by taxis practised around the finger the bowel easily slips back to its normal position (Mathews).

Sometimes the bowel goes up more readily if the finger is covered with a soft handkerchief or a piece of lint. Should these measures fail, give an anesthetic, which, by quieting the voluntary movements and relaxing the sphincter, allows the bowel to go back without difficulty. To prevent a recurrence several operative procedures have been recommended. The mucous membrane may be cauterized in strips by solid nitrate of silver or nitric acid. The cautery has been a favorite remedy with many surgeons, owing to the contraction which follows its application. It should be applied in the long axis of the bowel in four lines a quarter of an inch wide (Cripps). After the cautery has been quickly passed over the surface in this manner a tube is passed into the rectum a distance of five or six inches, and the space around it packed with iodoform and absorbent cotton. The bowels are kept quiet by opium for about ten days, and defecation allowed only while lying on the side.

In aggravated cases a more radical operation may be called for, and we have a choice of several procedures: (*a*) One or more of the folds of the mucous membrane may be removed by the clamp and cautery. (*b*) A V-shaped piece may be removed from the sphincter and the edges brought together by sutures. (*c*) A V-shaped portion is removed from the posterior part of the sphincter and the entire thickness of the rectum, having a common base below (Roberts). (*d*) The protruded mucous membrane may be excised and the lower edge of the remainder attached to the skin (Treves).

Pruritus Ani.—A complication of many diseases of the rectum and anus is a very distressing itching. In some cases this disagreeable sensation is constantly present. In others it is quiescent during the day, but just as the patient is getting warm in bed and sleep begins to steal over him an intolerable itching around the anus begins, and he spends a wretched night. Scratching makes matters ten times worse. After enduring this torture for an indefinite time, the patient consults the physician for what he terms "itching piles." Examination shows thickened, hardened, excoriated skin around the anus, often eczematous from constant irritation, and the patient can scarcely keep his fingers off, so urgent is the desire to scratch. Further investigation will lead to the discovery of hemorrhoids, prolapsus, stricture, or other rectal disorder. Sometimes the only apparent derangement is a mucous secretion which keeps the parts moist. Many people suffer only during periods of constipation or when the functions of the liver are being imperfectly performed, and in others the affection is a pure neurosis. Alcohol and highly seasoned foods have been known to act as exciting causes, and women suffering from uterine diseases appear to form a large class of cases.

The itching is most intense just inside the anus, and extends about an inch up the rectum. The inferior hemorrhoidal nerve supplies this area as well as the skin in the neighborhood of the anus, which explains anatomically why the itching so uniformly extends over these surfaces.

Treatment.—The treatment of pruritus is very unsatisfactory and its results uncertain. When it is possible to ascertain and remove the cause this should be done. If thread-worms are present, injections of the infusion of quassia should be employed. Whatever rectal diseases coexist should receive prompt treatment. For the relief of the itching I have found nothing so generally useful as calomel, either applied in powder or made into an ointment with vaselin. Inasmuch as the most trouble is experienced after the patient goes to bed, Mathews recommends that the parts be bathed in water as hot as can be borne, then wiped dry and the following lotion applied:

℞. Campho-phenique, ʒj;
Aquæ dest., ℥j.—M.

Morain paints the parts night and morning with a mixture containing 60 grains of alum, 30 grains of calomel, and 300 grains of glycerol.

To produce sleep 10 grains of sulphonal may be given.

Local applications, however, will produce no permanent benefit as long as there is a thickened and scaly condition of the skin. To get rid of this the tincture of iodin is applied and renewed in two or three days, or a solution of nitrate of silver 20 or 30 grains to the ounce.

After the removal of the scarf skin local applications of a milder nature can be used. Some of the preparations of tar have been very popular, as the oil of cade or marine lint (which contains tar) placed between the buttocks to prevent their apposition. A lotion containing a mixture of menthol and cocain and an ointment of oxid of zinc and

balsam of Peru are favorite applications. Bulkley's ointment is the following:

℞.	Ungt. picis,	ʒiij;
	Ungt. belladonnæ,	ʒij;
	Tinct. aconiti rad.,	ʒss;
	Zinci oxidi,	ʒj;
	Aquæ rosæ,	ʒiij.

After the disease has resisted every other treatment it may be cured by dilatation of the sphincter or by the wearing of a bone plug which keeps the anus slightly distended during the hours spent in bed.

Inflammatory Diseases of the Rectum.—Inflammation in and about the rectum not only produces painful and troublesome conditions, but leads to secondary affections. Thus proctitis, or inflammation of the mucous membrane of the rectum, is likely to end in ulceration, while periproctitis paves the way for fistula in ano.

Proctitis is a catarrhal inflammation of the mucous membrane of the rectum, and is due to irritation or infection. Among the causes, therefore, we find the abuse of purgatives, the presence of foreign bodies or hardened feces in the rectum, gonorrhea, gout, and syphilis.

The disease may be acute or chronic. In the *acute* form the inflammation does not go deeper than the mucous membrane, which is congested and hyperemic. When the cause can be removed this variety gets well in from eight to fourteen days. In very exceptional cases, however, it may go on to gangrene of the bowel and end in death. In the chronic form the submucous and muscular layers are involved, the bowel-wall becomes thickened and infiltrated, and frequently the disease goes on to ulceration.

Symptoms.—A sensation of burning and heaviness in the rectum is a pretty constant symptom. Naturally, this burning is attended with a frequent inclination to have a movement of the bowels; the action is painful, and attended with tenesmus. Neighboring organs sympathize; hence there is pain in the bladder, and frequent micturition, pain in the uterus with leukorrhea, pain in the sacrum, in the loins, and along the thighs. An examination of the parts will show that the anus is inflamed, painful, excoriated, and contracted. The mucous membrane of the rectum is intensely congested, and the temperature, even to the examining finger, is greatly increased. The feces are streaked with mucus, blood, and finally with pus. As a result of all this local disturbance there are constitutional effects, as fever, nausea, and loss of appetite. In chronic proctitis the symptoms are not so well marked. Diarrhea may alternate with periods of constipation. The pain is not so severe as in the acute variety. It is generally associated with stricture of the rectum. Below the stricture the mucous membrane is congested and covered with pus or bloody mucus, while above it is eroded or destroyed (Kelsey).

Ulceration of the rectum is caused by the irritation of foreign bodies or the passage of hard, scybalous masses, or it is a consequence of chronic proctitis. Thrombosis and phlebitis are also causes. The ulceration may be superficial, simply involving the epithelial lining,

or it may be so deep as to perforate all the coats of the bowel. This is, of course, a serious matter, but much depends upon the position of the perforation. If it is low down, it leads to abscess and fistula; if it is above the reflection of the peritoneum, a fatal peritonitis is a probable termination.

Syphilitic, tubercular, and lupoid ulceration are not uncommon in the rectum.

We know that ulceration of the bowel higher up, such as occurs in typhoid fever, is attended with diarrhea. The same symptom attends ulcer in the rectum. In the early and milder stage the patient has a call to stool as soon as he gets out of bed. He passes a small quantity of liquid feces containing mucus like the white of an egg. Once or twice in the forenoon this is repeated. The rectum is now empty, and the rest of the day is spent in comparative comfort. The condition is apt to get worse; diarrhea increases in frequency and is attended with painful straining; from mucus the motions change to a dark coffee-ground material; the skin about the anus is constantly moist, covered with vegetations and excrescences, giving rise almost invariably to itching. When you make a local examination you find that if the ulcer is about the anus, it takes the form of a fissure, which is usually exceedingly tender. If inside the sphincter, the ulcers lie deep between the folds, and so sensitive are the parts that for an examination with the speculum an anesthetic is required. The finger, however, is generally sufficient, and it should be introduced with the greatest gentleness. The point of the finger will meet with a variety of conditions: in one part are felt soft, smooth patches with ragged, overhanging edges; in another hard nodules project from the surface or dense bands of cicatricial tissue traverse a part of the circumference of the bowel, simulating stricture. When the finger is withdrawn it is usually smeared with mucus and blood. An ulcer due to *syphilis* is found near the verge of the anus, and makes its appearance during the first year after the contraction of the initial lesion. Inherited syphilitic ulcer appears three or four months after birth. The tertiary stage has also its rectal ulcers which are due to the breaking down of gummata. The *tubercular* ulcer may occur as a primary lesion or as a secondary manifestation of tuberculosis in other parts. It is oval in shape, its long axis corresponding to that of the bowel; its edges are ragged and undermined, and it often ends in fistula and abscess.

Treatment.—Removal of the cause and the securing of perfect rest are the first requisites. Injections which will cleanse and soothe the bowel are very useful. A solution of chlorate of potash, followed by an enema of starch and a few drops of laudanum, gives great comfort in the milder cases of proctitis. A dose of castor oil or small doses of a saline aperient should be given to remove acrid contents of the bowel. The diet should be light and easily digested, and such articles avoided as tend to form bulky stools. Bread, meat, and vegetables are to be avoided. Milk, soft-boiled eggs, and prepared foods are generally satisfactory. In chronic cases astringent injections of alum, tannin, nitrate of silver, and suppositories of iodoform are recommended.

Constitutional treatment must be directed to the existing conditions. Syphilitic cases require iodid of potash. Cod-liver oil is valuable, as it

not only tends to replace the waste of flesh, but it keeps the motions soft.

Operative interference may be required, but is not to be hastily adopted. In obstinate cases benefit has been derived from stretching or dividing the sphincter, and where every local remedy has been tried in vain colotomy has been resorted to.

Periproctitis.—Inflammation around the rectum may occur in one of three situations—close to the anus (marginal), in the ischio-rectal fossa, or higher up about the insertion of the levator ani and the recto-vesical fascia.

1. *Marginal.*—This is a superficial inflammation involving the skin only of the margin of the anus. It is merely a collection of pus originating in one of the small glands of the part, and may be caused by a traumatism or any irritation, such as the pressure of a rough seat, the use of improper toilet-paper, or unhealthy discharges occurring in menstruation, diarrhea, or dysentery. The swelling is seldom larger than an almond; it rapidly goes on to the formation of an abscess and opens on the cutaneous surface. In phthisical persons it not infrequently ends in a fistula. Instead of appearing at the cutaneous surface, this little abscess may form near the mucous membrane, and usually it is the result of an inflamed internal hemorrhoid at, or just inside, the sphincter. It varies in size from a grape to an almond, and is excessively painful. This is the starting-point of nearly every blind internal fistula. After a few days of suffering the abscess bursts into the bowel, and the escape of pus from the anus accounts for the whole trouble.

Treatment.—The important practical point in all inflammations about the rectum is the danger of their resulting in fistula. In order to prevent such a termination the abscess should be opened as early as possible and at right angles to the folds, so as to secure gaping of the wound. The incision should be kept open and the cavity allowed to heal from the bottom.

Another form of superficial abscess occurs in the subcutaneous tissue; hence it is more diffuse and more difficult to dispose of than the preceding. The diagnosis needs no special mention, except that fluctuation is best elicited by placing one finger in the rectum and the other outside. Early and free incision is the only treatment.

2. *Ischio-rectal Abscess.*—Bounded above by the levator ani and below by the skin, on the inside by the rectum, and on the outside by the pelvis, is a space which is a favorite position for suppuration.

The most common cause for ischio-rectal inflammation is traumatism. Generally the injury is from within the rectum. The rough use of a syringe and the swallowing of fish-bones or other sharp objects figure largely in the causation. External to the rectum the causes are kicks and blows, the pressure of the fetal head during parturition, extravasation of urine from ruptured urethra, and necrosis of the sacrum, the coccyx, or the lumbar vertebræ.

Symptoms.—The disease may be obscure at its onset, the patient complaining of a dull pain about the pelvis and loins, with general malaise, or the symptoms may be acute chills, high temperature, and severe pain. The first definite symptom will probably be pain in

defecation, which is often so severe as to amount to perfect torture. Constitutional symptoms become more marked, such as high temperature, rapid pulse, and occasionally chills. On local examination a hard brawny mass is felt on one or other side of the anus, which later becomes red and fluctuating. Sometimes the tendency of the abscess is to burrow upward to the prostate and urethra, in which case there are retention of urine and other symptoms pointing to prostatic or urethral complications.

Examination by the finger or speculum is generally so painful as to be out of the question. If not opened early, this abscess is apt to burst into the rectum, forming a fistula. A chronic form of the disease is met with in the feeble, debilitated, and phthisical.

3. *Abscess above the Levator Ani Muscle.*—The levator ani forms a sling-like support for the lower part of the rectum. It arises on either side from the posterior surface of the pubic bone below the symphysis, from the curved white line indicating the separation of the obturator and recto-vesical layers of the pelvic fascia, and from the inner surface of the spine of the ischium (McClellan). Passing downward and inward toward the middle line, the muscle is inserted around the rectum between the internal and external sphincter ani muscles.

Inflammation and suppuration above this muscle is a very serious matter. The abscess may assume enormous proportions, blending laterally with the subperitoneal connective tissue of the iliac fossa, and burrowing in almost any direction in the true pelvis (Kelsey). The disease is generally an extension from some of the neighboring viscera or the result of stricture in the rectum. It is not uncommon after parturition or metritis, the disease in this case extending from the uterus, thus causing stricture of the rectum to be much more common in women than in men. In men the pus generally burrows along the side of the bowel, making its way into the ischio-rectal fossa, and finally through the skin of the perineum at some distance from the anus. In females it not unfrequently burrows upward, reaching the skin about the crest of the ileum or in the groin. Not unfrequently the abscess ruptures into the rectum. We then have a characteristic symptom. Pus is discharged at each act of defecation. If the opening is near the anus, the pus comes before the feces; if it is above the rectal pouch, it comes after the feces.

In very exceptional cases the abscess ruptures into the bladder, the uterus, the peritoneum, or the vagina.

Treatment.—Early incision is here the only proper course. As soon as diagnosis of the existence of pus is made, even before fluctuation is detected, the patient should be anesthetized and the abscess freely and deeply incised. All pockets should be explored, thoroughly evacuated, and made to communicate freely with the main cavity. This should then be well irrigated with a 1 : 2000 sublimate solution, dusted with iodoform, and packed loosely with iodoform gauze. A drainage-tube should be inserted and the cavity made to granulate from the bottom.

Fistula in Ano.—Any of the forms of abscess just mentioned may heal to a certain point and then remain stationary, keeping up a constant discharge of pus by an opening into the rectum or externally through the skin, or in both directions. When the fistula has an open-

ing through both skin and rectum, it is called *complete;* when the opening is in only one direction, it is termed *incomplete* or *blind.* A fistula whose only opening is into the rectum is a *blind internal* fistula, and one opening only through the skin is a *blind external* fistula.

Fistulæ may be divided into anal and rectal. In the first class the opening is close to the anus, almost entirely subcutaneous or penetrating some of the lower fibers of the sphincter. They are generally the sequelæ of marginal abscesses. Rectal fistulæ are deeper, traversing the ischio-rectal fossa and passing into the bowel between the external and internal sphincter or even above the internal. Sometimes there are numerous fistulous channels running in different directions until the perineum is fairly riddled by them (Fig. 144). Pus burrowing in

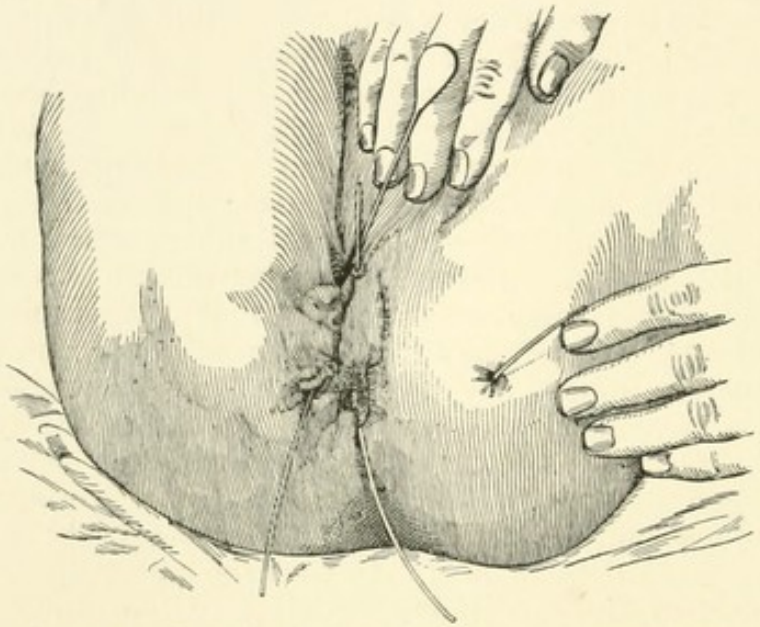


FIG. 144.—Horseshoe fistula with multiple openings (Gant).

the loose tissues of the perineum may travel far, and thus the external opening is often found at a considerable distance from the anus. Some cases have been recorded in which the opening was in the groin, others in which pus burrowed beneath the gluteal muscles and opened in the thigh and even the popliteal space. The walls of the fistula are generally thickened by increase of fibrous tissue, the result of chronic inflammation; the surface is covered with granulations which secrete a thin purulent fluid. The external opening is generally small, scarcely admitting a probe, and sometimes surrounded by a mass of granulations. The course of the channel may be direct from the skin to the rectum, and the point in the rectum which is the seat of the opening is about an inch from the anus or between the internal and external sphincter. Sometimes the sinus runs partly around the rectum, giving what is called a horseshoe fistula.

Symptoms.—The early history of a fistula is the history of the abscess which produced it. Generally the patient seeks advice long after the abscess has discharged. He expects the opening to heal, and, as it gives no trouble beyond a daily discharge of pus and serum, he bears the inconvenience until the opening closes temporarily and a

new collection of pus takes place. The skin at such a time becomes red and tender, movement of the bowels causes great pain, and the symptoms of abscess are repeated until discharge of pus takes place, either by the old or through a new opening. In the ordinary condition of the fistula the skin about the part is always moist, sometimes eczematous or covered with small boils. In the subcutaneous tissues fistulous tracts can always be detected by their hard, resistant feel.

From the opening escapes a thin purulent fluid, always offensive in smell; when the opening is large enough, gas and even feces escape. These are positive signs of fistula, but the variety of fistula must be determined by further examination. Place the patient on the affected side with the knees drawn up. The external opening is generally easily found, but sometimes it is concealed between the folds of skin or it may be temporarily closed. Even then its position can often be determined by the induration and thickening of the tissues at that point. Having found the external opening, a probe is inserted and gently pushed toward the opening in the rectum. Here let me warn you against two common errors: Do not look for the internal opening too high up. It is generally between the internal and external sphincter. Do not pass the finger into the rectum until you have pushed the probe as far as it will go. The presence of the examining finger causes the sphincter to contract violently, which changes the relation of the fistulous track and prevents the probe passing through it. Insert the finger after the probe has passed as far as it will go. If the course is moderately straight, the examining finger will find the point of the probe in the rectum. If the probe has not passed through the internal opening, the finger must search for it. No matter how many external openings exist, there is only one internal. The finger can generally detect it even if the probe does not go through. In some cases the end of the probe can be felt with only a thin portion of the mucous membrane between it and the finger. This is sufficient. Push the probe through this thin spot.

A valuable aid to diagnosis which I have never found to fail is the injection of peroxid of hydrogen. A speculum is introduced, the peroxid injected by the external opening, and its appearance watched for at the internal opening. If a fistula be present, the froth caused by the peroxid will be seen to ooze through the internal opening, and in a short time it almost fills the rectum.

A diagnosis of the fistula and the kind of fistula is not sufficient. A very important practical point remains to be settled: Is there a stricture of the rectum? Sometimes stricture and fistula coexist, the stricture being high up and the fistula near the anus. To operate on the fistula and overlook the stricture would be a bungling piece of work. Again, the abscess which led to the formation of the fistula may have been due to necrosis of the sacrum, coccyx, or vertebræ. An operation dealing only with the fistula would be worse than useless.

Blind internal fistulæ have generally large openings, and it is not uncommon to find that feces enter this *cloaca maxima* and keep up irritation which prevents healing for an indefinite time. These fistulæ are generally painful, not only during defecation, but when pressure is made externally near the anus. Diagnosis of this variety

is made by feeling the internal opening and by passing a bent probe through the anus and into the fistula.

Treatment.—Palliative treatment is of little or no avail in fistula. A free incision converting the fistulous track into an open wound, which is allowed to heal from the bottom, is the most satisfactory treatment. An aperient is given the night before, and an enema of soap and water on the morning of the operation. The patient is anesthetized, and placed either in the lithotomy position or on his side with the limbs well drawn up. A grooved director is passed by the external opening through the fistula and out at the anus, and then a curved knife is made to run along the groove (Fig. 145), dividing all the tissues, cut-

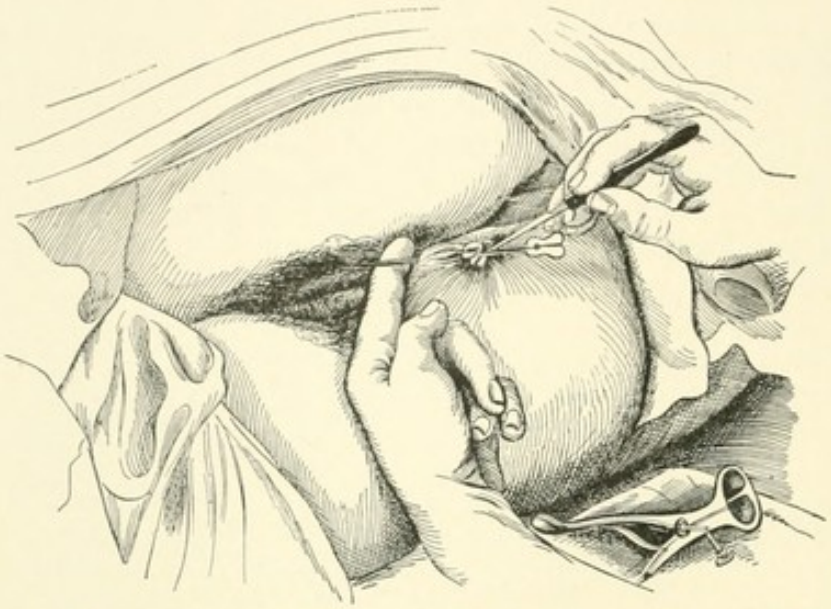


FIG. 145.—Typical case of fistula in ano, with operation for the same (Gant).

ting the fibers of the sphincter as nearly at right angles as possible. The track of the fistula should then be scraped with a Volkmann's spoon to remove all granulation-tissue. A packing of iodoform gauze and a pad of sterilized gauze and absorbent cotton held in position with a T-bandage complete the operation. The bowels should be kept confined for two days and the wound repacked daily with great care.

In horseshoe fistula the incision on one side should be made in the usual manner, while the opposite sinus should be freely dilated and drained. To open up both fistulæ would necessitate division of the sphincter in two places. This will almost to a certainty be followed by incontinence.

Goodsall recommends the following method of operating on horseshoe fistula: First pass a probe-pointed director through the internal aperture, and on its point incise the skin in the middle line behind; then push the director through, and slit up. Second, slit up the lateral sinuses on directors passed in at the external openings and brought out at the external incision. When numerous external openings exist it may be necessary to open up several of the sinuses and leave others for a second operation. A tortuous fistula, instead of being cut through at once, should be dissected up on a director from the external opening.

Sinuses which are offsets from the main fistula can be followed up in the same manner. The walls of the sinus should be dissected out and the wound packed with iodoform gauze. Closing the wound by sutures with the view of obtaining primary union is sometimes successful, but I have known cases in which this plan was attempted with very unsatisfactory results. The fistulous tracks retained suppurating material and necessitated operations at a later period.

Fistula in phthisical subjects should be operated upon under certain restrictions. A cough which is violent and frequent is a contra-indication, as it prevents healing of the incision. In rapidly advancing lung disease, in persistent diarrhea, or in an advanced stage of tuberculosis in any organ it is not advisable to operate. In ordinary cases of phthisis complicated with fistula improvement may be expected after treatment of the fistula, for, although the pulmonary disease may render the condition of the patient hopeless, he is saved the misery of a very exhausting complication.

Other methods of treating fistula have been advocated from time to time. Injections of iodin and of nitrate of silver have been known to cure, so also has dilatation of the mouth of the sinus, but the effect of such remedies is so uncertain that they scarcely deserve mention. The elastic ligature is employed in patients who are strongly opposed to the use of the knife. It is also recommended in a fistula whose internal opening is high up in the rectum. In every other case it is far inferior to incision. The ligature when employed should be of solid rubber about one-tenth of an inch in diameter. It is passed through the fistula and out the anus, then tightly secured by means of a lead clamp.

Fissure of the Anus.—A fissure or small ulcer at the anal orifice, attended with the most excruciating pain, and producing symp-

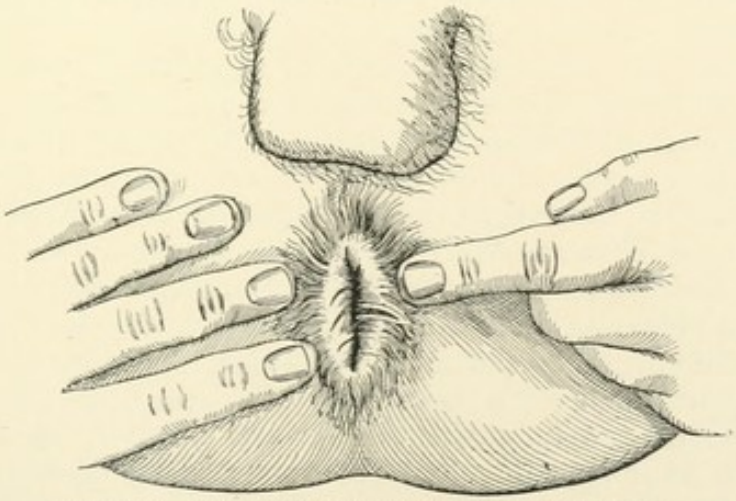


FIG. 146.—Painful ulcer (fissure) of the anus (Gant).

toms out of all proportion to the extent of diseased tissue, has been specially named anal fissure or irritable ulcer (Fig. 146). Its commonest situation is on the posterior wall of the rectum about the junction of the skin with the mucous membrane. It is not uncommon to find it lying under a small hemorrhoid, presenting the appearance of a little fissure lying between two folds of muco-cutaneous tissue. If, however,

the folds be separated and the anus dilated, the shape changes to a round or oval ulcer.

After all, there is nothing special about this form of ulcer, for it can be caused by anything which causes an abrasion or laceration of the tissue at the anal orifice. Its position gives it two characteristics which, kept in mind, make it easy to understand the disease: It is exceedingly painful, and therefore well named *irritable* ulcer. This is the first characteristic. The junction of skin and mucous membrane is always a highly sensitive line. An ulcer of the mucous membrane alone, however slightly removed from this line, is not nearly as painful. The extreme sensitiveness of the ulcer causes reflex contraction of the sphincter ani muscle, which is the second characteristic.

Symptoms.—There is nothing that can compare with a severe case of anal fissure. The patient at stool experiences a pain which he believes is tearing his anus or burning the part as with a red-hot iron. He is thrown into a state of collapse; the pulse becomes feeble, the surface of the body is damp and cold, and beads of perspiration break out on the forehead. For hours this may continue, and the sufferer naturally dreads to have a movement of the bowels, and they are allowed to become constipated. This only increases the suffering by hardening the feces and making defecation more painful than ever. Blood to the extent of a drop or two is sometimes seen on the motions. Retention of urine is common in men, and menstrual disorders in women. The sphincter is rigidly contracted and feels hard to the touch. Digital examination is out of the question without an anesthetic. An inspection shows a fissure, usually on the posterior wall, and taking a round or oval form when the anus is dilated. The surface is covered with red, inflamed granulations or a thin slough. In these red granulations are the exposed nerve-filaments to which are due the extreme sensibility. Hemorrhoids, blind internal fistula, and sphincterismus might be mistaken for ulcer.

Treatment.—In mild cases healing of the ulcer may be secured by astringent ointments, the application of weak solutions of nitrate of silver or sulphate of zinc, and by keeping the bowels in a relaxed condition. In more severe and obstinate cases the patient may be given an anesthetic, and the ulcer then freely cauterized with nitrate of silver or the acid nitrate of mercury. The bowels are kept from acting for a day or two, and the patient keeps his bed until the ulcer heals.

The most obstinate cases are those in which the sphincter is hypertrophied from constant contraction, and these require a more radical method of treatment. To overcome the action of the muscle its superficial fibers can be divided or it can be fully stretched. The patient is placed under chloroform; the sphincter is then stretched with the thumbs, and the floor of the ulcer divided with a knife down to the extent of a quarter of an inch, which is sufficient to sever the superficial fibers of the sphincter. The base of the ulcer should be dissected out and the wound packed with iodoform gauze. At the same time, any small hemorrhoid, polypus, or tag of skin should be removed; a sinus, if present, should be opened up, the upper region of the rectum examined, and in the case of females any retroversion of the uterus corrected.

Spasm of the Sphincter (Sphincterismus).—This is an affection which is most commonly seen in fissure of the anus, but it also exists in hysterical women, and in persons suffering from diseases of neighboring organs, as the uterus or bladder. In some cases there is an undiscoverable cause. When due to fissure this latter condition should be attended to; in hysterical women a suppository containing two grains of the extract of belladonna is very efficient, and in obstinate cases from any cause, stretching the sphincter is an almost certain cure.

Tumors of the Rectum.—Of the benign growths the most common in the rectum is polypus. The term polypus, however, is applied to any growth projecting from the mucous membrane into the cavity of the bowel. Sometimes it is an hypertrophy of the mucous membrane, sometimes a fibroma or an adenoma (Fig. 147), sometimes

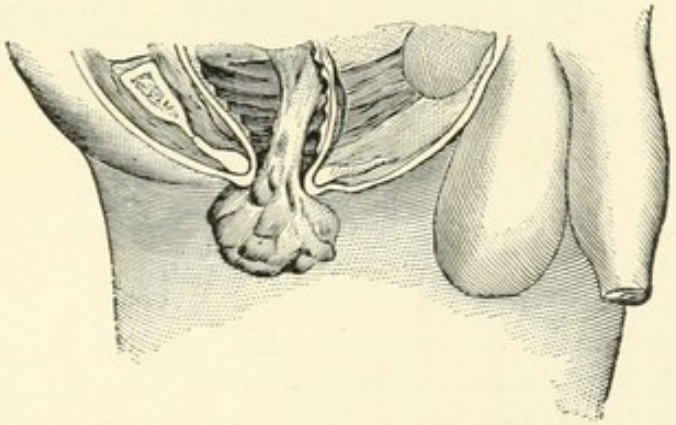


FIG. 147.—Fibrous (hard) polypus (Gant).

a villous growth. Polypi are generally single, occurring frequently in children below nine years of age. They are usually attached to the posterior surface of the rectum and not far from the anus. In size they seldom reach the dimensions of a walnut, but they have been found in such numbers as to block up the bowel and produce symptoms of intestinal obstruction.

Symptoms.—When a child has hemorrhage from the rectum polypi should always be suspected. Just as in uterine polypus, hemorrhage is a pretty constant symptom. A digital examination of the rectum should always be made in such cases, when, if a polypus be present, it will be felt hanging from the rectal wall, usually the posterior surface. When the pedicle is long, however, it may be directed upward, so that the tumor is out of reach. On this account an enema of warm water should be given before the examination. The expulsion of the fluid brings down the polypus to the full length of its pedicle (Fig. 148). The length of the pedicle varies greatly. In some cases it is so long that the tumor escapes through the anus during defecation, and it not infrequently happens that the sphincter, contracting firmly on the pedicle, strangulates the growth and causes it to drop off, thus effecting a spontaneous cure.

The *diagnosis* of polypus with a long pedicle is very simple. It is a very different matter when the attachment of the tumor is broad and

the pedicle absent. The question then arises as to whether the tumor is benign or malignant. Diagnosis must rest upon the following points:

1. In children malignant disease is exceedingly rare, while polypi are frequently met with.

2. Malignant tumors are not extruded and are not pedunculated, so that the existence of even a very short pedicle is strong evidence of polypi.

In adults an adenoid polypus which has ulcerated and which is not pedunculated cannot always be distinguished from malignant disease,

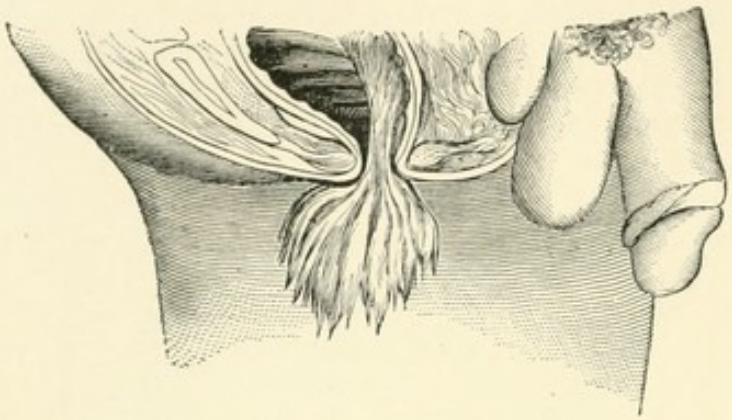


FIG. 148.—Adenoid (soft) polypus (Gant).

either by the microscope or the clinical history; for the ulcerated and bleeding tumor may cause a wasting and cachexia which strongly resemble cancer (Kelsey).

Treatment.—The treatment of polypi is very simple when the tumor is pedunculated. Hemorrhage is the only danger, and this can be obviated by first throwing a ligature around the pedicle and then dividing the tissue with scissors close to the point of ligation. Sometimes the pedicle is so long and slender that the tumor can be twisted off by grasping it with forceps and making simple torsion. When polypi have no pedicles, they must be removed in the same manner as ordinary tumors, and the bleeding stopped by forceps and by packing with gauze or sponges wrung out of hot water. Removal of polypi by clamp and cautery is advocated by some authors.

Papillomata, Warts, or Vegetations.—These warty growths occur about the anus in persons who are the subjects of warts in other parts of their bodies. Their development is favored by the presence of any irritating discharge, such as occurs in gonorrhea, leukorrhea, or any disease of the rectum. Formerly these growths were held in very bad repute, being considered positive evidence not only of syphilis but of sodomy. Mollière relates how in the time of Dionysius there was a hospital in Rome for the treatment of these growths; the surgeons, according to Dionysius, spared neither the iron nor the fire, and were not moved to pity by the cries of the patients, inasmuch as this disease was the result of unnatural intercourse between man and man (Mollière, quoted by Kelsey). The ideas of surgeons have undergone considerable change in recent years, the cause now being considered to be a tendency to warts, plus a local irritation.

Symptoms.—While papillomata occur at almost any age, they are most frequently found in adults. The appearance will vary according to the number of warts. When occurring singly the surface is dry; when existing in numbers they secrete a fluid of very disagreeable odor. This secretion is irritating, and not only causes inflammation in the warts themselves, but in the surrounding skin. When the growth begins on one side of the intergluteal fold, the pressure of their moistened surface against the opposite side produces a second growth at that point. The patient suffers great discomfort from the odor and irritation, and not infrequently defecation is attended with considerable pain. Little difficulty is experienced in the diagnosis of these growths; the most common error arises by mistaking them for syphilitic condylomata or for mucous patches. The surface of a flat condyloma or mucous patch is smooth and different from the cauliflower-like growth of a papilloma. The papilloma, moreover, is found to be attached to the skin by a number of small pedicles, so that if the whole growth be cut off at the level of the skin, it does not leave a raw surface, but a number of minute bleeding points.

Treatment.—Excision with knife or scissors is the best and most rapid treatment. Applications of strong astringents, such as tannin or alum or strong acetic acid, are sometimes sufficient to remove them.

Condylomata.—This is a term applied to several different growths about the anus, as the raised mucous patches and the remains of external hemorrhoids. There is a growth known as condyloma which is non-syphilitic. It is attached by a broad base, is of a pink color, soft, fleshy, moist, and flattened where two are pressed together. Condylomata generally begin at a fold of the anus (Kelsey). They are due to a localized chronic inflammation of the skin. They are most likely to be confounded with syphilitic gummata.

Syphilitic condylomata begin as red spots with slight effusion beneath the epidermis. The thin covering formed by the epidermis is rubbed off, and a raw surface is left covered with a thin pellicle. Upon this surface a new growth takes place, composed of papillæ, connective tissue, and blood-vessels. In this respect it closely resembles the papillomata, and in fact their appearance is sometimes identical. Diagnosis must rest, therefore, upon the history, the mode of development, and the results of treatment.

Fibromata, lipomata, villous growths, enchondromata, and sarcomata are so rare as to need no special mention.

(For cancer of the rectum see Cancer of the Intestines.)

Stricture of the Rectum.—Stricture of the rectum may be due to changes in the bowel-wall which lessen its caliber, or to pressure from without. Tumors in the pelvis by gradual encroachment on the rectum may cause a diminution of its caliber, but this is generally an obstruction rather than a stricture.

Two classes of stricture are recognized—simple and malignant. The latter has been discussed in the section on Rectal Cancer. Simple stricture is generally associated with inflammation, and, bearing this in mind, its etiology is readily understood. Inflammation, and especially the chronic form, tends to increase the connective tissue of the part affected. The connective tissue of the rectum is arranged in a circular

manner around the bowel, so that inflammation by increasing this fibrous tissue causes a constriction. We have, therefore, the following among the causes of simple stricture:

1. Traumatism, such as kicks, blows, the application of strong acids, operations on the rectum, ulceration, and the presence of foreign bodies. All of these produce stricture close to the orifice of the anus.

2. When the stricture is higher up the principal causes are—operations for internal hemorrhoids, tuberculosis, syphilis, dysentery, parturition, pelvic cellulitis, and imperforate rectum, partial or complete.

Strictures arising from any of these causes may affect a small or a large portion of the rectum, and two varieties are spoken of according to the extent of the stricture. If it involves an inch or less, the stricture is called *annular* (Fig. 149); if more than an inch, it is tubular (Fig. 150).

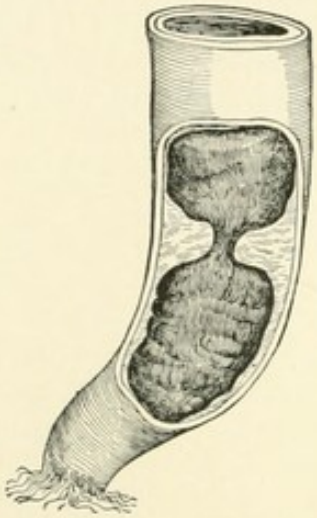


FIG. 149.—Diagrammatic drawing of annular stricture (Gant).

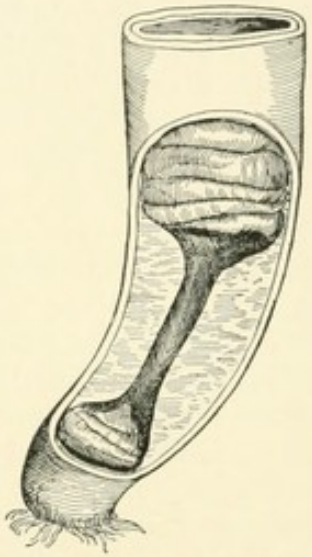


FIG. 150.—Diagrammatic drawing of tubular stricture (Gant).

Symptoms.—Of seven patients suffering from stricture of the rectum, six are women. Common sense tells us that the leading symptoms are obstruction, due to narrowing of the bowel and irritation and inflammation which produce the stricture. When high up obstruction may be an early symptom, and may appear with very slight warning. In stricture low down it does not appear until a late period. The first symptom is generally a diarrhea coming on when the patient gets out of bed and after each meal. The motions are either small like pellets, or ribbon-shaped and covered with mucus. Later on, constipation alternates with diarrhea. Pain becomes a prominent symptom, felt especially in the perineum and radiating to the hips and down the thighs. The sphincter loses its tonicity, becomes flabby, and, later on, raw and excoriated. There is a constant offensive discharge about the anus which keeps the parts moist and irritated. Later on, obstruction becomes more apparent. In some cases the transverse and descending colon can be felt distended with feces, dull on percussion, sensitive to touch, and retaining indentations made by pressure of the fingers. The bowels are never properly emptied; abscesses, fistulæ, and ulceration

are common; and at last the patient dies either of peritonitis, the result of complete obstruction, or wastes away from sheer exhaustion.

No *diagnosis* is complete without a local examination, which can be digital or by bougies. The finger is preferable. A constriction, ring-shaped or tubular, is felt, which at once settles the question. Should the stricture be too tight to allow the finger to pass through, no attempt should be made to force it. Death has occurred more than once by rough examination. Having satisfied yourself that a stricture exists, examine the condition of the rectum below the narrowing. In females the vaginal examination may throw considerable light on the subject.

No end of mistakes have been made by depending upon bougies. Many supposed strictures have proved to be nothing more than the arrest of the instrument by the promontory of the sacrum. When the stricture appears to be beyond the reach of the finger, something can be gained by having an assistant press the elbow of the examining arm, thus pushing the perineum well up. Olive-pointed bougies or long rectal tubes are sometimes useful.

Stricture high up in the rectum or in the sigmoid flexure is very difficult of diagnosis. The symptoms complained of by the patient are different from those already described. Chronic constipation and dyspepsia are the most prominent. Pain is felt in the abdomen, generally, but not always, in the left side; sometimes in the loins and down the thighs. An examination of the feces gives nothing satisfactory. The motions, being formed in the rectum, have not the ribbon or pellet-shape characteristic of a stricture low down. The most significant appearance is the presence of blood or slime in streaks in the feces. When the constriction is due to a morbid growth, palpation, inspection, and percussion of the abdomen may afford valuable evidence.

In making a diagnosis of high stricture I would recommend the following procedures:

1. Obtain a history of the subjective symptoms, such as constipation, diarrhea, pain in the left side of the abdomen, loins, and thighs.
2. An examination of the feces for streaks of blood or slime.
3. Inspection, palpation, and percussion of the abdomen for tumor or fecal impaction in the colon.
4. Examination with the finger under anesthesia, aided by an assistant pushing against the examiner's elbow to raise the perineum.
5. The insertion of bougies. The best instrument is hollow, and to its lower end should be fitted the tubes of a fountain syringe or irrigator containing warm sterilized water. The bougie must be inserted with the greatest gentleness, and as soon as resistance is felt the water should be allowed to flow and distend that portion of the bowel. This will dispose of folds of mucous membrane which are so ready to obstruct the tube. In order to pass the promontory of the sacrum the bougie requires to be flexible.
6. Failing in making a diagnosis by any of the preceding, the hand may be pressed into the rectum under the restrictions already mentioned.

Differential Diagnosis of Benign and Malignant Stricture (Ball).

BENIGN.	MALIGNANT.
Generally a disease of adult life.	Generally a disease of old age.
Essentially chronic, and not implicating the system for a long time.	Progress comparatively rapid, and general cachexia soon produced.
The orifice of the stricture feels as a hard ridge in the tissues of the bowel. Polypoid growths, if present, are felt to be attached to the mucous membrane.	Masses of new growth are to be felt, either as flat plates between the mucous membrane and the muscular tunic, or as distinct tumors encroaching on the lumen of the bowel.
Ulceration of the mucous membrane may be present, but without any great induration of the edges.	Ulceration, when present, is evidently the result of the breaking down of the neoplasm, and the edges are much thickened and infiltrated.
The entire circumference of the bowel is constricted unless the stricture is valvular.	Generally one portion of the circumference is more obviously involved.
Pain, throughout the whole course, is in direct proportion to the fecal obstruction, and only complained of during the effort of defecation.	For the advanced stages pain is frequently referred to the sensory distribution of some of the branches of the sacral plexus, due to direct implication of their trunks.
Glands not involved.	The sacral lymphatic glands can sometimes be felt through the rectum to be enlarged and hard.

Treatment.—The diet of the patient requires careful attention. It should be nutritious, containing such articles as leave a small residue. The feces should be kept soft. When the stricture is due to syphilis or tuberculosis the general treatment of these diseases must be employed. The local treatment of stricture must depend upon the variety. Many annular strictures can be completely cured, while tubular strictures are frequently beyond the reach of local treatment. The operative treatment may be considered under the following heads:

(*a*) *Gradual Dilatation.*—Bougies have been so much abused that it is difficult to estimate their proper value. When they are employed to overcome a stricture it should be clearly understood by both patient and surgeon that a long course of treatment will be necessary. Without this understanding it is useless to begin. An annular stricture may be compared to a rubber ring. The passage of a bougie will dilate the ring, but it speedily returns to its original size. The use of the instrument daily for weeks, and even months, will, however, in many cases finally overcome the elasticity and cause the stricture to disappear. This little operation is very simply done, and especially in stricture low down the patient or a nurse with very little instruction can attend to the treatment. Great care should be taken to make sure that the instrument really passes through the stricture. Sometimes a pouch forms below the stricture, and into this the nurse, or even the physician, has been known to pass a bougie daily for weeks in the belief that he was dilating the stricture.

Half an hour before using bougies it is best to give the patient an enema of warm oil and water, which not only empties the bowel, but quiets the irritability of the sphincter (Cripps). The patient lies on his side with one knee drawn up. Beginning with a size which easily passes through the stricture, larger instruments are employed as dilatation advances. Great benefit is obtained by keeping the instrument in position from a few minutes to several hours a day as the patient can bear it.

(*b*) *Forcible Dilatation.*—This method is attended with too much risk to warrant a recommendation. A stricture when forcibly dilated gives way at its weakest point, and that is usually Douglas's cul-de-sac. The consequence of such an accident is the pouring of the fecal contents of the bowel into the peritoneal cavity, followed by general peritonitis and death. So great is the risk of rupture that in no case should an attempt be made to force the finger through a tight stricture for the purpose of ascertaining the condition of the bowel higher up. The only strictures of the rectum in which forcible dilatation can be at all warranted are those within an inch of the anal margin.

(*c*) *Internal Division.*—This is another dangerous operation. An incision in the rectum is almost sure to result in suppuration, with formation of abscess and burrowing of pus in various directions. The cause of this is readily explained. The sphincter ani closes with more or less accuracy the lower end of the rectum, and acts as a barrier to the downward pressure of the bowel-contents. Before the resistance of the sphincter can be overcome the rectum is distended, and with the distention a stretching of the incision. This not only prevents healing but allows fecal matter to get into the incision and produce suppuration.

(*d*) *Posterior Division of the Stricture and External Parts.*—The great objection to internal division is the impossibility of free drainage. That objection is overcome when a free division is made, not only of the stricture, but of all the tissues between it and the surface.

Operation.—The bowels having been thoroughly evacuated by a cathartic followed by an enema, the patient is placed in the lithotomy position. The finger of the left hand is pressed through the stricture. If this is impossible, a probe-pointed bistoury is passed through, and, its edge being directed backward, the stricture is cut exactly in the middle line sufficiently to allow the finger to pass through. A long curved, sharp-pointed bistoury, guarded by the finger-nail or a director, is then passed through the stricture; the point is directed backward in the middle line, and made to transfix the rectal wall behind, coming out at the end or side of the coccyx. It is then made to cut its way out. Bleeding points are ligated as far as possible. A drainage-tube is placed in the rectum, its upper end reaching beyond the seat of the operation. Around the tube the space is packed with iodoform gauze and a T-bandage applied. The packing is removed daily, the parts irrigated, and again packed. About the tenth day bougies are passed to prevent recurrence of the stricture, and this is continued for six months. During the healing a full-sized bougie should be kept in for several hours a day.

(*e*) *Colostomy.*—When other measures are unavailing relief from suffering and prolongation of life can be obtained by the formation of an artificial opening in the colon (see Colostomy).

Congenital Malformations of the Rectum and Anus.—These malformations are the result of arrested development in early fetal life. The bowel and the sinus from which are later developed the genital organs are not at first separate in the fetus. If the opening between the two persists, malformation is the result, and the feces may pass by the urethra (Fig. 151), or vagina, or the bladder (Fig. 152).

If not wholly absent, the rectum and anus may be very narrow, though not entirely occluded.

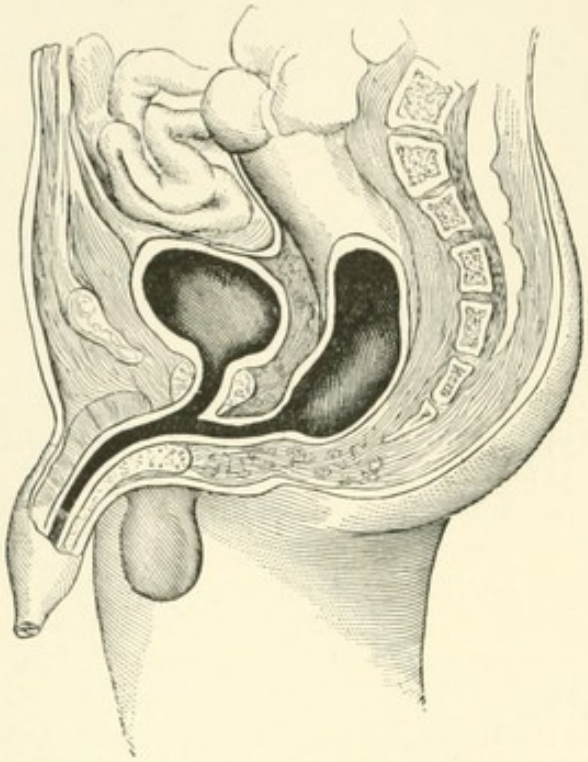


FIG. 151.—Imperforate anus, the rectum terminating in the urethra (Gant).

Imperforate rectum and imperforate anus are the most common deformities.

The bowel is developed from the hypoblast, except the lower por-

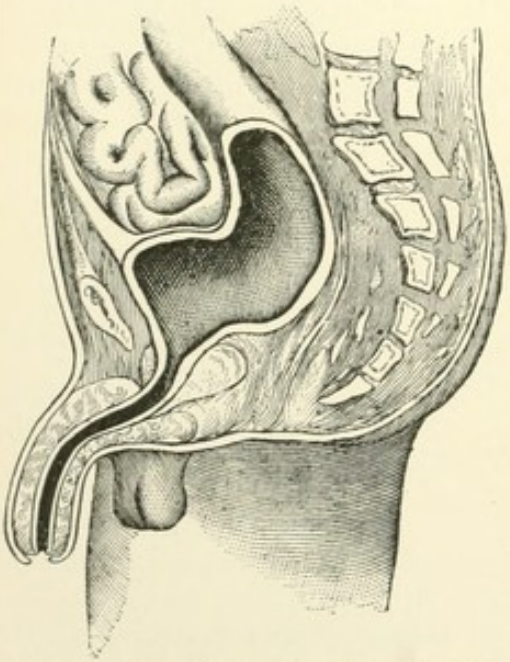


FIG. 152.—Imperforate anus, the rectum terminating in the bladder (Gant).

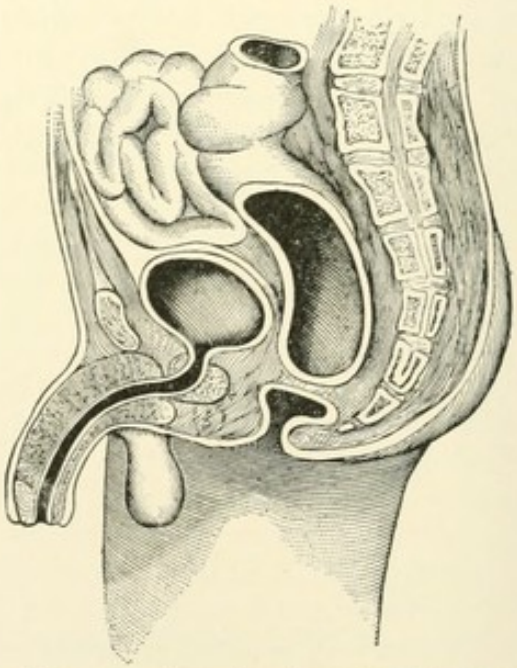


FIG. 153.—Imperforate rectum, the anus natural, but rectum separated from it by a membranous partition (Gant).

tion, which, together with the anus, is an involution from the epiblast. As the fetus develops the bowel pushes its length downward, and the

involution proceeds upward from the surface to meet it. Absorption of intervening tissue takes place, and the two become one continuous passage. If development is arrested at any point, imperforate rectum or anus, or both, may occur. Should the involution at the surface not begin at all, or cease after a mere depression has taken place, the condition is known as *imperforate anus.* The involution, on the other hand, may proceed to a normal exent, but, the bowel not descending sufficiently, absorption of intervening tissue may not take place, producing a condition known as *imperforate rectum.*

All degrees of malformation may exist—from that in which only a thin membrane lies between the rectum and anus (Fig. 153) to those in which, by absence or obliteration of the rectum, there is a space of several inches between the anus and the bowel.

Symptoms.—The diagnosis of these conditions is made from the fact that the child has had no motion from the bowels, or by the presence of a fistula connecting the bowel with the bladder or urethra or vagina, through which the feces are passed. In addition, the abdomen is distended, and there may be vomiting severe and persistent.

Treatment.—If only a membrane separate the rectum and anus (Fig. 153), a simple incision affords an opening. During the process of healing care must be taken to prevent contraction by daily insertion of the finger.

If the rectal pouch is situated high up, but low enough, so that bulging can be detected, an incision should be made in the median line. All tissues are dissected away until the pouch is reached. It should be opened, emptied, cleansed antiseptically, and its edges sutured to the edges of the incision. It is then dressed antiseptically, and bougies inserted daily to prevent contraction. If no pouch can be detected, an incision is made in the left inguinal region, and search made for the end of the bowel and inguinal colostomy performed.

When the opening is into the urethra or vagina this fistula should be closed, and an outlet established at the anus if possible; otherwise, in the left inguinal region, as in high imperforate rectum.

CHAPTER VII.

THE GENITO-URINARY SYSTEM.

I. INJURIES AND DISEASES OF THE KIDNEYS.

Surgical Anatomy.—The kidneys lie behind the peritoneum deep in the lumbar region and imbedded in abundance of loose fatty tissue. Each kidney lies upon the posterior portion of the diaphragm, the transversalis aponeurosis, and the psoas muscle. The upper end of the right kidney is in contact with the under surface of the liver. In front the anterior surface is in relation with the duodenum and the right flexure of the colon. The upper end of the left kidney is in contact with the stomach; its outer border for two-thirds of its length touches

the spleen, and its lower end is crossed by the descending colon; in front toward the inside lies the pancreas. The upper end of the kidney corresponds with the left intercostal space, and the lower end is on a level with the middle of the third lumbar spine. The right is a little lower than the left, owing to the pressure of the liver from above. The left kidney may occupy a position above the spleen. It sometimes happens that there is only one kidney. In this case the organ is large enough to compensate for the absent one. Sometimes both organs are closely united at their extremities, forming the "horseshoe" kidney, so called.

The kidneys are subject to great variations both in regard to the size and the position of the organs. They may be placed as low down as the brim of the pelvis or even in the pelvic cavity, and in either of these situations they are likely to give considerable trouble during menstruation or in the progress of parturition. The vessels may also be abnormal. Thus the organ may receive its arterial supply from a vessel rising from the aorta higher up or lower down than in the normal condition, or springing from the common iliac. The ureter is just as variable. Sometimes it is double either at its origin or in its whole course, or it may be tortuous, especially when encroached upon by morbid growths. The ureters lie obliquely, and in such a position that if their axes were prolonged upward they would meet on the ninth dorsal vertebra, and if prolonged downward would pass over the tips of the iliac crests. The inner border of each kidney is concave, forming a longitudinal gap called the hilum, which contains three very important structures—viz. the renal artery, the renal vein, and the ureter. These constitute the pedicle in removal of the kidney.

The arteries arise from the aorta about the level of the first lumbar vertebra, and pass almost horizontally to the kidneys. The right vessel takes a slightly upward course to reach its organ; it passes behind the inferior vena cava, and is of course longer than its fellow, for the aorta has the vena cava between it and the right kidney. The left artery generally rises a little higher up than the right. Before reaching the hilum each artery divides into three, four, or five branches which go to supply the renal tissue. The position of the structures at the hilum are, from above downward and backward, *artery*, *vein*, *ureter*.

The renal veins pass at right angles from the hilum of each kidney to enter the vena cava inferior. The left vein is slightly higher and longer than the right. The ureter is the membranous tube which conveys the urine from the kidney to the bladder. It is about fourteen inches in length and its diameter is about one-eighth of an inch. It begins at the lower border of the kidney, and expands into a funnel-shaped sac called the pelvis; then passes down behind the peritoneum lying upon the psoas muscle, and crosses the bifurcation of the common iliac artery to reach the base of the bladder.

Following the ureter from the pelvis into the substance of the kidney, we find that it divides into two or three short trunks, and these again subdivide to form the primary tubes or infundibula which receive the papillæ.

The kidney is held in position by a mass of fat which forms its bed. In this it enjoys a slight degree of mobility, and when the fat is opened

up the kidney may be seen to rise and fall with respiration. Sometimes this fatty capsule is wanting, and the organ is held in place only by the blood-vessels and ureter at its hilum, or, the fat being lost by sudden emaciation of the patient, the movements of the kidney are greatly increased. To this condition the name "movable kidney" is applied. Sometimes the peritoneum invests the organ, forming a mesonephron, and the kidney becomes displaced into the general peritoneal cavity, moving freely in every direction as far as its vessels and ureter will permit. To this abnormality the name of "floating kidney" is applied.

Injuries of the Kidney.

The kidneys are well out of harm's way, being protected in the rear by the strong, thick muscles of the lumbar region, and in front by the abdominal wall and the abdominal viscera. Injuries of the kidney are on this account comparatively rare. They may be divided into three classes:

1. **Contusion without Laceration of the External Tissues.**—This is one of the most frequent of renal injuries. It may be produced by blows or falls, especially when the body is in a sitting position or forcibly bent forward at the time of striking the ground. Another common cause of renal contusion is a squeezing or crushing of the loins between carriage or machine wheels. Whatever the cause, it may produce injury varying from little discomfort and few symptoms up to complete rupture and even pulpification of the organ. Traumatisms in the renal region, according to Küster, cause either laceration of renal tissue or mobility of the organ. As a rule, laceration occurs in males, mobility in females. This is accounted for by the fact that in the female the conformation of the body, the thickness of the adipose tissue, and the protection afforded by the corset break the direct force of a blow, and thus guard against lacerations.[1]

Symptoms.—The violence which produces the kidney lesion is likely to cause so much pain in the loin as to mask the symptoms which point more directly to the kidney. The pain shoots down the thigh and into the testicle and loin. If the kidney is injured, we have in addition frequent micturition and sometimes hematuria. Blood in the urine, however, is a symptom that must be carefully weighed. It may be present when there is sudden congestion in any portion of the urinary tract, as in violent strains. On the other hand, there may be extensive laceration and hemorrhage from the kidney, but, owing to the formation of a clot in the ureter, no blood escapes with the urine.

The quantity of the blood that escapes is very variable. When it is extravasated around the kidney it causes swelling in the loin, and as the blood-stained serum passes downward along the vessels the skin becomes discolored in the inguinal region, in the scrotum, and in the thigh. When only the cortex of the kidney is torn the hemorrhage is usually slight. If the laceration extends into the hilum or a vessel of considerable size is torn, then a profuse flow of blood runs down the ureter, filling the bladder, and perhaps coagulating therein. The symp-

[1] *Ann. of Univ. Med. Sci.*, 1896.

toms of renal colic follow, and in some cases long worm-like clots are expelled per urethram. There is intense pain about the pubes and at the end of the penis. If the ureter becomes completely occluded by a clot, hydronephrosis follows. Still more copious is the loss of blood when the peritoneum is ruptured and the hemorrhage is poured out into the abdominal cavity. The symptoms of profuse hemorrhage rapidly come on and the patient may bleed to death in a short time.

Extravasation of urine from the kidney is a symptom which is of rare occurrence. It does not take place unless the pelvis or the hilum is ruptured. Then the urine is poured out either into the peritoneal cavity or into the areolar tissue around the kidney. Inflammation follows, and often results in suppuration and sloughing, to which the patient eventually succumbs.

Treatment.—The patient should be kept in the recumbent posture and fed on liquids. The loins should be supported by a broad strip of adhesive plaster, as in the treatment of fractured ribs. Gallic acid, ergot, acetate of lead, and opium are valuable in checking hematuria. The bowels can be relieved by enemata, but purgatives are to be avoided. When the bladder is filled with blood, as evidenced by tenesmus and the passage of clots, every care must be taken to prevent cystitis. A double-current catheter should be inserted and irrigation carried out with some mild disinfecting fluid, as boric acid or Thiersch's solution; or one of the evacuating tubes and evacuators used in lithotrity can be employed to throw in and withdraw quantities of water from the bladder.

When the coagula are so large and firm as to resist these methods perineal section is indicated. Severe cases which are attended with profound shock and a rapidly increasing tumor in the loin demand a lumbar incision. After exposing the kidney the bleeding points are sought for and ligated; if the kidney is disorganized, it should be removed.

2. **Wound of the Kidney with Laceration of the External Parts.**—The anterior surface of the kidney may be penetrated by an instrument or missile entering the abdomen and passing through both layers of peritoneum. The symptoms in this case are those of hemorrhage or extravasation of urine into the peritoneal cavity. When the wound is received in the loin, the posterior surface of the kidney is the part to suffer. If urine escapes, it is proof positive of renal laceration, but it must be remembered that the cortex may be incised without flow of urine. Hematuria is also a sign, but the same uncertainty attends it here as in the preceding class of injuries. Perinephric abscess is a frequent sequel of renal wound. Extra-peritoneal wounds generally do well, but those which are intra-peritoneal have a very high mortality.

Treatment.—Wounds of the kidney inflicted through the loin are extra-peritoneal and require the same treatment as nephrotomy. A drainage-tube is inserted down to the wound in the kidney, and the surrounding space packed with strips of iodoform gauze. Should further drainage be required, the external wound should be enlarged.

3. **Intra-peritoneal wounds of the kidney** demand celiotomy, and in most instances nephrectomy.

Diseases of the Kidney.

Examination of the Kidneys.—In the injuries which have just been described our attention is naturally directed to the kidneys by the position of the traumatism and the nature of the accident. In surgical *diseases* of these organs we are led to the kidneys by the general examination of the patient. When, for instance, we get a history of violent attacks of pain in the loin shooting down toward the bladder, the testicle, and the thigh, we suspect renal calculus, and the suspicion grows upon us if we learn that during or after these attacks small quantities of bright-red blood have come away with the urine. Again, if the patient complains of periodical attacks of violent pain with marked diminution of the quantity of urine, followed by a copious flow and relief of all symptoms, we suspect hydronephrosis due to movable kidney, and our suspicion is confirmed if he also tells us that a tumor of a somewhat erratic character can be felt from time to time.

In the examination of the kidney our methods of investigation are somewhat limited.

Inspection is only of value when the loin is greatly distended by a solid or cystic tumor, in cases of hydronephrosis or pyonephrosis, in enlargement of the kidney, and in cases of hemorrhage which is extra-peritoneal.

Palpation is often of great value. The healthy kidney of normal size and lying in its proper position is beyond the reach of palpation. It is only when the organ is enlarged that it can be felt. To examine it by palpation place the fingers of one hand just below the twelfth rib and at the outer edge of the erector spinæ muscle, or about two and a half inches from the spinous processes; the other hand is placed on the abdominal wall in front. The enlarged kidney can be felt between the two hands. Sometimes the finger and thumb of one hand are sufficient, and in this way a good idea of the size of the kidney can be obtained. In very lean persons with lax and thin abdominal walls the lower third of the kidney may be felt; with this exception, if you feel the kidney at all, you may set it down as an enlargement of the organ. As the kidney enlarges it extends in two directions, downward and forward. The ribs and spinal column prevent its extension backward, and its own weight tends to drag it downward. Hence the greater the enlargement the more easily can the kidney be palpated.

Israel's method of palpation is as follows: A line parallel with the middle line of the abdomen is drawn from the middle of Poupart's ligament to the margin of the ribs. The finger-tips, placed two finger-breadths below the margin of the ribs and upon this line, are directly over the lower extremity of a kidney in place. In order to feel this kidney we must avoid poking with eager hooked fingers, or the abdominal muscles will contract in resentment. The tips of the straight-extended fingers are placed upon the point indicated while the patient lies supine, with flexed legs, upon a hard bed or table. The other hand now lifts the loin gently toward the opposed fingers. At each expiration which the patient makes the fingers upon the abdomen are pressed a little farther toward the kidney; the impress-fingers easily recognize the object sought for. If the patient now takes a full breath,

a wandering kidney will be forced far under the finger-tips (Israel, cited by Fenwick).

Percussion.—The solid structures which surround the kidney render its percussion impossible. On the right side the liver, on the left the spleen, form its upper boundary; behind is the spine, over it the muscles, and surrounding it a mass of adipose tissue. There is therefore nothing resonant about the kidney on any side. Only when the organ is greatly enlarged can we gain anything from percussion, and then it simply confirms what we have learned by palpation. Sometimes a resonant area traverses a greatly enlarged kidney; *this is the distended colon.*

Exploratory puncture is valuable, and, as it is extra-peritoneal, the danger attending its employment is less than in abdominal explorations. In hydronephrosis and pyonephrosis the needle is of great value, for, having established the diagnosis, it can be used to evacuate the fluid and thus produce relief, possibly a cure.

Movable Kidney.—Care should be taken to avoid the common error of confusing the terms *movable kidney* and *floating kidney.* Movable kidney is an acquired condition in which the organ remains behind the peritoneum, but with more or less movement. It is simply loosened up in its fatty bed. Floating kidney, on the other hand, is a congenital abnormality in which the peritoneum surrounds the kidney forming a renal mesentery. The kidney in this case has no fatty bed, but floats about the abdominal cavity as far as its mesentery will permit.

Movable kidney is more common on the right side than on the left, and this has been accounted for by the downward pressure of the liver. Women suffer more frequently than men, for the reason that repeated childbearing, with its alternate distention and relaxation of the abdominal wall and sudden loss of the fatty tissues of the body, is a prominent cause of renal displacement.

Symptoms.—The sufferings of the patient depend to a great extent upon the degree of mobility of the kidney. There may be only slight discomfort or there may be the most agonizing pain. When there is slight mobility, discomfort is usually felt after exercise, and especially after long walks, or rides in which there is much jolting. The menstrual period seems to have a powerful effect in bringing on pain. There is a sense of dragging in the loin, and the pain shoots down the groin and the thigh, as it always does when the kidney is the seat of irritation. Very serious and alarming symptoms set in when the kidney turns over in such a way as to twist its pedicle and cause obstruction in the ureter and the renal vessels. The urine, no longer allowed to flow away, distends the kidney, producing the condition known as hydronephrosis. When we stop to consider the disturbances which would naturally be caused by a kidney distended almost to bursting by the pent-up urine, we can readily understand the remaining symptoms. The flow of urine from the bladder is diminished. Resorption of urea takes place, and there are headache, stupor, foul tongue, vomiting, and sometimes jaundice. In nearly all cases of movable kidney the patients are nervous and hysterical. Dyspepsia, loss of appetite, and general debility are always present. On palpation, with one hand at

the outer border of the erector spinæ muscle and the other in front, the kidney may be felt. Sometimes it is difficult to find it, and the patient should be placed upon his hands and knees, in which position the kidney falls forward upon the palpating fingers. Some patients have a way of assuming positions which bring the wandering organ into prominence, and I am in the habit of giving them an opportunity of doing so.

In favorable cases a tumor can be felt which is of the shape, size, and consistency of a kidney. It is freely movable over a certain area, but returns naturally to the normal position of the kidney in the loin, Sometimes the organ can be grasped between the thumb and fingers of one hand and made to slip from place to place. The mobility of the kidney may give one loin a want of resistance in comparison with the other. Pressure applied to the kidney causes a sickening pain very similar to that felt in the testicle or ovary, and when this can be elicited in a movable tumor it is strongly confirmatory of a wandering kidney. The failure to find a movable tumor by palpation must not be taken as settling the question. If the other symptoms are present and constant, and if they are breaking down the patient's health, operative procedure is indicated.

Diagnosis.—Many other tumors are liable to be mistaken for movable kidney, but it is seldom that a movable kidney is mistaken for anything else. The history of the case, the position of the tumor, its tendency to return to the loin after it has been pushed to the length of its tether, and a careful study of the symptoms must be our safeguard. Floating kidney cannot be positively distinguished from movable kidney by any symptom yet known. The length to which a mesonephron permits the kidney to wander has been supposed to afford a criterion, but when a movable kidney has become so loose that its movement is only restricted by the renal vessels and the ureter, it has every characteristic of a floating kidney.

Treatment.—Inasmuch as exercise and jolting of the body increase the suffering, the patient should be kept as quiet as possible. In mild cases patients may experience great relief by wearing an elastic belt with an air-pad so constructed as to push the kidney well back into the loin. When the cause of mobility is the loss of fat, as in women who have undergone rapid emaciation, an attempt should be made to restore normal conditions by keeping the patient in bed and on a diet which will produce the greatest amount of fat. The most troublesome cases are those in which renal colic occurs from twisting of the pedicle. During an attack perfect quiet in the dorsal position must be enjoined, with hot fomentations and sedatives to relieve pain. Such cases are not infrequently attended with degenerative changes in the kidney itself, and thus the condition is rendered more serious. When ordinary means fail, relief must be sought by operation.

The operation by which a movable kidney is made to form attachments in its original position is called nephrorrhaphy (νεφρὸς, a kidney; ῥαφὴ, a suture). A better word would be nephropexy (νεφρὸς, a kidney; πήγνυμι, I fix). The mortality of the operation is probably not more than 2 per cent., but the results are not always satisfactory. The patient is placed on the sound side with a firm round sand-bag or

pillow under the body to increase the costo-iliac space as much as possible. The incision is made in the loin, and is practically the same as that employed in lumbar colotomy, only about an inch farther back. Its beginning is at the lower border of the twelfth rib and at the outer border of the erector spinæ muscle. This point is generally about two and a half inches from the spinous processes of the vertebræ. From this, as a starting-point, the incision is carried downward and outward toward the crest of the ilium for three inches or more. The skin and fat are divided and any bleeding points secured. The superficial fascia is next laid open to the full extent of the wound, exposing the outer edge of the latissimus dorsi and the posterior border of the external oblique. Broad retractors in the hands of an assistant hold the edges of the wound apart and afford working space. The edges of these muscles are divided with scissors and the internal oblique and transversalis come into view. These in their turn are severed as far as the upper and lower limits of the skin-wound, and lastly the deep layer of the lumbar aponeurosis. The peritoneal fat is now seen bulging up into the wound, and it is an easy matter to tear it apart with scissors and expose the kidney itself. To bring the kidney up to position an assistant with strength and endurance in his arm pushes it from the front. In all operations on the kidney the organ gradually comes up into the wound by internal abdominal pressure, so that, although it may seem very far away when first exposed, it comes nearer and nearer to the surface and can soon be conveniently handled.

Having exposed the kidney, two fingers are passed around the capsule to ascertain the condition which is the cause of the mobility. By tearing the fatty tissue and irritating the fibrous capsule, either by manipulation or by scratching with the point of a needle, adhesive inflammation will be induced, and upon this our chief reliance must be placed. The renal capsule is opened and stripped off for a short distance, so as to expose a raw surface of kidney. Sutures are then passed through the lumbar aponeurosis, the capsule, and the border of the kidney-substance. Some surgeons fasten the kidney to the twelfth rib, and with a show of reason, for when the organ is hardened *in situ* it bears a deep groove, which is the impression of the twelfth rib, and shows that in normal conditions the kidney lies in contact with that bone. Chromicized catgut is a suitable material. Its service is but temporary, for it only keeps the parts in apposition while adhesive inflammation is taking place. Three or four sutures are sufficient. A drainage-tube or strip of iodoform gauze is next placed in the wound with its inner extremity touching the kidney. The wound is closed with silkworm gut and a full dressing applied. The patient should lie on the back as much as possible, in order that the kidney may not gravitate from its position, and should keep his bed for six weeks.

Nephrectomy has been resorted to for the worst forms of movable kidney. It is only when the organ is diseased as well as distressingly movable that such a procedure is warrantable.

Renal Calculus.—Stones are formed in the kidney by the aggregation and consolidation of certain constituents of the urine which under normal conditions the kidneys eliminate. Of this class the most common are uric acid and oxalate of lime. In unhealthy conditions

of the urine, and especially when it undergoes decomposition, a precipitation takes place which may result in the formation of stone. The constituents in this class of cases are most commonly phosphate of lime and the ammonio-magnesium phosphate.

Renal calculi vary greatly in size, number, and shape. Frequently they are round, and so small and smooth that they pass with ease through the ureter and are voided in the urine. Others are rough and pointed with crystals, so that on their passage they lacerate the delicate lining of the urinary passages and cause it to bleed. Others are so large that they cannot pass away from the kidney, but, continuing to increase in size, produce one of the most distressing conditions which a human being can be called upon to endure—exciting inflammation, stopping the flow of urine, and bringing about the destruction of the kidney itself.

Symptoms.—The symptoms of renal calculus are practically those of a foreign body in the kidney. Depending upon the position of the stone and other circumstances, these symptoms are subject to considerable variation. They are not usually all present in any given case, but the cardinal signs are not often wanting. These are pain and hematuria.

1. *Pain.*—Two kinds of pain are recognized, direct and reflex. Direct pain may be constantly felt in the region of the kidney or it may only be present when the patient is in active exercise. Movement and jolting always aggravate it. When pressure is made over the kidney or the organ grasped by the hands in the loin the tenderness is very great.

It may be that no other symptoms are manifested, and yet a diagnosis of stone is warranted, and it may further be assumed that the calculus is either in the cortical substance or in some part of the kidney in which it cannot move.

Very different is the character of the suffering when the calculus rolls about in the pelvis of the kidney, becomes blocked in the ureter, or performs its painful journey to the bladder. Renal colic is the name applied to these attacks when they appear in their worst form. The local pain is intense, and the patient clutches the affected loin as if to pluck some cruel dart from his tortured flesh. He rolls from side to side bathed in perspiration; rigors are frequent, and vomiting is often severe and persistent. There are frequent calls to micturate, but the quantity of urine is small. All this time the stone is working its way down the slender ureter, rasping, scratching, and tearing the delicate lining and causing more or less blood to flow. At last, after a couple of hours or it may be several days, the calculus drops from the ureter into the bladder. If it be true, as stated by some old philosopher, that "the height of happiness is relief from pain," the patient experiences real happiness, for the pain suddenly ceases and a great calm follows the storm.

But a well-marked attack of renal colic may occur and no stone pass into the bladder. The concretion may get into the very beginning of the ureter, where the tube is larger than elsewhere; it goes far enough to produce occlusion; the urine collects behind it, producing hydronephrosis; after a time the stone drops back into the renal pelvis and the pain subsides.

Reflex pain is felt at a distance from the seat of trouble. It runs to the loin and the testicle, causing the latter to be drawn strongly upward. It runs down the thigh along the inner side, and even extends to the leg. Sometimes the patient traces a line along which he says the pain is intensified, and this line corresponds with the course of the ureter.

It must be carefully borne in mind that stone in one kidney may cause pain in the opposite organ. Indeed, cases are on record in which all the symptoms were on the side opposite to the disease.

2. *Blood in the urine* is the second cardinal symptom. An attack of renal colic followed by hematuria is almost pathognomonic of renal calculus. The blood may appear in the form of small rounded clots or it may be mixed with the urine less intimately than in other renal diseases, but more freely than when the blood comes from the bladder or prostate.

Hematuria may be absent from first to last. When the urine contains blood, it of course gives the test for albumin. There are cases in which albuminuria exists without the presence of blood.

Pus is frequently found in the urine of persons suffering from stone in the kidney. It is a symptom of great gravity. It proves that inflammation has gone on to suppuration, and that destruction of kidney-tissue is taking place which may result in complete disorganization. Mucus in the urine is also an important symptom. It is of special significance in young persons, who are not likely to suffer from enlarged prostate.

In the majority of cases the diagnosis of stone in the kidney is not difficult. The most fruitful source of error is stone in the gall-bladder. It is remarkable how silent the text-books are upon this point, and yet there are cases in which a positive diagnosis is impossible. (See Diagnosis of Gall-stones.) The differentiation must rest upon two points: 1. A microscopical examination of the urine, which in the case of renal calculi will almost surely contain blood- or pus-corpuscles. 2. Tenderness over the kidney. Another condition simulating in some degree the passage of renal calculi is the discharge of tubercular abscess from the kidney to the bladder by way of the ureter. Considerable pain may be experienced and the symptoms closely resemble renal colic. In gouty persons a discharge of large quantities of crystalline uric acid may simulate calculus, but in either of the above the history will generally remove all doubt.

The *x*-rays have been successfully employed in a number of cases. In one case which came under my observation they proved misleading; the skiagraph seemed to reveal a stone, but on operation nothing but a healthy kidney was found.

Commencing tuberculosis in the kidney may lead us into error. The symptoms already laid down and the examination of the urine for the tubercle bacilli will generally settle the question.

The pathological condition and the size and position of the stone may in many cases be diagnosticated. When pain and hematuria are the only symptoms, we may assume that the *kidney is healthy* and the *calculus large.* When there are pus in the urine, a swelling or increased resistance in the loin, and tenderness over the kidney, *an abscess with*

small calculus may be diagnosed. Hydronephrosis, as evidenced by a swelling in the loin, which is not tender to pressure and not very hard, accompanied by alkaline urine, little pus, and repeated attacks of renal colic, points to a *stone that is blocking the ureter.*

Treatment.—During attacks of renal colic pain should be relieved by hypodermic injections of morphin and the application of heat to the loin. It is possible to aid the expulsion of a small stone by giving the patient bland fluids in abundance to flush the urinary tract. These measures, however, will in the great majority of cases be of little or no avail, and considering the stone as a foreign body, the only hope of permanent benefit lies in its removal.

Indications for Operation.—Not every renal calculus requires an operation. If the stone is lying quietly in its bed, producing no pain and causing no serious mischief, it should be let alone. When attacks of renal colic follow closely upon each other, making the patient's life a burden and preventing him from following his occupation, then an operation is clearly indicated. Even if the diagnosis be shrouded in more or less doubt, an incision for exploratory purposes should be undertaken.

Operation.—For the operation of nephro-lithotomy the incision is the same as that described under Nephrorrhaphy. When the kidney is exposed the finger should be passed over its surface both before and behind in search of inequalities which would indicate the presence of a stone, a collection of fluid, a new growth, or abnormal mobility of the organ. Failing to find evidence of a calculus by digital examination, a fine aspirating needle can be used with the view of searching for stone or of finding a cavity containing pus or other fluid. As a means for finding stone I am convinced that punctures with a needle are of very little value. In one case I passed a needle in about a dozen places without feeling the least sensation of the instrument touching a stone, and yet when I laid the kidney open forty small stones were removed. Influenced by this and several similar experiences, I have come to the conclusion that when digital examination fails to find a stone the next step should be to lay the kidney open. By such an incision an abscess can be evacuated or a stone in the pelvis of the kidney exposed. The opening should be made on the convex surface of the kidney and large enough to admit the fore finger. If no stone can be felt by the finger in the pelvis of the kidney, a uterine probe bent so as to form a short-beaked sound is employed to search the calyces. A flexible probe can be passed down the ureter to the bladder. When a stone is found it is removed by forceps. If the calculus be branched so as to fill a number of the calyces, it may be necessary to break it into fragments before removal. These cases are often exceedingly troublesome, and require the utmost perseverance and ingenuity of the surgeon. Having gotten rid of the stone, a drainage-tube is introduced down to the opening in the kidney. Around the tube is placed a packing of iodoform gauze, the wound in the loin is closed except at the point of exit of the tube, and a dressing applied.

Nephrectomy (removal of the kidney) is indicated when the organ is so disorganized by the presence of stones or from any other cause that it cannot return to its normal condition. When calculi are found

imbedded in abscess-cavities this question must be considered, for it is better to remove a kidney that is riddled with abscesses than to let it remain with the certainty of a second operation later on. To remove a kidney is a serious consideration. The question of throwing the whole of the work on one kidney is by no means the most serious problem involved. If the remaining organ be healthy, it is probably already doing its own work and that of its fellow.

In a case of nephrectomy for chronic abscesses I found that the patient was voiding thirty-one ounces of urine daily; in the twenty-four hours following the operation it amounted to twenty-nine ounces; and at the end of three or four days it was restored to the normal quantity.

A much more serious question is the possibility of there being only one kidney. In one out of every four thousand persons all the renal substance is enclosed within one capsule, the removal of which would leave no kidney at all. Another consideration is the possibility that both kidneys are diseased. Assuming that one kidney is so seriously diseased as to warrant its removal, the state of the other organ must be systematically examined. A good routine method of investigation is the following:

1. Examine the organ by inspection, palpation, and percussion.

2. By repeated examinations of the urine satisfy yourself that a normal quantity and quality is being voided. The quantity of urea should be carefully noted.

3. Examine the interior of the bladder with the cystoscope. The pumping action of the ureters can in this way be brought under observation, and the appearance of the urine as it escapes from each ureter can be studied.

4. In the female the ureters should be catheterized. (See Cystoscopy.)

The operation of nephrectomy is thus performed: The incision is the same as for nephrorrhaphy or nephro-lithotomy. After exposing the kidney the finger is made to pass around it on every side to free the organ from its fatty capsule. It is then very carefully drawn into the wound as far as possible and handed to an assistant. The next step in the operation is to find and secure the pedicle. In this case the pedicle consists of the renal artery and veins and the ureter. The fingers of the operator tease out the fat about the pelvis of the kidney, exposing the vessels. The pulsation in the renal artery is a guide of great value. Two ligatures are necessary—one for the vessels, the other for the ureter. A pedicle-needle armed with a stout silk thread is made to surround the vessels which form the upper part of the pedicle. The ligature is then tied, care being taken that during the tightening the assistant relaxes the traction on the kidney. The ureter is then isolated and clamped with a pair of forceps as a temporary measure. The kidney is now cut away. To be on the safe side against cutting too closely to the ligature, a strong pair of forceps may be placed upon the pedicle between the ligature and the kidney. By cutting on the outside of the forceps ample space will be given to prevent slipping of the ligature. We must relax tension on the

pedicle while the ligature is applied; we must be equally careful to do the same thing while the pedicle is being divided, for an artery put on the stretch at this critical juncture might retract beyond the ligature and produce fatal hemorrhage. The kidney disposed of, attention is now turned to the ureter which was left secured by a clamp-forceps. If there is no thickening of the walls of the duct, it can be secured by a strong silk ligature and dropped into the cavity. If there is much thickening or ulceration in its walls, it is best to attach it to the parietal wound.

In the case of a large suppurating kidney there may be no room for the application of a ligature between the aorta or vena cava and the kidney. A temporary elastic ligature can then be thrown around the base of the kidney and the diseased organ cut away with scissors. This will do away with the risk of making too great traction on the pedicle, and by cutting it away in pieces will allow a greatly enlarged kidney to be delivered through the parietal wound. As soon as the kidney is removed the pedicle is secured by ligatures, forceps, or actual cautery and the elastic band removed.

If there is any apprehension of hemorrhage, strong forceps can be applied to the pedicle and left in position for thirty-six hours. They serve an excellent purpose in the way of drainage. The external wound is stitched with silkworm gut and a full absorbent dressing packed around the forceps.

When the forceps are not left in the wound, a full-sized drainage-tube is inserted and the opening closed and dressed as in the preceding operations.

Abdominal nephrectomy is rarely indicated. It has one advantage over the lumbar operation, in that the operator can settle the question of the presence and integrity of the opposite kidney. It is more suitable than the lumbar operation for large movable, non-adherent tumors and for a movable kidney which has become diseased and does not admit of lumbar nephrectomy.

The incision is made in the linea alba or in the linea semilunaris. The length should in no case be less than four inches, for it will be necessary to admit the whole hand. For the removal of large tumors the incision must be correspondingly extended. The middle of the incision should be on a level with the umbilicus. Having entered the abdominal cavity, the first point to settle is the condition of the other kidney by direct palpation. Satisfied on this point, the peritoneum over the diseased organ is scratched through. This opening must be in the outer layer of the mesocolon. The fingers separate the front of the kidney from its fatty capsule. The pedicle is exposed and one ligature passed around the vessels, while strong forceps secures the ureter. The kidney is then cut away at a safe distance from the ligature, and all bleeding points carefully secured. The ureter is dealt with according to circumstances. If healthy, it is washed, ligated, and allowed to drop. If suppurating, it can be secured in the parietal wound or brought through an opening in the loin. This will allow of its being irrigated from time to time and will prevent the formation of an abscess. The question of abdominal drainage here is settled by the rules which govern it in other celiotomies. If pus or urine has escaped into the

peritoneal cavity during the operation, a drainage-tube should be inserted, otherwise it is not necessary.

Perinephritic and Nephritic Abscess.—Suppuration occurs around the kidney as a result of direct violence, such as blows or kicks upon the loin. It may be produced by the presence of a renal calculus or it may spread from more distant organs, such as the liver, gall-bladder, spleen, the intestine, or the vertebræ. Urinary fistula and extravasation of urine are also causes. It not infrequently happens that a perinephritic abscess is a metastasis from some distant organ, or it may be a direct migration of septic infection from the urethra or bladder.

Symptoms.—The *local* symptoms of a typical perinephritic abscess are—tenderness in the loin with swelling more or less tense, the swelling and tenderness being due to a collection of pus. We naturally look for fluctuation, but, owing to thickness of the overlying tissues, it is generally impossible to find it. To wait for the abscess to come near enough to enable us to find fluctuation would be bad surgery. Much better is it to make an exploratory puncture or incision and settle the question. No harm can come from it, and neglect of this measure may prove disastrous.

The *general* symptoms are those of suppurative inflammation, high temperature, rapid pulse, chills, and general malaise.

In the course of time the pus has a tendency to burrow in one of several directions and the symptoms are modified accordingly. It is a rare event for the abscess to rupture into the peritoneal cavity. When this happens the symptoms are those of general peritonitis. The most common directions in which the pus is likely to burrow are the following:

1. It is confined by the fascia surrounding the neighboring muscles, and eventually points in the loin. In this case we will have pain, tenderness, swelling, edema, and, at a late stage, fluctuation in the loin.

2. The pus gets into the sheath of the psoas, and, following the course of that muscle, points in the inguinal region after the manner of a psoas abscess. The psoas being involved, we naturally find the muscle contracted. Hence the hip is flexed and the patient is unable to extend the thigh. Pain is felt in the thigh and may run down the obturator nerve to the knee. Reflected pain is felt in the testicle or vulva.

3. The pus burrows upward through the diaphragm, and, penetrating the lung, is got rid of by expectoration. Here we must be on our guard lest the pleuritic and pulmonary symptoms divert our attention entirely from the kidney. In a case which came under my care in 1884 a fistulous opening in the fifth interspace on the left side was supposed to be due to empyema. On passing a flexible catheter through the opening it took a direction directly downward and was arrested in the loin. Cutting down upon the end of the catheter, the sinus was traced directly to the kidney. Free dilatation and drainage stopped the suppuration. When pus takes this upward course we expect to find pleuritic friction, effusion and empyema, dyspnea and expectoration of pus. On the right side the liver is liable to be involved, hence jaundice is a common symptom; the stomach sympathizes, and there is

vomiting; pressure interferes with the venous circulation, and there is ascites. In rare cases perinephritic abscesses have burst into the colon, the duodenum, and the bladder.

Treatment.—Hot fomentations give temporary relief, but valuable time should not be wasted in employing such remedies. The proper treatment is to make an incision, wash out the pus, and drain the cavity.

The term *nephritic* abscess is to be restricted to a collection of pus in a kidney otherwise healthy. Abscesses of this character seldom contain more than half an ounce of pus. The tendency is for the pus to find its way into the pelvis of the kidney, thence being expelled with the urine, recovery taking place. The symptoms are usually severe at the outset of acute cases, while in chronic cases there may be little or no fever. Pain is usually felt in the loin and is intense; rigors occur at frequent intervals, and the temperature is high. There is a feeling of increased resistance in the loin, and sometimes there are redness and edema of the skin. The urine should be carefully examined for pus; if it occur in considerable quantity and is followed by diminution of a tumor in the loin, a diagnosis of renal abscess can be made with certainty.

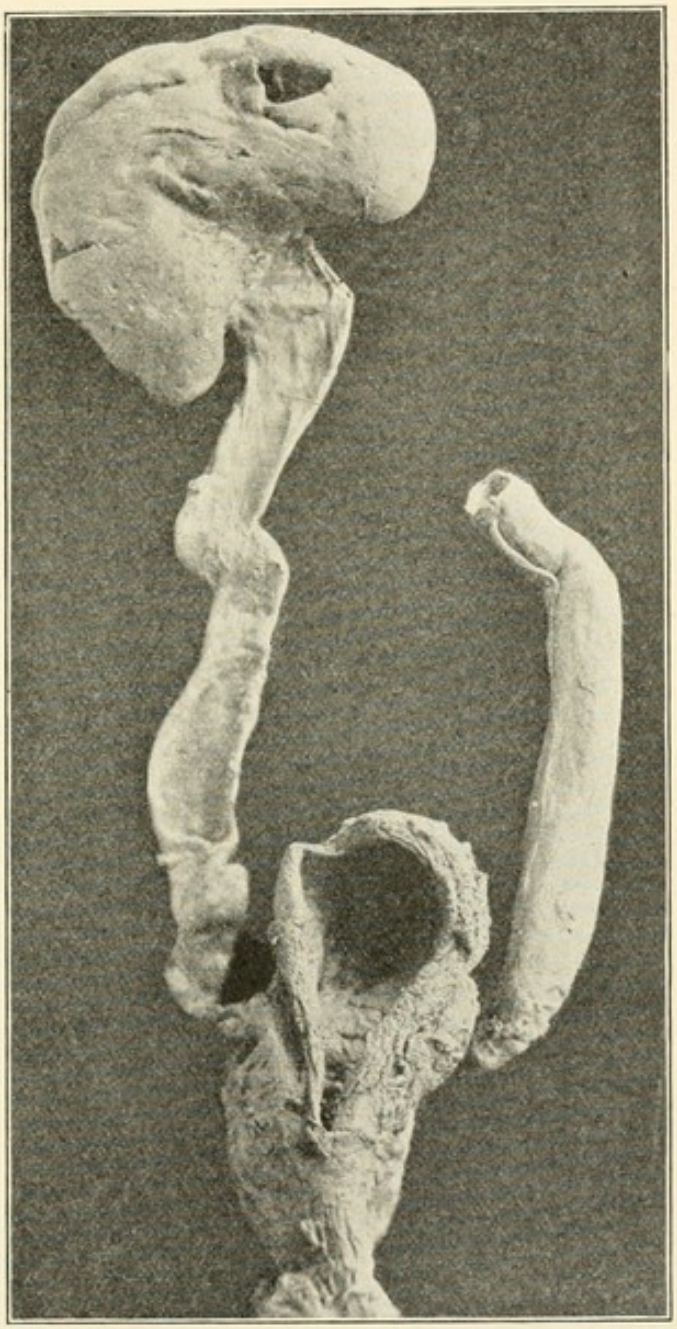


FIG. 154.—Suppuration in right kidney, ureters, bladder, and prostate from stone in the bladder. The left ureter, filled with water, measured ⅞ in. in diameter. The capacity of the bladder was only 9 drams. The bladder contained a calculus 1½ in. in diameter (from a photograph in the collection of Dr. Jepson, Sioux City, Iowa).

Treatment.—Incision is the proper treatment. Sometimes the pus lies beneath the capsule of the kidney, and a simple incision of the membrane is sufficient. When it lies deeper in the substance of the organ the kidney must be incised and drained.

Surgical Kidney.—This is an unfortunate choice of a name, and

means nothing. It is used to designate a general suppuration in the kidney which is secondary to suppuration of the urinary tract lower down, as, for instance, in the bladder or urethra (Figs. 154, 155). It was observed to frequently follow surgical operations on these parts, and hence the name "surgical kidney." In reality, it is more fre-

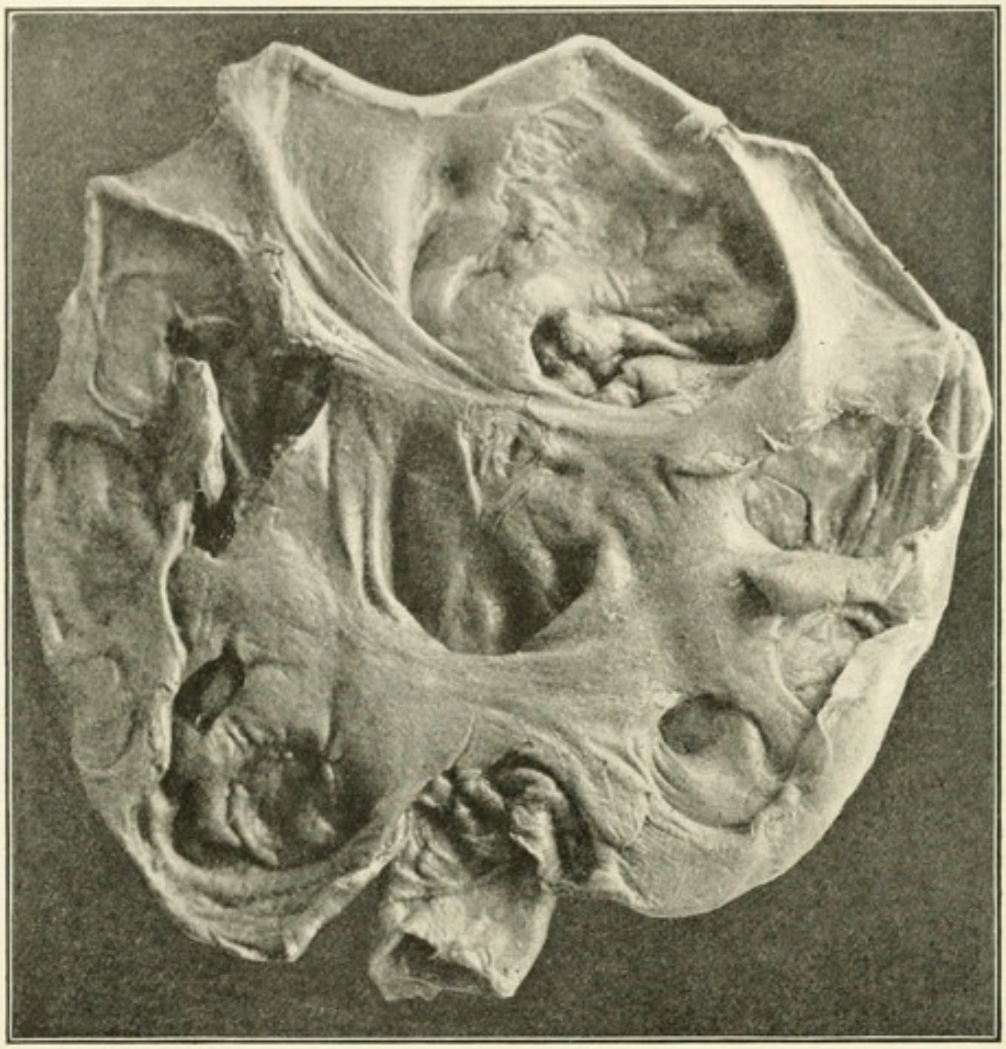


FIG. 155.—Left kidney of same case as Fig. 154. It is laid open to illustrate to what extent the secreting structure was absorbed. It is simply a large pus-sac; the walls in some places are no thicker than brown wrapping-paper (from a photograph in the collection of Dr. Jepson, Sioux City, Iowa).

quently the result of the lack of surgical procedures, and is to be traced to infection spreading unchecked up the ureters to the pelvis and lastly to the renal cortex. The disease frequently affects both kidneys simultaneously, both being equally exposed to infection.

Symptoms.—The patient is usually a sufferer from some chronic urinary disorder, as stricture or enlarged prostate, requiring the frequent use of a catheter. The extension of sepsis to the kidney is observed after the employment of catheters or other instruments, but it may be entirely independent of them. At first the symptoms are of a typhoid character. The patient becomes feverish, has a furred tongue, dry skin, foul breath, and is restless and sleepless. Rigors are frequent, sweating profuse, and emaciation becomes marked. The urine generally contains pus and is ammoniacal. Death by exhaustion

is the rule, but in some cases suppression of urine, followed by uremia, brings about a painless dissolution.

Treatment.—Prevention is better than cure. In every case requiring the use of a catheter or the simplest operative procedure on the urethra or bladder the greatest care should be taken to disinfect the seat of operation and the instrument employed. When, after the use of a catheter, symptoms of urethral fever set in, the urine should be disinfected by the administration of salol or quinin, and the patient kept on nutritious and easily digested food. Should there be evidence of cystitis or an unhealthy condition of the urine, a soft-rubber catheter should be introduced with the least possible irritation and the bladder washed out with boracic-acid solution. When there is suppurative cystitis the bladder should be washed out, and injected with an ounce of water containing three grains of nitrate of silver, after which the bladder should be again irrigated with sterilized water. The question of nephrotomy for surgical kidney is advisable in certain cases. If there be evidence of renal abscess and the condition of the patient will justify it, an exploratory incision should be made over one kidney in the hope of giving exit to an abscess or of checking the septic process by incision and drainage.

Hydronephrosis.—The kidney may be compared to a lake among the hills, drawing its water from numberless springs and rills, and having as its outlet a mountain-stream which bears the surplus water to the sea. If from any cause the outlet becomes obstructed, the lake must overflow. So it is with the kidney when its outlet, the ureter, becomes impervious. The numberless tubules like tiny mountain-rills continue to pour urine into the renal pelvis, from which there is no escape; the pelvis and calyces expand, eventually forming a tumor in the loin attended with most disagreeable symptoms. It is a serious matter when one kidney is thus affected; it is disastrous when hydronephrosis occurs simultaneously in both.

The obstruction which produces this serious condition is congenital in about one-third of the cases. A stone impacted in the ureter is responsible for about 40 per cent. of acute cases, and is one of the serious results of renal calculus. Sometimes the pedicle of a movable kidney becomes twisted and obstruction in the ureter is complete. Growths in the bladder, tumors pressing upon the ureter, enlarged prostate, and pregnancy are also entitled to places on the list of causes. It is a curious fact that frequent micturition of itself is a sufficient cause of hydronephrosis. This is how it happens: Every time the bladder contracts the ends of the ureters which pass obliquely into the bladder are compressed and the flow of urine is obstructed. Stone in the bladder causes oft-repeated contractions and is a common cause of hydronephrosis.

Symptoms.—There are two leading symptoms of hydronephrosis: 1. The formation of a tumor in the loin or abdomen, increasing rapidly and fluctuating. 2. An excessive flow of urine, followed by subsidence of the tumor. This is pathognomonic. It is seldom, however, that these two symptoms are found together. The tumor, when it is apparent, varies greatly in size. In one case examined post-mortem by Glass the right kidney formed a tumor which so distended the abdo-

men that it measured six feet four inches in circumference, and from the ensiform cartilage to the pubis it measured four feet and half an inch. The fluid contained in the cystic kidney measured thirty gallons and was of a light coffee-color. The tumor is sometimes irregular or lobulated, and fluctuation may be felt. Without a tumor there are no symptoms which are distinctive of hydronephrosis. Sometimes hydronephrosis is intermittent, the tumor at one time being tense and at another soft and easily compressed, and if care be taken to measure the urine, the amount voided will be found to be increased with each subsidence of the tumor.

The character of the urine is of no value in diagnosis when only one kidney is involved, for the healthy kidney is capable of keeping up the normal character of the excretion. The fluid in the affected kidney is a very dilute urine, having a specific gravity of about 1002, and containing the natural constituents in small amounts.

When both kidneys are affected the condition is serious and may lead to uremic poisoning. The diagnosis in the case of a tumor forming in both loins can be settled by aspirating one or other kidney.

The danger of hydronephrosis is destruction of the affected kidney, the constant pressure producing absorption of the excreting part of the renal substance, and eventually converting the whole organ into a fibrous sac containing fluid. When only one organ is affected, the opposite one often proves equal to the requirements of both, and the full amount of urine is excreted.

The *diagnosis* must be made between hydronephrosis on the one hand and ovarian cyst, ascites, and hydatids on the other. On palpation and percussion a dilated kidney has the colon in front of the swelling, and there is dulness in the lumbar region. An ovarian cyst can be palpated by the vagina, and has its dulness in the middle line, gradually growing from the pelvis. In ascites the patient is like a rubber water-bag, the level of the fluid varying with change of position. Hydatids cause a painless, slowly-growing tumor, in rare instances having the hydatid fremitus, and definitely determined by the presence of vesicles in the urine.

Treatment.—When there is evidence of obstruction of the ureter either by a calculus or other foreign body an attempt may be made to facilitate its passage toward the bladder by massage of the loin. The injection of water into the bladder to fully distend it has occasionally proved of assistance in favoring the release of a calculus down the ureter (Reginald Harrison). Failing in these measures, the next effort should be to relieve the symptoms by aspirating the tumor. In some cases this has not only given immediate relief, but effected a permanent cure. If repeated aspirations prove unavailing, the next question to take into consideration is the opening and drainage of the kidney. The operation consists in a lumbar incision with an opening into the kidney, and the establishment of drainage until the sac consolidates or becomes a harmless sinus. This is preferable to nephrectomy, which has also been resorted to by some surgeons as a remedy for hydronephrosis.

Pyonephrosis.—Just as water in the pleural cavity may be changed to pus, so a hydronephrosis may become a collection of purulent matter; or if, during the course of a pyelitis, obstruction of the ureter takes

place, the secretion of pus gradually distends the kidney till it reaches the dimensions and character described under Hydronephrosis. The symptoms are practically the same. When a diminution in the size of the tumor takes place the excreted fluid is found to be pus.

Tuberculosis of the Kidney.—Tuberculosis of the kidney is to be suspected when chronic renal symptoms exist, combined with a family history of tubercular disease. Males form a large majority of the patients, and the most susceptible period of life is during early adolescence and while the sexual functions are most active. One reason of this distinction is the important part which gonorrhea plays in the causation. The female when the subject of gonorrhea is more readily cured, and is not so liable to complications as the male, and when the tubercle bacillus attacks women it shows a decided preference for the lungs. In males a gonorrheal orchitis is almost a constant forerunner of renal tuberculosis, and while it occasionally happens that the tubercular process begins in the kidney and makes its way downward, the opposite direction from testicle to kidney is the rule.

Symptoms.—The patient is generally a male below middle age, having a family history of tuberculosis and frequently the subject of a chronic orchitis. With these data to start from, the symptoms of tuberculosis in the kidney bear a close analogy to those manifested by the disease in the lung. There are hematuria, corresponding to hemoptysis; irritation in the urinary tract, causing frequent micturition, corresponding to cough; and increase in the quantity and change in the character of the mucus, corresponding to expectoration in phthisis.

Although hematuria can occur in the early stage of the disease, it is after ulceration has been established that it appears in its most marked form. Frequent micturition in children leads to a suspicion of stone in the bladder, and this source of error must be guarded against. As the disease advances the excess of mucus undergoes a change, and the urine is found to contain considerable quantities of pus.

The thermometer is valuable here as in the diagnosis of pulmonary tuberculosis, a persistently high temperature in the latter part of the day being very characteristic. The demonstration of the bacilli in the urine settles the diagnosis beyond question.

Treatment.—The general treatment as regards diet, climate, and hygiene are the same as indicated in pulmonary tuberculosis. The local treatment involves some serious considerations. When the testicle is tuberculous, the gland should be treated as any other tuberculous gland. If there be no evidence of the disease in any other part of the body, the cheesy masses should be removed or the testicle completely excised. The bladder requires close attention, especially when the urine is offensive. Injections of a weak solution of nitrate of silver, preceded and followed by irrigation, is one of the best methods of disinfection. Reginald Harrison recommends iodoform suspended in mucilage in the proportion of five grains to the ounce. Nephrotomy or nephrectomy cannot be recommended, for the disease is seldom confined to one kidney or to any one portion of the urinary tract.

Hydatid Cysts.—The kidney is much less frequently affected by hydatids than the lungs or the liver. In the majority of cases the left

kidney is the seat of the parasites, and males suffer more frequently than females. The cyst begins, as a rule, in the secreting substance, but occasionally in the cellular tissue beneath the capsule or surrounding the pelvis. Small portions of the contents frequently escape through the ureter, and it is probably on this account that hydatid cysts of the kidney seldom attain to large size. Rupture is not uncommon, and the discharge may take place into the intestine or lung, but never externally through the loin. Sometimes the cyst undergoes inflammatory or absorptive changes, as happens in hydatids of other organs.

Symptoms.—When the tumor is small a hydatid cyst of the kidney may present no symptoms, and in the favorable cases in which it discharges through the ureter the disease may undergo a spontaneous cure without recognition. In many cases (52 out of 63, according to Roberts) vesicles are passed in the urine and afford the first clue to the nature of the affection. In their journey down the ureter these vesicles produce well-marked attacks of renal colic, and occasionally hydronephrosis. The tumor in the loin is smooth, but seldom is fluctuation elicited. When the vesicles get into the bladder they may produce irritation and tenesmus; in the urethra they may cause retention of urine. In any case inflammation and suppuration may supervene, while blood and pus escape with the urine. The hydatid fremitus so constantly mentioned as a diagnostic sign is really of little value, owing to the extreme rarity with which it can be detected. To settle positively the diagnosis, exploratory puncture is a proper measure, the demonstration of the hooklets under the microscope leaving no possible room for doubt. It must, however, be borne in mind that exploratory puncture is not devoid of danger. When it is necessary to resort to it the surgeon should be prepared to operate the moment the diagnosis is settled.

Treatment.—The surgical treatment is the same as that indicated for hydatids of the liver. An incision as for nephrorrhaphy is made in the loin, the cyst freely opened, its edges stitched to the external wound, and the cavity cleaned out and drained.

Simple Cysts.—Serous cysts springing from the renal cortex are recognized on palpation as thin-walled globular tumors. Their contents vary from a thick jelly-like substance to a thin, straw-colored fluid containing albumin, cholesterin, and sometimes blood.

There are few symptoms to aid the examiner except a painless, smooth tumor in the loin, growing slowly and producing neither disturbance of the general health nor derangement of the urinary organs. The diagnosis must rest upon the exclusion of other tumors of the kidney of a cystic nature.

Solid Tumors.—Before five years of age and after thirty solid tumors of the kidney are not uncommon. No matter how fine the distinctions made by the pathologists, or how exhaustive the classification adopted by the clinician, tumors will always fall under one of two great classes—benign and malignant. In the kidney benign solid tumors are almost never found. When you make a diagnosis of solid tumor it is equivalent to saying that the growth is either a sarcoma or a carcinoma. For the sake of being systematic we adopt a classifica-

tion of renal tumors, and that of Paul seems to be the simplest and is sufficiently comprehensive:

Of congenital origin: Sarcoma, hydronephrosis, cavernous tumors, dermoid tumors.

Of adult origin: Cystic disease, cavernous tumors, sarcoma, adenoma, carcinoma.

Symptoms of Solid Tumors.—In examining a tumor in the lumbar region the following points require attention: A kidney as it enlarges takes a direction forward, while an abscess or other lesion which can simulate an enlarged kidney causes bulging posteriorly. A kidney is always round, and can thus be distinguished from the liver, which has a sharp edge, and from the spleen, which has a characteristic notch.

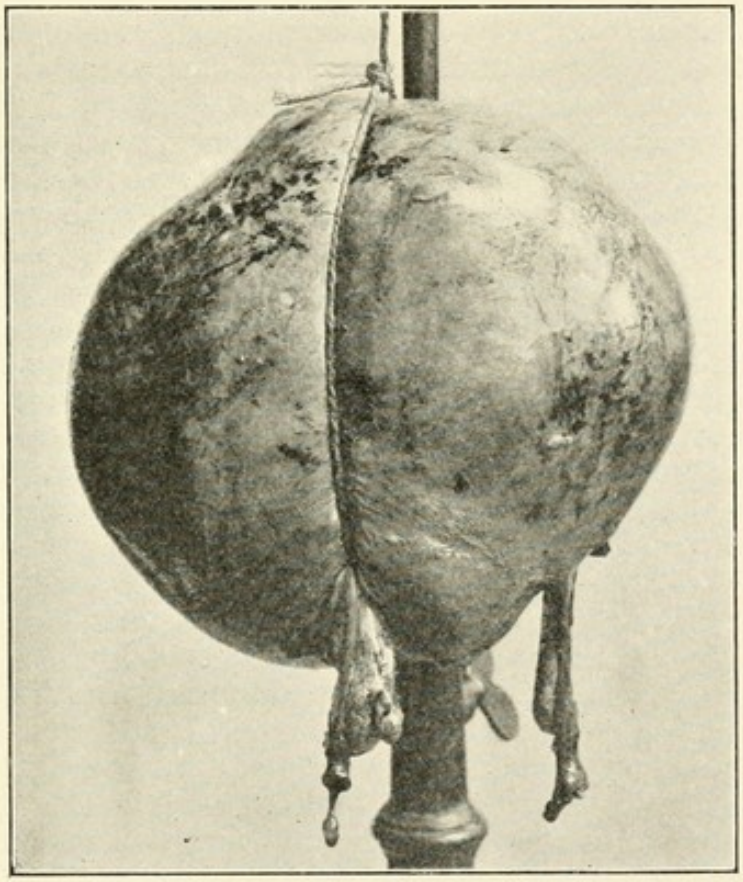


FIG. 156.—Carcinoma of the kidney from a patient aged eighty. Patient made a good recovery from the operation, but died two months later of persistent vomiting and dilated stomach (from a photograph in the collection of Dr. Andrews, Mankato).

The kidney does not rise and fall with the respiratory movements as freely as does the liver. A tumor of the kidney has usually a resonant zone in front of it, which is the ascending or descending colon. This may be absent, owing to congenital malposition of the colon. When the intestine fails to give resonance on percussion, the bowel can sometimes be felt as a cord-like structure between the tumor and the skin. Briefly stated, the distinctive symptoms of cancer of the kidney are a tumor in the lumbar region and hematuria (Fig. 156). The tumor grows in the direction of least resistance, which is forward, and overlying it is the colon recognized by a zone of resonance. From tumors of the liver a renal growth is distinguished by the following points:

1. The liver rises and falls with respiration.

2. Hepatic tumors have no bowel-resonance in front.

3. The sharp edge of the liver can frequently be felt; kidney tumors are always round.

4. Between a renal tumor and the edge of the ribs is a space into which the fingers can be pushed.

Between a splenic and a renal tumor the differences are—

1. A splenic tumor has no bowel in front.

2. It has usually a well-defined edge, and sometimes a notch can be felt.

Hematuria is found in about half the cases. It may occur at any stage of the disease, and is generally intermittent. When the amount of blood is large it may form clots in the ureter or bladder, and then renal colic or vesical tenesmus becomes a prominent symptom. In the intervals between attacks of hematuria the urine is normal or it may contain pus- or tube-casts.

Pressure-symptoms are sometimes prominent. One or both legs may be edematous, and large veins may course over the abdominal wall; the bladder may be irritable and the bowels constipated.

Pain is not a constant symptom, but in a majority of cases it is pronounced. It is most prominent in the loin and abdomen, but is reflected down the thigh and around the back and shoulders.

Treatment.—All congenital solid tumors of the kidney must be considered malignant, and therefore the treatment is by no means hopeful. Internal remedies, such as iodid of potassium and Chian turpentine, have given some encouragement. When improvement appeared to take place it was only temporary. The toxins of erysipelas and bacillus prodigiosus enjoyed a reputation for a time, and several cases of sarcoma were reported as cured by their use. A most patient trial in three cases of my own ended in utter disappointment.

The question of removal of the growth, including the kidney, is a most serious one. Of 35 operations reported by Mr. Sutton for renal sarcoma in children under six years of age, 15 recovered, but all died within a year from recurrence of the growth. If recognized at an early period of the disease, extirpation would give a chance of future immunity, and several cases are recorded in which the patients remained free from recurrence at the end of two or three years. In adults, when urgent symptoms such as profuse hematuria or intense pain call loudly for relief, operation may afford the only prospect, but the possibility of cure is so remote that the brightest side that can be claimed for the operation is that it is likely to end the patient's suffering by an easy death.

II. INJURIES AND DISEASES OF THE URETER.

Surgical Anatomy.—The ureter is a muscular canal which carries the urine from the pelvis of the kidney to the bladder. Its average diameter is one-eighth to one-sixth of an inch, and its length from ten to thirteen inches. Its walls consist of three coats. The outer is composed of connective tissue with elastic fibers; the middle coat is muscular, the fibers being both longitudinal and circular; the inner

coat is composed of mucous membrane. The ureter lies behind the peritoneum, but bound to that membrane by fibrous bands, so that when the peritoneum is stripped from the parts behind the ureter always follows it. On this account the ureter is difficult to find in the bottom of a deep lumbar wound, especially in fat subjects.

Its course is downward from the kidney, at first lying on the psoas muscle, and then crossing the bifurcation of the common iliac arteries. Although nearly straight, the tube really takes two curves—the first from the kidney to the brim of the pelvis, its convexity toward the middle line; the second or pelvic curve has its convexity directed toward the outer wall of the pelvis. The ureters enter the neck of the bladder about two inches apart, running obliquely between the muscular and mucous coats for a distance of a half or three-quarters of an inch. In the male this opening is external to the vas deferens; in the female the ureter penetrates the plexus of veins beneath the broad ligament.

The canal is not absolutely uniform in caliber throughout its entire course; Halle and Tanguery have shown that in normal subjects it is narrowed in three places—viz. (*a*) At a point between one and a half and two and a half inches from the pelvis of the kidney; (*b*) at the junction of the pelvis and vesical portions; and (*c*) at the place where it crosses the iliac artery. These are the localities where small stones from the kidney have been found to be arrested (Fenger).

In palpating the ureter the following landmarks from Tourneur are of importance: At the junction of the internal with the middle third of Poupart's ligament erect a vertical line. This line corresponds with the course of the abdominal portion of the ureter. It crosses the brim of the pelvis four and a half centimeters from the middle line. This point is found by drawing a horizontal line from one anterior superior iliac spine to the other, and intersecting this by a vertical line through the pubic spine. At the point of intersection gentle steady pressure can be made by the fingers until the brim of the pelvis is reached. Tenderness or dilatation of the ureter at this point can thus be detected. The vesical portion of the ureter can be palpated through the rectum in the male. When a stone is lodged in the ureter, even at a point high up, exquisite sensitiveness is experienced in this examination (Guyon, cited by Fenger). In females the ureter can be palpated through the vagina for a distance of two or three inches as it runs in the broad ligament close to the upper wall of the vagina (Cabot).

Rupture of the Ureter.—It would seem almost impossible that the ureter should suffer injury, protected as it is by strong masses of muscle and fat and guarded by promontories of bone. When rupture does occur, it is by the application of very great violence to the trunk or abdominal region. The kick of a horse, the passage over the body of a heavily-laden wagon, a blow from the handle of a wheelbarrow, violent over-stretching, and other traumatisms have been reported as causes.

Symptoms.—The symptoms are generally obscure, and often they are long delayed. When the bladder or the kidney is ruptured, the symptoms are prompt in making their appearance. Not so with the ureter, for at the beginning there are no grave symptoms unless some other important organs are injured.

When there is an external wound through which urine is found to escape the diagnosis is positive. In the absence of this sign the evidence must rest largely on the nature and severity of the injury. In some cases the urine is bloodstained. A swelling in the loins and a collection of fluid, which when drawn off by the aspirator is found to resemble urine, are very suggestive of rupture. This swelling does not occur until some time after the receipt of the injury. The time varies from seven days to seven weeks. The swelling is round, oblong, or sausage-shaped, following the course of the canal, and is palpable from the abdomen (Fenger).

The fluid which produces the swelling just mentioned is not pure urine, nor is the rupture of a ureter followed by extravasation of urine, as we would naturally infer. The clinical fact remains that in cases of ruptured ureter a fluid is poured out at the seat of rupture which is not productive of the disastrous consequences which follow extravasation of urine in other parts. When extravasation of urine takes place in the scrotum or perineum from ruptured urethra, inflammatory symptoms soon appear and rapidly proceed to gangrene of the parts involved. In rupture of the ureter a swelling forms and continues for days or weeks without any inflammation or gangrene. In explanation of this singular condition Reginald Harrison suggests that the rupture of the ureter is followed by the formation of clots, not only in the ureter, but in the corresponding kidney; that these ante-mortem clots are a provision for the substitution of a kind of urine which is incapable of proving destructive to the tissues with which it may come in contact. In a case of his own he was able to examine this kind of urine, and found that there was almost a complete absence of urea. There being no urea to decompose, there is no source for the production of the ammonia by which the destruction of tissues is effected when normal urine is extravasated. The absence of urea renders the urine chemically harmless to the tissues with which it comes in contact.

One of the consequences of ruptured ureter is the formation of dense and unyielding strictures. As a consequence of stricture the kidney may suffer from hydronephrosis and undergo atrophy.

Treatment.—If an early diagnosis can be made (and this is only possible when there is a wound through which urine is trickling), the proper treatment of ruptured ureter would be to enlarge the incision, find the divided ends of the tube, and unite them in the manner which will be presently described. So far, this has not been attempted. In the majority of cases the diagnosis is arrived at after the formation of a swelling due to a collection of modified urine above described. The treatment in vogue for this condition is puncture or incision, and drainage either through the abdominal cavity or by a lumbar incision. Nephrectomy has been resorted to in a number of these cases and in accidental division of the ureter during celiotomies.

Nephrectomy is too radical an operation to be thought of before every other expedient has been tried to restore the function of a ruptured or severed ureter. Instead of proceeding deliberately to remove the kidney, an exploratory incision would be the proper course. Search should be made for the ends of the ureter, and if found an attempt should be made to unite them. Access to the ureter can be had by

the abdominal or by the lumbar incision. An incision in the middle line or a little to one side exposes the whole length of the ureter with little difficulty, but the operation is intra-peritoneal, and unless the urine is aseptic the danger of peritonitis is great. The lumbar incision renders it more difficult to reach the ureter, owing to the depth of the wound, but when it is practicable it should be chosen as much the safer operation. The incision begins at the lower border of the twelfth rib, at the edge of the erector spinæ muscle, and extends along a line one inch anterior to the ilium, and thence along Poupart's ligament to about its middle. Only the upper two-thirds of the ureter can be exposed by this procedure.

Van Hook's method of suturing the divided ureter (uretero-ureterostomy) is as follows: 1. "Ligate the lower portion of the tube one-eighth or one-fourth of an inch from the free end. Silk or catgut may be used. Make with fine sharp-pointed scissors a longitudinal incision twice as long as the diameter of the ureter in the wall of the lower end one-fourth of an inch below the ligature.

2. "Make an incision with the scissors in the upper portion of the ureter, beginning at the open end of the duct and carrying it up one-fourth of an inch. This incision ensures the patency of the tube.

3. "Pass two very small cambric sewing-needles, armed with one thread of sterilized catgut, through the wall of the upper end of the ureter one-eighth of an inch from the extremity, from within outward, the needles being from one-sixteenth to one-eighth of an inch apart and equidistant from the end of the duct. It will be seen that the loop of catgut between the needles firmly grasps the upper end of the ureter.

4. "These needles are now carried through the slit in the side of the lower end of the ureter into and down the tube for half an inch, where they are passed through the wall of the duct side by side.

5. "It will now be seen that the traction upon the catgut loop passing through the wall of the ureter will draw the upper fragment of the duct into the lower portion. This being done, the ends of the loop are tied together securely, and, as the catgut will be absorbed in a few days, calculi do not form to obstruct the passage of the urine.

6. "The ureter is now enveloped carefully with peritoneum, as already described in other operations, provided an intra-peritoneal operation has been done."

As an additional security against leakage Bloodgood recommends the application of two sutures through the external coats (Figs. 157–161).

Another method of dealing with a divided ureter is by *implantation*. When there is loss of substance or when from any cause the ends of the tube cannot be approximated, the following expedients have been resorted to:

1. Implantation of the proximal end of the ureter into a loop of intestine. This is objectionable on account of the risk of septic infection of the kidney by the gases escaping from the bowel.

2. Implantation into the bladder. When the proximal end of the ureter is long enough to reach the bladder, this procedure is better than any other, as it re-establishes the natural course of the urine and is free from danger of septic infection.

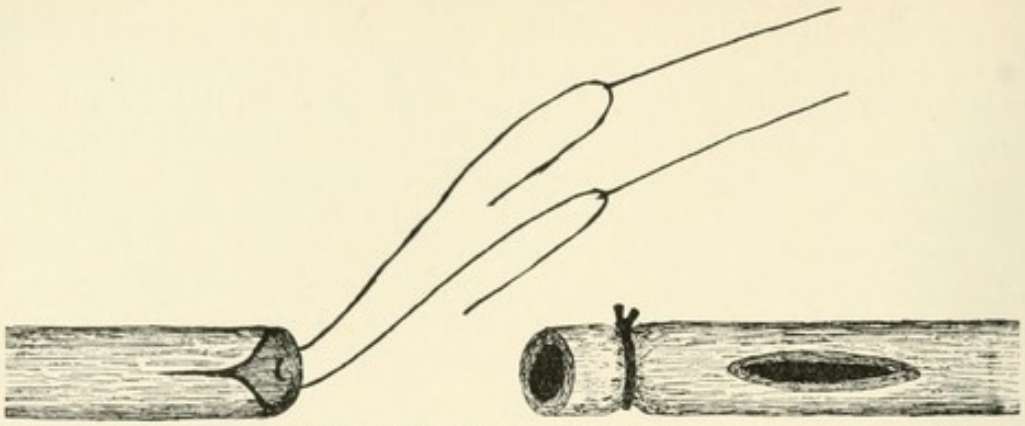


FIG. 157.—Uretero-ureterectomy (Van Hook's method). The needles have been introduced into the wall of the renal portion of the ureter. The end of the vesical portion of the tube has been ligated and a slit made in its wall.

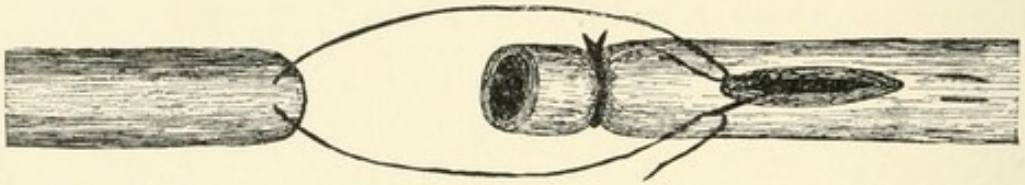


FIG. 158.—The needles carrying the traction suture attached to the renal portion of the ureter have been passed into the slit in the wall of the vesical portion, carried down a short distance, and pushed out through the wall.

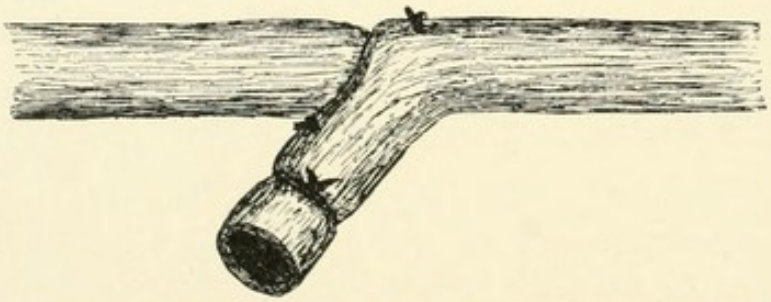


FIG. 159.—By means of the traction suture the renal portion of the ureter has been implanted into the vesical portion. The ends of the traction suture have been tied together.

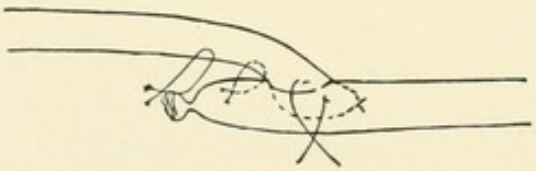


FIG. 160.—Ureter anastomosed; traction sutures tied; and two fixation sutures in place ready to be tied.

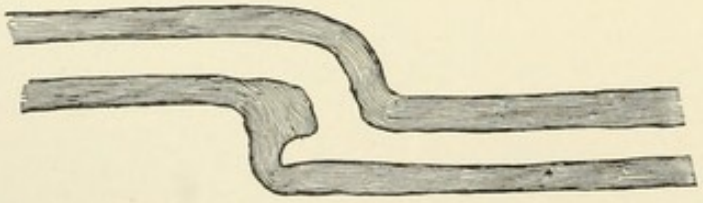


FIG. 161.—Longitudinal section of ureter, showing new lumen and diverticulum.

3. Implantation into the pelvis of the kidney. This is applicable to cases in which the division is at the upper portion of the ureter.

4. Implantation through the skin. When the ureter is divided in

the pelvis and cannot be connected with the bladder and vagina, it has been suggested by Van Hook to attach the proximal end by sutures to an opening in the skin.

Ureteral Calculus.—A stone in the ureter is likely to be arrested at one or other of three portions of the tubes which are naturally narrowed—that is to say, at a point between one and a half and two and a half inches from the pelvis of the kidney, at the junction of the pelvic and vesical portions, and at the point where the ureter crosses the iliac artery. Of these three portions, the upper is most frequently the lodging-place of a calculus, while stone is found in about equal frequency in the two lower portions.

Diagnosis.—The diagnosis of stone in the ureter is only possible in that portion of the duct which can be palpated from the rectum or vagina. Even when thus favorably located errors in diagnosis are apt to occur. A calculus palpated from the vagina is likely to be mistaken for a diseased ovary, as happened in Collingworth's case. The symptoms of stone in the upper portion of the ureter are those of stone in the kidney, and a differential diagnosis is impossible.

Removal of stones from the ureter is effected by different methods according to their location:

1. *Longitudinal Ureterotomy.*—When the calculus is lodged in the upper part of the ureter an attempt should be made to push it back into the renal pelvis, whence it can be withdrawn through an incision in the renal tissue. Failing in this, an incision should be made in the long axis of the ureter over the stone. The wound in the ureter is carefully closed with sutures if the operation is intra-peritoneal. When extra-peritoneal no sutures are required, as the urine can be drained until the wound closes by granulation.

The consequences of obstruction with calculi of one or both ureters are serious. When one tube only is obstructed, absorption and disintegration of the corresponding kidney take place. When both tubes are occluded, speedy death results from mechanical suppression of urine.

2. *Ureterotomy through the Vagina.*—When by palpation a stone can be felt in the lower end of the ureter, its removal by way of the vagina may be accomplished without great difficulty. The usual position of the calculus is in the broad ligament close to the cervix uteri. The incision is best made with scissors, and the wound can be closed with interrupted sutures.

3. *Removal through the Rectum.*

4. *Removal through the Bladder.*—The stone may be so near the lower end of the ureter as to give a click when examined with a sound. In this case the urethra is dilated, and also the orifice of the ureter if necessary, and the stone withdrawn. Whitehead removed eleven calculi in this manner. Sometimes the mucous membrane has to be divided before the stone can be set free.

Ureteritis.—Inflammation of the ureter is probably a quite common condition, but masked by renal and vesical diseases. According to Mann, ureteritis has seven causes: (1) injuries during childbirth; (2) previous disease of the bladder; (3) gonorrhea; (4) suppuration of the pelvis of the kidney; (5) pelvic inflammations and tumors; (6)

abnormal conditions of the urine; (7) tuberculosis. The pathological changes produced by inflammation are in some cases a slight swelling of the tubes and desquamation of the epithelial lining; in others a purulent condition indicating ulceration of the lining membrane; in still another class the tube is thickened, increasing the caliber of the ureter to the size of a lead-pencil or larger.

Symptoms.—The most constant symptoms are frequent or almost continuous micturition and a boring pain along the course of one or both ureters. The left suffers more frequently than the right. The disease is usually chronic in its course, and great depression of spirits is not uncommon.

Treatment.—The general treatment consists in securing the best hygienic surroundings, avoiding alcoholic and other irritating beverages, and paying careful attention to diet. The bowels should be kept relaxed and alkalies should be given continuously. For improving the condition of the urine copaiba, oil of sandalwood, and benzoic acid are recommended.

Local applications of nitrate of silver or boracic acid may be made to the ureters after first dilating the urethra in the manner recommended by Simon, Pawlik, and Kelly.

Stricture of the Ureter.—The healing of a wound of the ureter

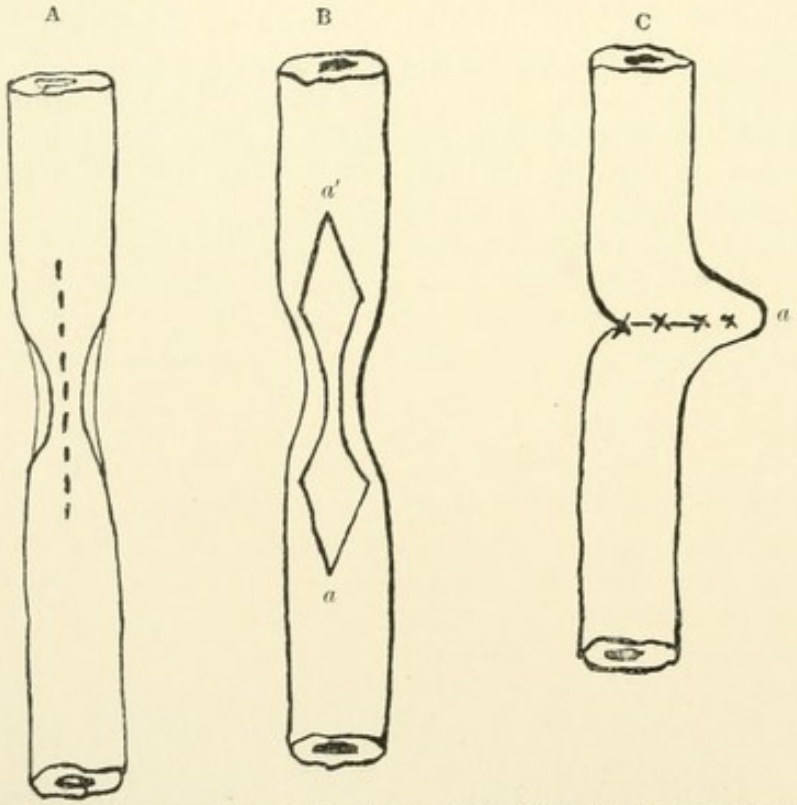


FIG. 162.—Fenger's plan of operating for ureteral stricture on extra-peritoneal surface of ureter: (*A*) ureter stricture and line of incision; (*B*) opening through the stricture extending into the proximal and distal portion of the ureter, the extreme ends of the incision *a* and *a'* to be united; (*C*) ureter after suturing; *a*, the bend at the site of the stricture.

is likely to be attended with the formation of cicatricial tissue, which by its contraction narrows the tube in the same manner as occurs so frequently in the male urethra. There is a question whether stricture can

be caused by gonorrheal infection spreading from the urethra to the bladder and thence to the ureter. Tumors in the pelvis and abdomen are common causes of obstruction of the ureters.

In many of the cases stricture results from the healing of ulceration caused by the temporary obstruction of a calculus or by the healing of a tubercular abrasion.

Operations for the Relief of Stricture of the Ureter.—1. Fenger's method consists in making a longitudinal incision at the seat of stricture and converting it by sutures into a transverse incision. The ureter is opened above or below the stricture and the incision carried through the constricted portion, as seen in Fig. 162. The upper and lower ends of the longitudinal wound are then brought together by folding the ureter upon itself. The remainder of the wound is approximated by sutures which catch the outer and middle coats, thus converting the longitudinal into a transverse wound (Fig. 162).

2. Dilatation by bougies has been successfully practised by Alsberg in a case of stricture near the pelvis of the kidney attended by hydronephrosis.

3. Resection of the ureter and implantation of the distal end into the pelvis of the kidney.

III. INJURIES AND DISEASES OF THE BLADDER.

In the general examination of a patient our attention is usually drawn to the bladder by one or more of the following symptoms—viz. pain, frequent micturition, and hematuria. The significance of these symptoms we shall now consider.

Pain.—This is not necessarily felt at the seat of the disease, but, like the pain in hip-disease, may be felt at a distance. Stone in the bladder produces pain on the under surface of the penis a little behind the meatus. When the kidney is the seat of the disease, pain is felt in the groin, in the testicle, and down the thigh. Disease in the testicle produces pain along the inguinal line. These are reflected pains, and are felt at the termination of the nerve and not at the spot where the nerve is irritated.

Direct pain, however, is not uncommon. When the bladder becomes over-distended the pain is felt over the viscus itself. Urethritis causes pain at the seat of the inflammation, which is always accentuated by external pressure at that point. In inflammation of the prostate the pain is most marked in the perineum and rectum, and is greatly increased by digital pressure by way of the rectum. Combined with these direct we may also have indirect pains running along the course of the urethra, and leading us to suspect the presence of stone in the bladder.

A valuable aid to diagnosis is a consideration of the time at which pain is felt. If it is felt during micturition, we naturally suspect inflammation in the urethra, the prostate, or the bladder. A patient with stone in the bladder complains of pain at the end of micturition, and well he may, for the viscus, after expelling all the urine, violently contracts upon the calculus in a vain but painful effort to get rid of the foreign body. Pain that is felt before the act of micturition, and which

ceases after the act, is due to cystitis or to retention of urine. Pain during micturition, greatly aggravated by the act of defecation, is an indication of inflammation in the prostate.

Frequent Micturition.—The expulsion of urine from the bladder is a reflex act. In the normal condition the urine trickling down the ureters gradually expands the bladder till a certain degree of irritation is applied to the terminal branches of the sensitive nerves which supply the viscus. This stimulus runs up the sensory nerves to the spinal cord, and thence to the motor nerves which supply the muscles of the bladder and urethra. These muscles contract and empty the bladder. Any stimulus applied to the terminal branches of the sensitive nerves will produce the same result; consequently, frequency of micturition is a symptom of cystitis, urethritis, or prostatitis. It also occurs when the capacity of the bladder is lessened, when the urine undergoes certain changes, when there is phimosis, contracted meatus, stricture, or calculus. Taken by itself, frequent micturition is a symptom of very indefinite significance. When it is met with, the question should be decided as to whether it is increased by exercise or by rest. A stone or a tumor in the bladder may be suspected when movement increases the frequency; atony of the bladder and disease of the prostate are to be suspected when the frequency of urination is increased by rest. The size and force of the stream should be carefully noted. A small stream is caused by stricture, by a contracted meatus, or by inflammatory swelling in some part of the urethra. If the time spent in the act of micturition is lengthened and the force of the current is slow, obstruction may be suspected, the most common causes of which are stricture, prostatic disease, and muscular atony.

Hematuria.—Bleeding may occur from any part of the urinary tract, and by close observation we can generally locate its origin. When it comes from the kidneys it is well mixed with the urine, giving the fluid a smoky appearance. In addition there is a history of renal disease, as indicated by albuminuria, the presence of granular or hyaline casts, degeneration of the retina, etc. The color alone should not be relied upon, for smoky or beef-tea-colored urine may be produced when blood in small quantities escapes from the bladder-wall and has time to mix freely with the urine before being expelled. Black or coffee-colored blood is produced by profuse hemorrhage from the bladder accompanied with retention from clotting. Blood from the ureter is an accompaniment of renal colic, and is usually due to the passage of a calculus on its way from the kidney to the bladder. The quantity of blood is seldom large, but the terrible pain up the back and loin, in the testicle, and down the thigh leaves little doubt as to its origin. Hemorrhage from the prostate comes away in clots, and is usually a concomitant of chronic disease of the gland, such as tuberculosis or carcinoma. The prostate is generally enlarged. When the urethra is the seat of hemorrhage it is generally due to the use of instruments. The blood comes before the urine and is clotted. The bladder is frequently the seat of hemorrhage, owing to the presence of calculi and morbid growths, especially papillomata. We recognize this source of bleeding by excluding the other localities and by the history of the case. As a rule, the blood comes with severe straining at the end of urina-

tion. An ingenious test for ascertaining the existence of a wound or abrasion of the bladder is the so-called absorption test of Ultzmann. A solution of iodid of potassium is injected into the bladder. If there is a breach in the continuity of the mucous membrane, the iodid is absorbed and can be detected in the saliva. The absence of iodin in the saliva would indicate an uninjured mucous membrane. The following axioms from E. Hurry Fenwick may be taken as in the main correct:

1. "The brighter and more arterial the color of the urine, the nearer the source of the bleeding is to the meatus urinarius.

2. "Long dark clots like earth-worms or quill-barrels indicate bleeding from the renal pelvis, for they are clots or moulds of the ureter.

3. "Large irregular-edged scarlet clots are derived from a bladder source if traumatism of the kidney and renal tumor are excluded.

4. "Blood appearing toward or at the finish of clear urination denotes a vesical or a prostatic origin.

5. "Blood issuing from the meatus independently of micturition is from an urethral source."

In cases of doubt the microscope may throw some light upon the source of the hemorrhage. Blood-casts indicate the renal tissue as the seat of hemorrhage, and the same is true of granular casts. When the bladder is the seat of a morbid growth small portions of the neoplasm are likely to be voided with the urine, and may be subjected to the microscope.

The voided blood may be further examined by allowing it to subside in a conical glass. Of this test Von Jaksch says: "When blood-cells are intimately mixed with the urine in such a way that, though present in large quantity and deeply tingeing the fluid, they do not form a sediment after many hours' standing, it may be inferred that the hemorrhage took place in the substance of the kidney or in the renal pelvis or ureters. If, under these circumstances, they are seen with the microscope to be profoundly altered, having lost their coloring matter and presenting the appearance of pale yellow rings, the further conclusion results that the blood has been effused from the kidney itself, and the symptoms point to acute nephritis or to a fresh exacerbation in the course of chronic nephritis."

Having completed the examination of the urine, the next step in the investigation of the seat of hematuria is a physical examination of the various parts of the urinary tract as follows:

1. *The Kidneys.*—The method of palpating the kidney has been already described. By palpation we ascertain the presence or absence of *tenderness* of the kidney. Tenderness can be elicited on deep pressure in the following conditions: viz. pyelitis, chronic abscess, inflamed cyst, and acute suppurative nephritis. A stabbing pain elicited by pressure over the front of the kidney is very suggestive of renal calculus, but too great stress should not be laid upon the absence of this sign. Enlargement of the kidney may be due to the following conditions: (*a*) It may be a simple hypertrophy of the organ to compensate for atrophy of its fellow. (*b*) It may be due to the presence of a large calculus and to the inflammatory changes which such foreign bodies produce. (*c*) Tuberculosis is a common cause of enlargement:

this condition appears after the age of twenty and the patients show a history of tubercular disease in other organs. (*d*) Hydronephrosis is suggestive of obstruction by calculi or the twisting of the renal vessels and ureter. (*e*) Perinephritis with abscess in its early stages produces adhesions and subsequent contraction which draw the kidney upward beneath the ribs. (*f*) Tumors of the kidney, which in the vast majority of cases prove to be sarcomata or carcinomata.

2. *The Ureters.*—Deep pressure along the course of the ureters may elicit tenderness in the whole course of the tubes, and is suggestive of ureteritis. If the tenderness is only found in spots, calculi are probably the cause. The examination of the lower portions of the ureters per rectum in males and per vaginam in females must not be neglected.

3. *The Bladder.*—By rectal or vaginal examination the base of the bladder can be felt and any thickening or induration readily determined. After the age of forty-five the most common cause of thickening is carcinoma, and, as the infiltration begins near the opening of one or other ureter, the thickening occurs to the right or left of the middle line. Care should be taken in this examination, for rough palpation is frequently followed by profuse hemorrhage. Hardness and thickening are also felt when the bladder contains a calculus, and particularly if the stone is sacculated.

Injuries of the Bladder.

Rupture.—The bladder is liable to rupture by direct violence applied to the lower portion of the abdomen, and it may be laid down as an axiom that the more the bladder is distended the greater is the risk of this injury. Bullets and other missiles are causes of rupture which attack the bladder from without. The viscus may be ruptured from within, and the most frequent cause is the laceration of its wall by a fragment of bone occurring in severe fractures of the pelvis. Injuries to the rectum or vagina not infrequently involve the bladder.

The bladder has sometimes ruptured by over-distention, as when filled preparatory to the operation of cystotomy. It is only when its walls are weakened or sacculated from previous disease that this is likely to occur. In any severe injury of the pelvis or hypogastrium, if the patient be unconscious or has not the power to micturate, a catheter should be passed into the bladder and the effect carefully noted.

Rupture of the bladder is of two kinds—intra-peritoneal and extra-peritoneal. When the organ is ruptured and its contents escape into the peritoneal cavity, the most serious consequences follow: the shock is profound, and unless prompt treatment is resorted to the patient dies in from three to seven days. In such a case the catheter will be found to draw off only a small quantity of blood-stained urine. If the instrument happens to enter the laceration, it will pass freely up beyond the natural limit of the bladder. The catheter, however, may impinge against an unbroken portion of the bladder, in which event the contraction of the viscus prevents the instrument from passing its normal distance, and it appears to have gone in a wrong direction. To settle the point pass a finger into the rectum, when it will be found that the catheter is in the proper position, but firmly grasped by the bladder.

Should the surgeon still be in doubt as to the existence of intra-peritoneal rupture, he may next proceed to measure the capacity of the bladder. A rubber catheter is inserted, and Peterson's rubber bag passed into the rectum and distended with warm water. The bladder is then slowly filled by allowing a measured quantity of some mild antiseptic solution to flow through the catheter. If free from rupture, it can be felt to rise out of the pelvis and its limits can be defined by percussion. After the injection of six or eight ounces the fluid is allowed to flow out by the catheter, after which it is carefully measured and compared with the quantity injected. If the amount withdrawn is equal to the amount injected, the bladder is not ruptured. Another means of diagnosis is the injection into the bladder of filtered air through a Davidson's syringe over the outer end of which cotton has been tied. If there be an intra-peritoneal rupture, the air will inflate the whole abdomen; if the bladder be intact, it alone will be distended. Should this injection produce emphysema of the cellular tissue, it proves that an extra-peritoneal rupture of the bladder has taken place.

Treatment.—Several cases are on record in which careful drainage by a catheter, retained just inside the neck of the bladder, has been followed by recovery. This method, however, is not to be relied upon. As soon as possible after a satisfactory diagnosis has been made the abdominal cavity should be opened by an incision in the middle line just above the pubes. The rent in the bladder having been found, it is closed by a double row of carbolized silk sutures. There has been considerable discussion over the question of retaining a catheter in the bladder after this operation. The weight of opinion seems to be in favor of dispensing with the catheter. If the rent in the bladder be closely secured so as to prevent leakage, a moderate degree of distention is less likely to do harm than the retention of the catheter in the bladder for several days.

In extra-peritoneal rupture of the bladder the urine is extravasated in the prevesical connective tissue or into the vesico-rectal or vesico-uterine space. Its diagnosis is arrived at by exclusion of the intra-peritoneal variety, by the production of cellular emphysema when the bladder is distended with filtered air, and by the presence of urinary infiltration. When there is an injury which from its position evidently implicates the parts concerned in micturition, and when, after examination of the rectum or vagina, and the use of the catheter as already described, there is still doubt, a perineal incision should be made into the membranous portion of the urethra for the purpose of digital exploration of the neck of the bladder. On this point Reginald Harrison observes: "Many patients in cases of this kind have undoubtedly been lost for the want of that knowledge which can only be thus obtained. Where the suspicion is grave the possibility of not finding such a lesion by exploring should not be allowed to weigh against making the attempt. If a pelvic fracture with rupture of the viscus or rupture alone is discovered, a drainage-tube should be inserted into the bladder. If the prevesical space is also opened, an additional aperture above the pubes will be required in order that thorough drainage may be provided. Procedures of this kind are safe and slight compared with the risk connected with extravasation of urine imperceptibly going on in

a part where otherwise drainage is impossible and subsequent absorption uncertain."

The danger of this form of rupture is in the pent-up extravasated urine, which if allowed to remain in the tissues speedily produces cellulitis and sloughing, ending in many cases in septicemia. The treatment, therefore, must consist in free incision to allow the extravasated urine to escape, and, when necessary, in free drainage by the perineal or suprapubic route, or both.

Incised wounds in the hypogastric region are liable to be complicated with wound of the bladder; the methods of diagnosis are the same as for rupture. When a wound of the bladder is suspected, the urine should be drained off through the external wound or by a catheter in the urethra. Wounds of the anterior bladder-wall heal readily by granulation, and in view of the slight trouble which such wounds give when intentionally made in the operation of cystotomy, they should be dealt with on the principles which govern that operation.

Retention of Urine.—In its expulsion from the bladder the urine has to pass through a long tube having a small caliber and tortuous course—the urethra. Retention or inability to expel the urine is due to two classes of causes—viz. those which produce obstruction in the urethra, and those which result in a want of expulsive power. Of obstructive causes, by far the most common is stricture of the urethra, which may be organic or spasmodic. Other causes are enlarged prostate, inflammation or abscess of the prostate, impacted calculus, tumors of the bladder or urethra, pressure of the gravid uterus, and atresia of the urethra or meatus urinarius. The expulsive power may be wanting from any of the following causes: paralysis, atony of the bladder, reflex influences such as occur after the ligature of hemorrhoids. Retention is common in shock and in the great muscular exhaustion which attends fevers. Certain drugs, as opium, belladonna, cantharides, and alcohol, by their toxic influence produce want of expulsive power.

Diagnosis.—The symptoms of retention are very plain. Besides the inability to micturate, the patient complains of pain in the region of the bladder and the kidneys. There is a constant desire to empty the bladder, and the patient makes violent straining efforts, which sometimes expel the contents of the lower bowel. In many cases a few drops come away and lead to the erroneous belief that the bladder is being emptied. After a time the symptoms of uremic poisoning supervene—viz. rigors, fever, failing circulation, and death. In less acute cases the backward pressure of the urine produces destructive changes in the kidneys. On palpation the round distended bladder can be felt in the hypogastrium, sometimes extending to or even beyond the umbilicus. On percussion this tumor is dull, while the flanks on either side are resonant. In thin persons the tumor can be distinctly seen through the parietes, and is more prominent when the patient is in the erect position.

Treatment.—This must depend upon the cause of the retention. In the majority of cases the catheter is indicated, and should be resorted to without delay. In some cases it is impossible to pass a catheter, and aspiration of the bladder then becoms imperative. This can be done by three different routes:

1. *Suprapubic.*—The operation is very simple and free from danger. The pubis having been shaved and thoroughly disinfected, the aspirating needle is inserted in the middle line just above the symphysis pubis, and the bladder emptied. The puncture is then sealed with iodoformized collodion. This route should be chosen in preference to either of the two following.

2. *Rectal.*—Tapping the bladder by way of the rectum was formerly much in vogue. A large curved trocar was passed into the rectum and made to pierce the bladder just behind the base of the prostate.

3. *Perineal.*—This route is recommended when there is enlargement of the prostate, but in every other condition it is inferior to the suprapubic route.

Atony of the Bladder.—Atony of the bladder is a condition which is almost analogous to dilatation of the stomach. Its most important feature is that the viscus cannot expel the whole of its contents. At the end of micturition there is still a quantity of urine left in the bladder, to which the name "residual urine" is applied. The causes of atony are numerous. Every male who has passed the period of middle life has less expulsive power than he had in youth, and this debility increases as age advances. This, however, cannot be regarded as a morbid condition. The term "atony" is more correctly applied to a paresis of the muscular coats of the bladder. Coincident with this are certain changes in the vesical walls. They may undergo fatty degeneration and become atrophied, thinned, and distended. An almost opposite condition is sometimes observed, wherein the walls are changed by the formation of fibroid tissue, leading to contraction of the viscus and reduction of its capacity. Among the causes of atony may be mentioned stricture of the urethra, enlargement of the prostate, tumors in the vicinity of the neck of the bladder, and neglect to empty the bladder at proper intervals. All of these causes act in one direction—they produce over-distention. A single failure to relieve the bladder at the proper time is sufficient to produce atony.

Symptoms.—Atony of the bladder is to be taken into consideration when there is any cause of over-distention, as stricture, enlarged prostate, etc. After the patient has micturated and emptied the bladder to the extent of his ability, a catheter should immediately be passed. If it be found that an ounce, two ounces, even a larger quantity, of residual urine flows through the catheter, the case is one of either atony or sacculation of the bladder. It may be impossible to make a differential diagnosis between the two. In sacculation a soft catheter may empty the general cavity of the bladder, and after all the urine has ceased to flow a change in the position of the instrument may be followed by the flow of a quantity of residual urine. In atony the residual urine comes away with any form of catheter.

Treatment.—The most serious feature of atony is the retention of the residual urine and the chain of evils which are apt to follow—viz. decomposition of urine, cystitis, retention, and degenerative changes in the kidney. To guard against these the regular and persistent use of the catheter is necessary, and the patient should be taught to use the instrument for himself. The frequency of its employment must depend upon the amount of residual urine. When after the act of micturition

the bladder still retains four ounces, the catheter should be used night and morning; when six ounces are retained, the instrument is indicated three times a day; and if there be eight ounce of residual urine, it will need to be withdrawn every six hours. *Use the catheter once a day for every two ounces of residual urine.* The patient should be taught not only the use of the catheter, but the manner of disinfecting it and keeping it surgically clean.

The medicines of any value in giving more healthy tone to the walls of the bladder are strychnin, iron, tincture of cantharides, and ergot, but too much must not be expected from their employment.

Electricity is of great value in mild recent cases, and is a help to other measures when the condition is long continued and severe. It is employed as follows: an insulated electrode is passed into the bladder, while the other electrode is applied to the hypogastric region or passed into the rectum. A mild current is employed, and gradually increased till the patient complains of discomfort.

When cystitis complicates atony, special treatment must be directed to the inflammatory condition.

Sacculation and Pouching of the Bladder.—Two other conditions closely allied to atony are sacculation and pouching of the bladder. These terms are frequently used as synonymous. *Sacculation* may be defined as a hernia of the vesical mucous membrane through a weakened part of the muscular coat of the bladder; hence this portion of the bladder has no power to empty itself and becomes a receptacle for residual urine and for calculi. It is usually the result of over-distention, and may occur at any age and at any portion of the organ. Of the causes which lead to sacculation obstruction to the flow of urine plays the most important part. Intra-uterine pressure is also a not infrequent cause, while a third class of cases are of traumatic origin.

The diagnosis of sacculation is not always easy. A soft or flexible catheter passed into the bladder is found to draw off a certain quantity of urine; the position of the instrument is changed and the flow recommences. This is very suggestive of sacculation, and if the character of the urine drawn off from the two compartments is found to be materially different, the evidence is conclusive. Guthrie demonstrated the presence of sacculation by injecting the bladder with twelve ounces of warm water, and finding that only ten ounces could be withdrawn. Sometimes when digital examination is made by rectum or vagina the sacculation can be felt as a tumor in the proximity to bladder. Should the examiner meet with a tumor of this character, an effort should be made to pass a catheter into it; if he succeed, the tumor will quickly disappear.

One of the most serious results of sacculation is that it affords a hiding-place for calculi. Stones thus imbedded cannot be dealt with by the lithotrite, and even if they could the detritus would be sure to collect in the pouch and renew the trouble. The best way to deal with a stone thus sacculated is to make a suprapubic cystotomy, remove the stone, and treat the sacculation by drainage (Reginald Harrison).

Pouching differs from sacculation in that the whole thickness of the bladder is involved. It is also confined to the most dependent part of the bladder, and is in nearly all cases met with in persons well advanced

in years. A good-sized stone has a tendency to cause the floor of the bladder to form a pouch, and when this occurs the removal of the calculus can only be accomplished by a cutting operation.

Treatment.—Drainage of the bladder is the best method of dealing with sacculation or pouching. The effect of a sea-voyage is often remarkable; on this point Mr. Harrison observes: "I have known thick, cystitic urine, due to the pollution of the general cavity of the bladder by the contents of a stagnant sac, entirely recover itself when placed under these conditions. The constant movement of the ship both by day and night and in whatever position the body may occupy renders stasis of any of the fluids of the body impossible, and thus one element necessary for decomposition is removed. The immunity of seamen from stone and certain bladder affections may in some measure be due to this. In one instance at present under my observation, where there is very little doubt the patient has a sacculated bladder, the urine is invariably clear and normal when he is at sea, and turbid and offensive when he is on shore for any length of time. Yet in other respects, as far as I can judge, the conditions are the same."

Cystitis, or Inflammation of the Bladder.—It is customary to divide cystitis into two varieties, acute and chronic. The symptoms are almost identical in both, and, as every degree of chronicity is met with, it is sometimes difficult to draw a dividing-line.

Acute cystitis may arise from a great variety of causes—for example, direct injury to the bladder-walls by the unskilful use of sounds or other instruments; the presence of foreign bodies, either pushed into the bladder by way of the urethra or arising from within in the shape of calculi or fragments thereof; the use of cantharides; the extension of inflammation from the urethra, as in stricture or simple urethritis; the infection of micro-organisms, as the gonococcus or tubercle bacillus, and the presence of new growths, as carcinoma.

One of the chief dangers of cystitis is the liability of the inflammation to spread by way of the ureters to the kidney, causing a pyelitis, a pyelo-nephritis, disorganization of the kidney, and frequently death. The changes which take place in the bladder-walls are congestion, thickening of the mucous membrane, desquamation of the epithelial lining, and the formation of raw surfaces. In advanced stages of the disease the tissues become infiltrated with pus, and ulceration and sloughing are not uncommon. In some instances the inflammation is attended with the formation of a false membrane, which may be voided in pieces or in casts of considerable portions of the bladder. This may be a true diphtheritic membrane, the disease attacking the bladder simultaneously with other regions of the body.

Symptoms.—The first symptom to usher in an attack of acute cystitis is generally *frequent micturition.* This increases; the patient is obliged to empty his bladder more and more frequently, till at last he is kept constantly getting in and out of bed. Vesical tenesmus is also a prominent feature; the sufferer strains, trembles, and perspires, but can only expel a few drops of urine at a time. A feeling of weight in the perineum is not uncommon, attended with a sensation as if some foreign body were there which ought to be expelled.

A few hours after the onset of the symptoms just mentioned *pain*

becomes a prominent feature. It is usually deep-seated, and felt above the pubes, down the groin and thighs, and at the end of the urethra. Pressure over the bladder elicits tenderness.

Changes in the urine can be observed at an early period of the disease. It is high colored, and at the end of each effort to empty the bladder a few drops of blood are expelled. More or less mucus gives the urine a thickened appearance; lithates appear in abundance, and later the fluid becomes ammoniacal.

The *constitutional symptoms* do not follow a definite course. Rigors or chills are sometimes met with, and a high temperature and rapid pulse may exist throughout the attack.

Treatment.—Whatever the form in which cystitis presents itself, the first indication is to ascertain and remove the cause. Fragments of stone, retained unhealthy urine, gonorrheal secretions, or any other excitants should be sought for and either removed or their influence counteracted. The pain will call most loudly for prompt action. Injections of warm water into the rectum often afford great relief, but, as a rule, opiates will be required. Half a grain of morphin dissolved in half a pint of water and at a temperature of about 110° F., injected into the rectum, will be followed by an exquisite sense of relief, putting a speedy stop to pain, tenesmus, and constant micturition. Suppositories will produce the same effect, but their action is not so prompt. The patient should keep his bed, be restricted to a light diet, and partake freely of diluent drinks. Hot fomentations and hip-baths are favorite remedies, and the internal administration of hyoscyamus has long enjoyed the reputation of being the most useful single remedy in inflammatory affections of the bladder.

Chronic cystitis is frequently a continuation of the acute form. It is often a result of enlarged prostate, of calculus, atony, stricture, and new growths. Its origin is often traceable to the kidney, to defective digestion, or to gout. The symptoms in general are those of the acute form, but not so pronounced. There may be little pain; tenesmus may be slight or absent. Micturition is usually less frequent, and the majority of patients are able to move about, but they suffer inconvenience which makes their lives more or less of a burden. The urine seldom contains blood, but to offset this it is thick, filled with ropy mucus or pus, and often ammoniacal and foul-smelling. Catarrh of the bladder is a popular name for this disease.

Treatment.—Removal of the cause must claim the closest attention. Many a patient who has suffered from chronic cystitis for years has been restored to health after he had fallen into the hands of a surgeon who took the pains to search for, find, and remove a calculus which had never been suspected by previous advisers. *The treatment of chronic cystitis should never be begun until a most thorough ond searching examination has been made for the cause.* The prostate is responsible for a large proportion of all cases. A digital examination by the rectum will speedily settle the question as to whether the gland is enlarged. A vesical calculus will manifest its presence by the symptoms peculiar to stone, and the bladder should be searched for stone.

Urethral stricture is another cause which should receive careful attention. It is readily recognized by the diminished or forked stream

of urine, difficulty in micturition, and by examination with the urethral sound or catheter.

The general treatment may be summed up under the following heads:

1. Remedies administered internally or by the rectum. The drugs which have found most favor in the treatment of chronic cystitis are buchu, pareira brava, oil of sandalwood, balsam of copaiba and cubebs, uva ursi, etc. Quinin, salol, and boric acid are valuable on account of their power to disinfect the urine and prevent the growth of micro-organisms.

2. Irrigation. Washing the bladder with warm sterilized water or boric-acid solution is very important, after which the organ is ready to receive an injection of one or other of the solutions mentioned in the following paragraph.

3. Injections. Of all the remedies used for injecting the bladder, nitrate of silver must take the first place. Nothing will act more

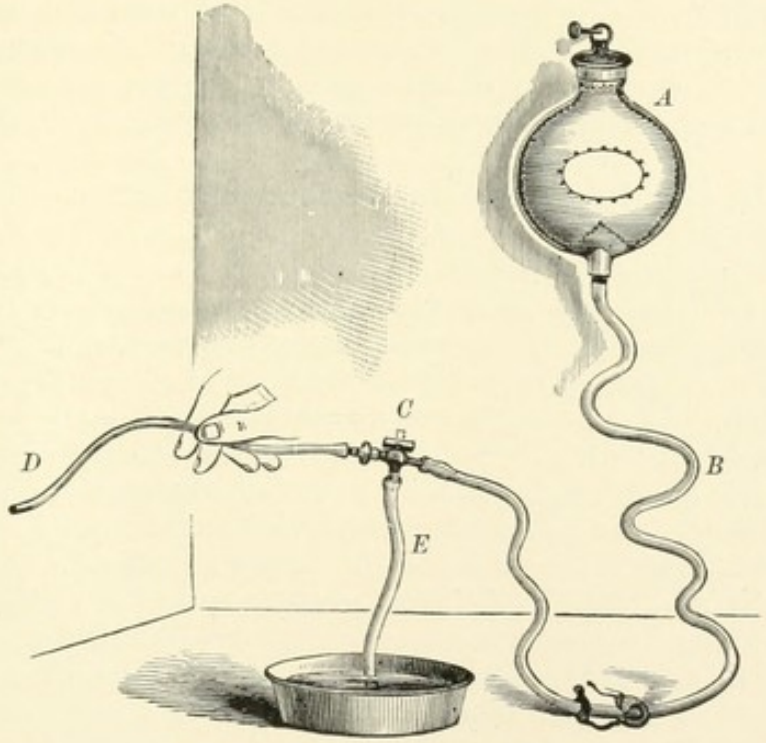


FIG. 163.—Keyes' irrigator for bladder.

promptly in destroying the bacteria, and its action upon a chronically inflamed mucous membrane is superior to anything else. The bladder is first washed out with sterilized water. Two ounces of water holding five grains of nitrate of silver are then allowed to flow into the bladder and out again, after which the bladder is again washed out with sterilized water. Other solutions which are recommended for irrigation are the following: boric acid of a strength of 5 to 10 per cent.; bichlorid of mercury, 1 : 10,000; permanganate of potash, 3 per cent.; carbolic acid, 1 : 500. The method of irrigating the bladder is shown in Fig. 163. It consists of a rubber bottle (*A*) which holds about a pint and can be suspended at a height of three or four feet above the level of the patient's bladder; a rubber tube (*B*) five feet in length, ending in a

stop-cock (*C*), which directs the fluid into the catheter (*D*) or the outlet-pipe (*E*). The apparatus is used as follows: Fill the reservoir and hang it up; open the stop-cock to allow the fluid to expel the air from the tubing; then pass the catheter. Turn the stop-cock (*C*) to allow the fluid to enter the bladder, and when the viscus is full reverse the tap and allow the fluid to escape from bladder and run into the receptacle (4). By alternating this action the bladder is repeatedly filled and emptied.

A simpler contrivance is a glass funnel connected with a catheter by means of a rubber tube two feet in length. The funnel is elevated and the fluid poured into it, which by gravitation reaches the bladder. By lowering the funnel below the level of the patient's pelvis the fluid escapes. The objection to this method is that it allows air to enter the bladder.

Drainage.—In spite of the most persevering efforts in the use of these remedies some cases will show no improvement. Another resource is still open to the patient, which gives not only a fair prospect of relief from pain and constant urination and tenesmus, but a possibility of perfect cure. This is perineal cystotomy. By means of it the bladder can be thoroughly drained, and the irrigations and injections given a better opportunity to exert their full benefit upon the inflamed surface.

Stone in the Bladder.—In its normal condition urine contains about 90 per cent. of water in which are dissolved 10 per cent. of organic and inorganic materials. The organic substances are urea and uric acid. Of these, uric acid plays an important part in the formation of calculi, for, although it exists in the proportion of only 1 to 1000 in the urine, it enters into the formation of a great majority of vesical calculi. The inorganic constituents are sodium, potassium, and magnesium, bases with which uric acid unites. These bases also unite with sulphuric and phosphoric acids to form corresponding salts. Normal urine also contains chlorids, mucus, and epithelium.

While these substances are held in solution all is well. When they form deposits and their particles aggregate around a nucleus, stone is the result. In the majority of cases uric-acid crystals form the nucleus, the crystals being held together by the renal or vesical mucus. A drop of dried blood or a foreign body in the bladder, as a piece of catheter or a fragment of bone, is sometimes the nucleus. Nuclei composed of uric acid or of oxalate of lime are found in the kidney, and increase in size as they lie in the renal pelvis or the bladder. When composed of the triple phosphates the calculi begin to form in the bladder and owe their origin to ammoniacal urine.

The examination of a patient for urinary calculus may be considered under the following heads:

History.—A large proportion of cases of bladder-stone will be found to have had their origin in the kidney. The passage of the stone thence to the bladder is marked by an attack of renal colic, and the patient will probably give a graphic description of a terrible attack of pain which occurred weeks or months previously, and which was followed by freedom from suffering until the bladder began to give trouble. Chronic cystitis should excite suspicion of stone, for it may

either be the result or the cause of a calculus. The irritation set up by a stone invariably produces cystitis. The existence of cystitis, on the other hand, is attended with copious secretion of mucus or muco-pus, affording the colloid material which binds together the particles that form the nucleus of a stone. Enlargement of the prostate is another powerful predisposing cause, owing to the changes which take place in the urine and in the bladder as a result of obstruction to the flow of urine and the consequences of that obstruction—viz. atony and retention. For similar reasons inflammation or catarrh of any part of the urinary tract is a predisposing cause of stone. Persons who have been sufferers from gout or rheumatism are liable to stone, and a history of one or other of these diseases should arouse our suspicion.

As regards age, childhood and advanced life afford the largest number of cases. Children suffer from uric-acid, old men from phosphatic, calculi. Females on account of the shortness of the urethra and the freedom from causes of obstruction rarely suffer from stone in the bladder.

Symptoms Indicating the Presence of Stone.—*Frequent micturition* is generally the first symptom to draw the patient's attention to the fact that something is going wrong. At first he may be called to urinate once in three or four hours, the frequency gradually increasing until he is compelled to empty his bladder every few minutes. This symptom is more marked in children than in those advanced in years. It is increased by exercise, by walking or running, by riding on horseback or in a jolting vehicle. As might be expected, the patient is much better during the hours which he spends in bed. A small stone moves freely in the bladder with every change in the position of the patient's body, while a large stone may form for itself a bed in the floor of the bladder and be subject to very little movement. This explains the clinical fact that not only frequent micturition, but pain, is often more marked when the calculi are small.

Sudden arrest of the flow of urine is a symptom of great value. It is most marked when the stone is small, and during micturition rolls into the mouth of the urethra or the neck of the bladder, forming a ball valve and obstructing the flow. Many patients by painful experience learn to alleviate this by assuming an attitude which keeps the stone well away from the urethral opening.

Pain.—It is possible for a good-sized stone to exist without causing much pain, but this is very exceptional. If the stone is firmly imbedded in a vesical pouch or coated with a colloid material which covers up its rough points and gives it a smooth, soft surface, it may produce little irritation. As an almost invariable rule stone in the bladder is attended with intense suffering. The pain has two characteristics: (*a*) It is felt at the under surface of the penis near the meatus. This is why little boys with stone in the bladder keep up a constant pulling of the prepuce till it becomes greatly elongated and inflamed. (*b*) The period of greatest intensity is at the end of micturition. The bladder contracts upon the stone, and woe betide the poor sufferer if the surface of the calculus is rough, hard, and nodular, as is generally the case when it is composed of oxalate of lime! Firmly closing upon the stone, the bladder may hold its grip until the slowly collecting urine comes be-

tween it and the stone and affords a brief respite. Distal pains of reflex character are not uncommon. The rectum and perineum are most liable to suffer, but parts more remote are sometimes affected, as the lungs, the stomach, the extremities, the back, and the thighs.

Hematuria is a symptom frequently observed, and is a natural consequence of the rough treatment to which the mucous membrane is subjected by the presence of a stone. It is most marked when the patient takes exercise or is subjected to jolting, as in travelling. The character of the urine is worthy of attention. It is generally loaded with muco-pus, but, as this simply indicates cystitis, it is not of much value from a diagnostic standpoint. The passage of small calculi, the so-called "gravel," is much more significant.

The symptoms just mentioned are not sufficient to base a diagnosis upon. Their presence in whole or in part simply warrants us to proceed to the third part of the investigation—viz.:

Sounding the Bladder.—We cannot introduce the finger into the bladder, so we use a long, slender metallic finger called a *sound*. This instrument should have a straight shaft, a flat handle, and a short curve. It should be of the size of a No. 8 English or 13 French bougie. Two sizes are convenient—one having a slight curve (Fig. 164), the other

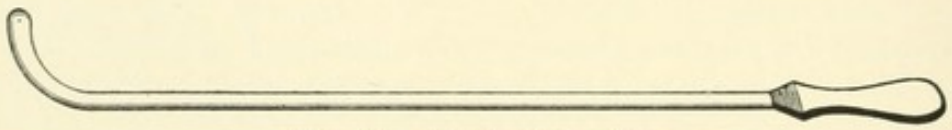


FIG. 164.—Harrison's searcher.

having a short, abrupt curve for the purpose of searching the part just behind the prostate, and which is likely to be the hiding-place of a stone.

The indications for resorting to the use of bladder-sounds are thus laid down by Reginald Harrison:

1. "In children suffering from vesical irritability, incontinence of urine, sudden interruption to micturition, retention of urine, blood in the urine, penile irritation inducing the pulling of the foreskin, and prolapse of the bowel.

2. "In the vesical irritability of adults after attacks of renal colic, where there are reasons for believing a calculus may be retained in the bladder; in cases of hematuria of a doubtful nature, or of chronic muco-purulent or ammoniacal urine, or where the urine contains on standing an excess of cloudy mucus.

3. "In pain after micturition referred to the end of the penis.

4. "In the enlarged prostate of elderly persons, with persisting symptoms of vesical irritability.

5. "Where calculi or portions of them have been spontaneously passed and symptoms of irritation continue.

6. "In cases of acute vesical spasm terminating the act of micturition, or where, though the bladder contains but little urine, there is frequently a sudden and uncontrollable desire to micturate.

"Though the indications of stone may be numerous, it will be seen that they all have reference to either a persisting source of irritation

within the bladder or a mechanical interference with the act of micturition."

The operation of sounding for stone is not to be lightly undertaken, and, when employed, the patient should be as carefully prepared as for a major cutting operation. If he has just completed a long journey by rail or carriage, time should be given him to rest and to allow the bladder to recover from the irritation consequent to the jolting movement inseparable from such a journey. The history and present condition of the patient should be thoroughly gone into, and a specimen of his urine taken for chemical and microscopic examination. The bowels should be emptied, and just before the passage of the instrument the urethra should be washed out with a mild antiseptic solution. None but a slovenly or antiquated practitioner would use an instrument without having first boiled or otherwise disinfected it, and the operator's hands should be as carefully scrubbed as if about to begin a laparotomy. The patient should lie on a table; his knees should be drawn up to flex the thighs upon the abdomen, and the limbs should be slightly separated. The bladder should be moderately filled, either by injecting it with warm boric-acid solution or by having the patient retain his urine for several hours previous to the examination.

Passing the Sound.—The instrument, having been disinfected by boiling, is dipped in sterilized olive oil, and while still warm is passed into the bladder in the following manner: Stand at the patient's left side; hold the sound in the right hand and take the penis between the thumb and fore finger of the left. Put the organ gently on the stretch in such a position that the dorsum faces the abdominal wall, with the urethra free from kinks or twists. Insert the end of the sound into the urethra, keeping the instrument parallel to Poupart's ligament. The handle is held low and the penis gently stretched while the instrument is passed in to about the membranous portion of the urethra. Sweep the handle round to the middle line of the body, still keeping close to the abdomen; then press the instrument gently downward toward the feet and make slight traction upon the penis. The instrument should glide a few inches farther in this direction; when it stops raise the handle, keeping it exactly in the middle line, and, passing the perpendicular, depress it between the thighs. During the time that the right hand is describing this arc of a circle the fingers of the left hand are shifted to the perineum beneath the scrotum, where they aid in directing the sound through the membranous and prostatic portions of the urethra into the bladder. Sometimes it will be found better to take the instrument in the left hand just after it has passed the perpendicular, and to use the index and middle fingers of the right hand, placed on each side of the root of the penis, to make downward pressure.

Searching for Stone.—Having now inserted the sound, a careful search must be made, not by pushing the instrument about on a happy-go-lucky chance of striking against a stone, but in a systematic manner. We know that the sound is in the bladder by the freedom with which we can move the tip of the instrument when we rotate the handle, and by the instrument remaining in the middle line and pointing away from the pubis when the hand is removed. The middle line should first be explored by slightly withdrawing and replacing the

sound, raising and depressing the handle. It should then be rotated so as to make the tip of the instrument turn to one side, and as it is slowly and gently pushed in and out the curve is made to feel the floor of the cavity to both right and left of the middle line. It may be that in all these maneuvers no stone is felt, and yet the sound repeatedly passes over it. This is because the calculus is lying in a pouch on the bladder-floor just behind the prostate, and the instrument with a slight curve fails to touch it. This possibility should always be taken into account, and, failing to find a stone with the first sound, a second instrument with a short, abrupt curve should be employed and the search renewed. It is not advisable to state positively that the patient has no stone in the bladder on the data obtained from one examination. A second examination a few days later will perhaps yield different results, as many surgeons have found by experience.

The presence of a stone is recognized by the sensation communicated to the hand when the sound strikes a hard body, and by the

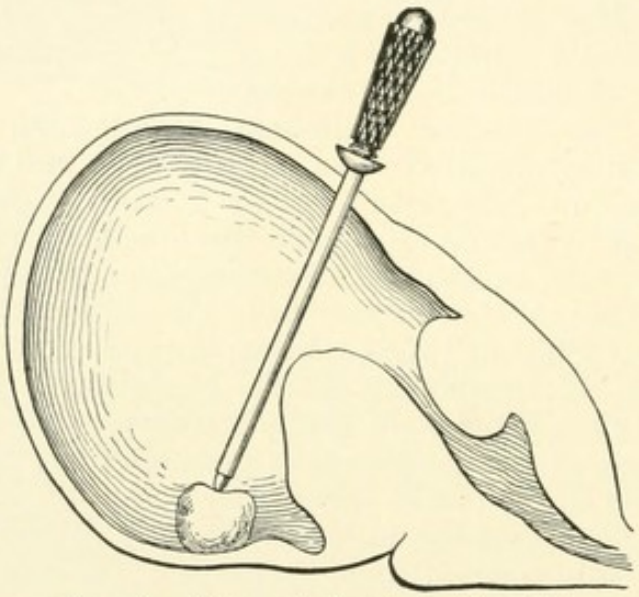


FIG. 165.—Diagnosis of calculus (Fenwick).

peculiar click which can generally be distinctly heard. To magnify this "click" a stethoscope can be placed over the hypogastrium, or one end of a rubber tube can be attached to the bladder-sound and the other end applied to the examiner's ear. As aids to the examination the following procedures may be mentioned: The anterior wall of the bladder can be brought within reach of the sound by the surgeon pressing upon the abdominal wall. A finger in the rectum can be used with advantage to raise the bas-fond of the bladder and bring it in contact with the sound. In cases of enlarged prostate a stone is apt to lie hidden behind the gland and thus elude the searcher; raising the hips or placing the patient in the Trendelenburg position will cause the stone to roll back toward the fundus. In the case of very small stones a hollow sound is useful. By means of it a portion of the bladder-contents can be removed while the patient is standing upright, and, if the sound be slowly withdrawn and turned from side to side until it comes to the neck of the bladder, the calculi, however small they may

be, are sure to come in contact with the instrument. Bigelow's evacuator and wash-bottle sometimes succeed in finding and removing a small stone which cannot be felt with a sound.

For the detection of stones lying in a deep post-prostatic pouch E. Hurry Fenwick recommends plunging a long trocar and cannula into the suprabubic region and directly backward to the stone (Fig. 165).

Examination by the Cystoscope.—In doubtful cases the use of the cystoscope in skilful hands is of great value. Leiter's cystoscope (Fig. 166) is of the shape and size of a No. 21 F. sound. At the extremity

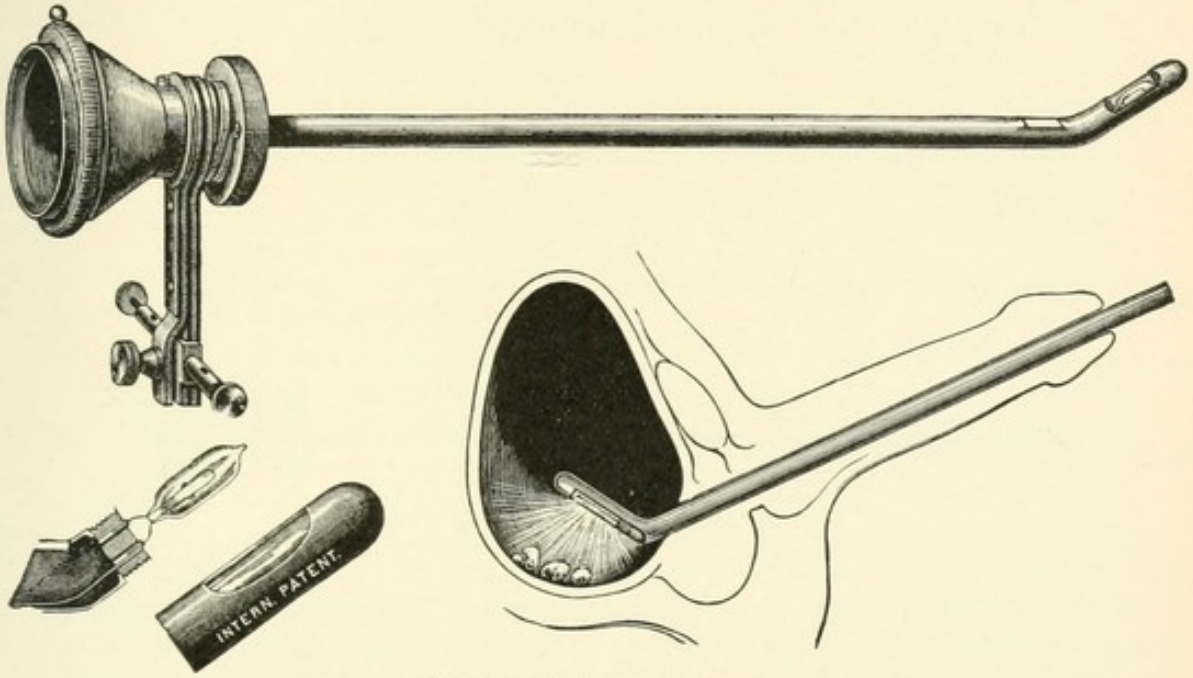


FIG. 166.—Leiter's cystoscope.

it carries an Edison incandescent lamp enclosed in a cup having a small aperture fitted with a plate of rock cystal. Two conductors passing within the shaft connect with the little sockets for the lamp and complete the circuit. The bend of the instrument contains a prism. To make use of the cystoscope the patient should be placed in the dorsal or the lithotomy position. The bladder ought to contain six to eight ounces of clear urine. Should the urine be turbid, wash out the bladder and inject boric-acid solution; if the urine is tinged with blood, irrigate the bladder with equal parts of extract of hamamelis and hot water. Anesthesia may be local or general or may be dispensed with. Should cocain be employed, it must be kept in mind that fatal results have followed its use, although Fenwick says that he has injected a dram or more of a 20 per cent. solution and never saw any evil effects. Having tested the lamp to ensure its being in working order, the instrument is introduced and carefully moved about, to be sure that the beak is not in contact with the bladder-wall. First the beak is directed upward, and then turned from side to side till all parts of the bladder come into view except the trigone. The handle is then lowered and the position of the beak reversed, bringing within the field of vision the trigone and the orifices of the ureters.

In its normal condition the mucous membrane of the bladder is of

a yellowish or reddish-yellow color. Its blood-vessels are tortuous and generally visible; the fibers of the detrusor urinæ muscle can also be seen, and they present a trabecular arrangement. At the posterior angles of the trigone are two prominent spots, the opening of the ureters. Every thirty or sixty seconds, according to Meyer, fine streams or jets of urine can be seen escaping from them.

This examination is valuable, not only in revealing a stone, but also in ascertaining the existence of morbid growths, cystitis, and tubercular disease of the bladder. Fenwick recommends a cystoscope for introduction by the suprapubic route (Fig. 167). This instrument can be inserted through the opening made by the trocar and cannula, as shown in Fig. 165.

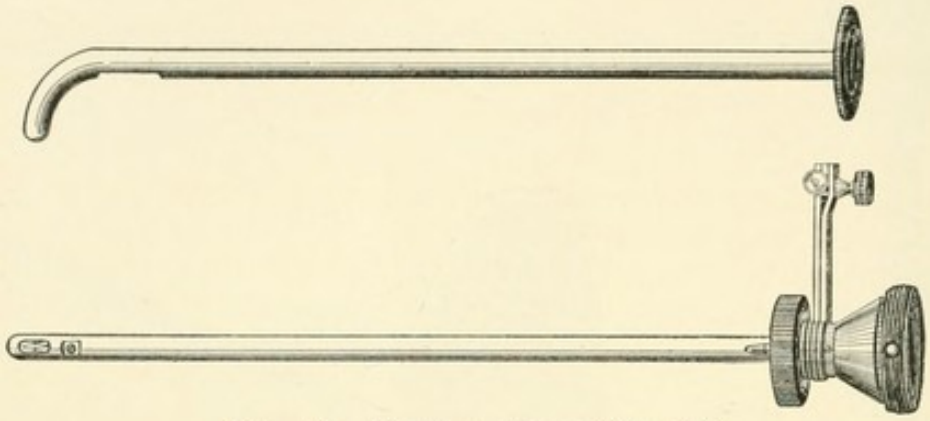


FIG. 167.—Electric cystoscope (Fenwick).

Composition of the Stone.—When sand or fragments of stone come away with the urine, they should be carefully examined to determine the composition of the calculus. The results obtained in this way, however, are not to be relied upon, for the urine may contain phosphates due to cystitis, while the nucleus of the stone may be composed of uric acid, oxalate of lime, or other ingredient.

Under any of the following conditions we may fail to detect a stone that is lying in the bladder:

1. The calculus may be covered with clotted blood or mucus, so that it feels like the bladder-wall when touched with a sound.

2. The stone may be so completely encysted that little or none of its surface is tangible.

3. It may be attached to the anterior wall of the bladder by fibrinous adhesions.

4. The stone may lie in a diverticulum which communicates with the main cavity of the bladder by only a small opening.

5. A stricture or enlarged prostate may prove a serious obstacle to a correct diagnosis.

Measuring the Calculus.—For roughly estimating the size of a stone Thompson's searcher (Fig. 168) is very convenient. It is hollow for the purpose of withdrawing urine or injecting water during the search. As soon as a stone is touched the collar on the stem of the instrument is pushed down to the meatus. The searcher is then slowly withdrawn, keeping its point in contact with the stone by gentle tappings, and marking the point on the stem when contact ceases. The distance

between this point and the collar will represent the diameter of the stone. More accurate measurement can be obtained by the use of a small lithotrite.

Lest the young surgeon should feel too confident in his ability to detect stone, let me remind him that surgical records afford several instances in which the most experienced surgeons failed to detect large calculi which were afterward found post-mortem. When such men as Cheselden, Dupuytren, Roux, and Crosse have cut for stone and found none, it behooves the tyro to be cautious. It should also be borne in mind that the operation of sounding the bladder is not free from danger.



FIG. 168.—Thompson's latest stone-searcher.

Fatal cystitis has been reported by several writers, but this was probably due to want of surgical cleanliness.

In most cases of sounding for stone an anesthetic should be given, as it relaxes all spasm and admits of immediate recourse to operative procedure without submitting the patient to a second ordeal.

Treatment.—To dissolve a stone by the administration of medicine or by the injection of fluids into the bladder is entirely out of the question. The preventive treatment of stone, in persons who are persistently passing large quantities of crystals or who have inherited a tendency to calculous disease, is another matter. The subjects of enlarged prostate, stricture, chronic cystitis, or atony of the bladder should be carefully watched lest changes in the composition of the urine and obstruction to its flow should result in the formation of calculi.

A person who passes urinary crystals, or who has had an attack of renal colic, or who passes habitually urine of high specific gravity containing uric acid in excess, should be very methodical in his manner of living, his exercise, and his diet. The urinary tract should be flushed out by drinking large quantities of water on retiring and on rising from bed, as well as between meals. Sugars and fats should be avoided. Meat should not be eaten more than once a day, and alcohol should be abstained from. Acids or alkalies should be administered as indicated by the reaction of the urine and its chemical composition. Exercise short of fatigue, life in the open air, and avoidance of profuse perspiration are to be highly recommended.

When there is chronic cystitis, atony, prostatic disease, or stricture, the treatment appropriate to these conditions respectively should be faithfully carried out. Particularly important is it that residual urine should be disposed of by the regular use of the catheter and by washing of the bladder when indicated.

Removal of Stone.—When once a stone has attained a size too large for passage through the urethra it must be disposed of by operation. The procedures by which this can be accomplished are—

1. Litholapaxy or lithotrity; 2. Perineal lithotomy, median or lateral; 3. Suprapubic lithotomy.

If the examination detailed in the foregoing pages be complete, it will give the data from which the surgeon can decide the choice of operation—viz. the age of the patient, the presence or absence of stricture of the urethra, the condition of the prostate gland, the presence, size, and composition of the stone, the condition of the bladder, and the state of the kidneys.

Litholapaxy has so encroached upon the fields of other procedures that it must be regarded as the operation always to be chosen unless there are special conditions in the individual case which contraindicate it.

Until recent years the question of operating on boys by crushing the stone was, to say the least, unsettled. In India, where the vast number of people suffering from stone affords the surgeons an unlimited experence, litholapaxy is becoming the universal remedy. J. Forbes Keith, who is said to have had the largest experience in this operation of any living surgeon, has performed litholapaxy on 503 boys with a result of 4 deaths, and 106 perineal lithotomies with no deaths—a total of 609 with 4 deaths. Freyer reports 852 operations, 158 of which were on boys, with a fatal result in 2 cases. These and several other operators of large experience have practically abandoned cutting operations for stone.

G. Barling of Birmingham estimates the mortality of suprapubic lithotomy in patients under twenty years of age at 17.4 per cent. in a total of 72 cases. In 61 patients under twenty operated by litholapaxy the mortality was 5 per cent. Lateral lithotomy yields a mortality of 5 per cent.

In British and American practice it is probably safer to employ lateral lithotomy in boys below ten years of age, for two reasons: first, because the rate of mortality is little if any higher than that following litholapaxy; and secondly, because the use of the lithotrite is attended with considerable risk in the hands of those who have not had a large experience.

In adults there can be no question that litholapaxy is the operation *par excellence*, and yet there are certain conditions in which it is contraindicated—viz.:

1. The existence of a stricture which cannot be dilated. In this instance a median lithotomy is the procedure to be chosen, for it will dispose of both stricture and stone.

2. Some cases of enlarged prostate complicated with chronic cystitis and a large stone. In this class suprapubic lithotomy is the operation of choice.

3. In atony of the bladder where there is a considerable quantity of residual urine and a corresponding want of expulsive power. Perineal lithotomy, except in the case of a very large stone, will give the best results. If the stone is large, it can be crushed by introducing an instrument through the perineal wound (*perineal lithotomy*).

4. Rare cases in which the stone is of moderate size, and of such hardness and density that the lithotrite cannot stand the strain of crushing it. W. S. Forbes of Philadelphia has found by experiments upon 184 vesical calculi that the majority of stones are crushed by a pressure of less than one hundred pounds; one of the stones required

a pressure of four hundred and six pounds to crush it. He has, as a result of these experiments, devised a lithotrite of greater crushing power than that of the instruments now in use.

The Operation.—Early diagnosis is of the utmost importance in the treatment of urinary calculus. If detected while the stone is yet small and before serious changes in the bladder and the composition of the urine have set in, litholapaxy is a safe operation and one that should supplant every other device.

The operation of lithotrity consists in crushing the stone at one or more sittings and allowing the débris to come away with the natural discharge of the urine. This operation is no longer practised. In 1878 the late Professor Bigelow devised and perfected a plan of performing lithotrity at a single operation by crushing the whole of the stone and abstracting all of the fragments and débris by an effective evacuating apparatus. This operation is the one followed universally

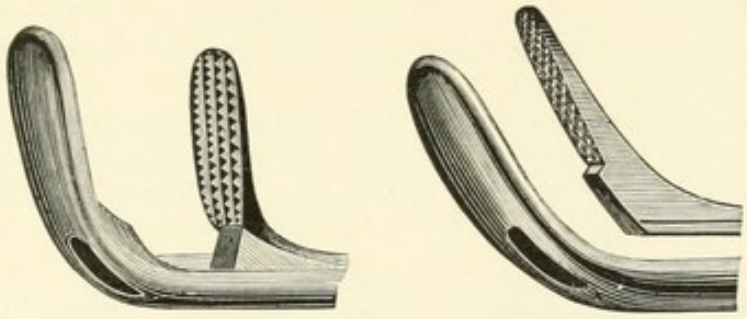


FIG. 169.—Non-fenestrated lithotrites.

at the present day. Lithotrites are made of different sizes and lengths. Fig. 169 represents smooth-bladed or non-fenestrated lithotrites suitable for crushing small stones of only moderate hardness. Fig. 170

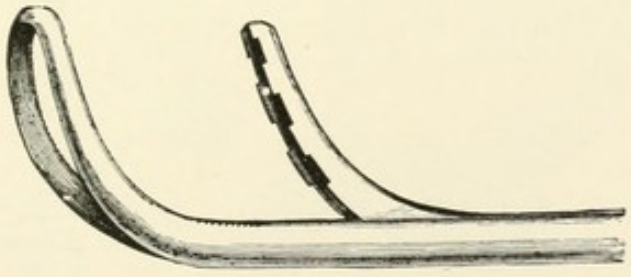


FIG. 170.—Fenestrated jaws of lithotrite.

represents a fenestrated instrument heavier and stronger than the preceding and adapted to large stones of great density and hardness. On account of its general adaptability it is the only form employed by many operators.

Chismore of San Francisco has improved the modern instrument by devising a tip by means of which fluid can be thrown into the bladder while the instrument is in position. By this means a commotion in the waters is produced which brings the fragments within the grasp of the instrument (Fig. 171).

Lithotrites are so constructed as to allow the male blade to slide within the female blade and to crush the stone by their approximation. A button on the handle regulates the movement until the stone is

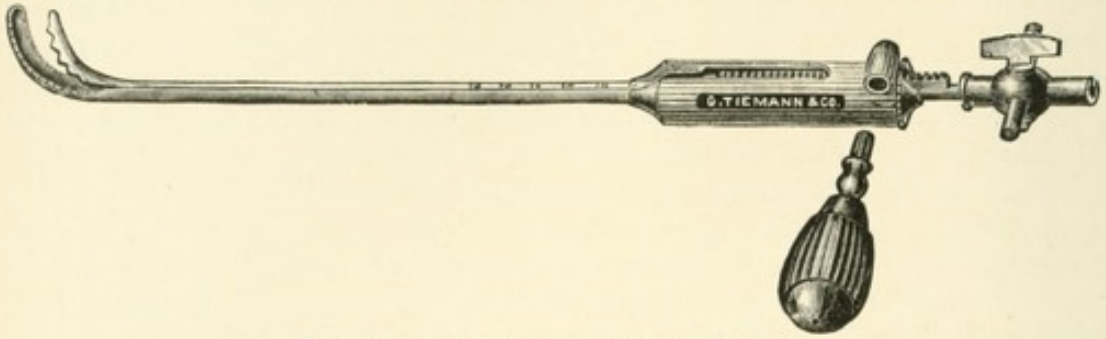


FIG. 171.—Chismore's evacuating lithotrite.

found and grasped; the operator then, without moving his hands, applies the more powerful mechanism by which the stone is crushed. Bigelow's lithotrite is provided with a corrugated ball handle; other instruments have a wheel which is turned by the thumb and finger of the operator's right hand.

After the stone is crushed an evacuating apparatus is necessary for the removal of the fragments and débris. Bigelow's evacuator is represented in Fig. 172. An evacuating catheter with a large eye,

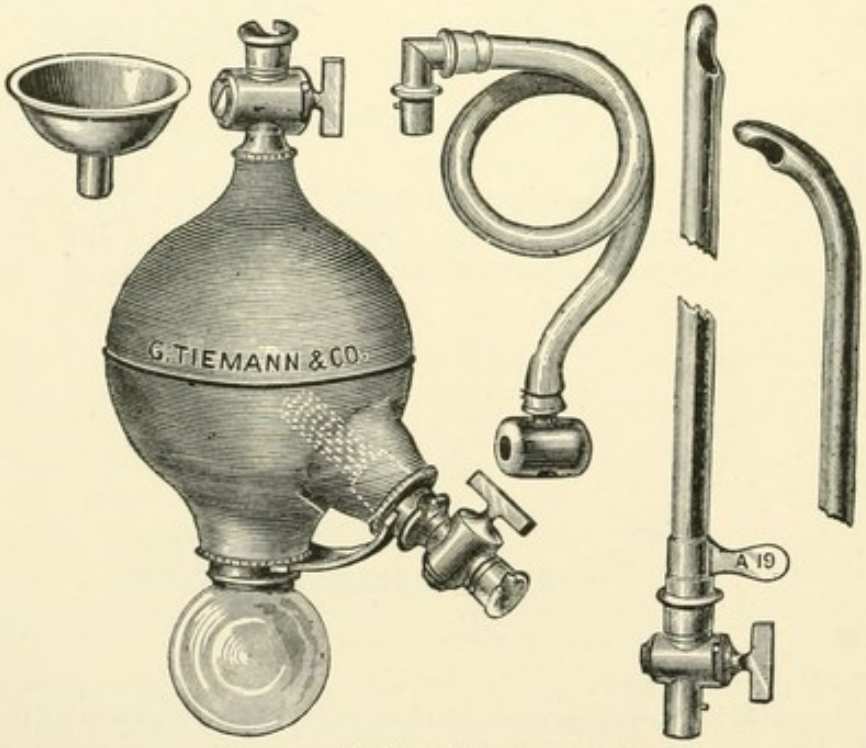


FIG. 172.—Bigelow's latest evacuator.

devised by Harrison, is represented in Fig. 173. Chismore's washing-bottle (Fig. 174) is light, easily handled, and less expensive than those hitherto in use.

Preparation of the Patient.—The practice of "educating" the urethra by passing large-sized instruments for days prior to the operation is now abandoned. The patient should be kept in bed for two

or three days to lessen as much as possible the irritation caused by the calculus and to allow vesical irrigation to be carried out if required. The bladder should be rendered as nearly aseptic as possible. If the urine is healthy, this point is already gained, for the normal urine of

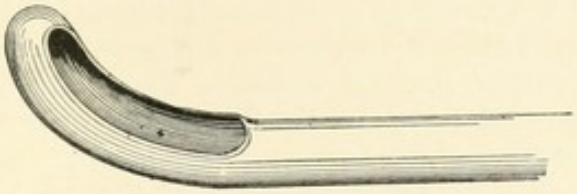


FIG. 173.—Harrison's evacuator with large eye.

the bladder is free from septic germs. In the presence of cystitis or suppuration in the kidney the urine is filled with septic micro-organisms and requires disinfection. It should be drawn off every eight hours, and the bladder washed out with Thiersch's solution or with a solution

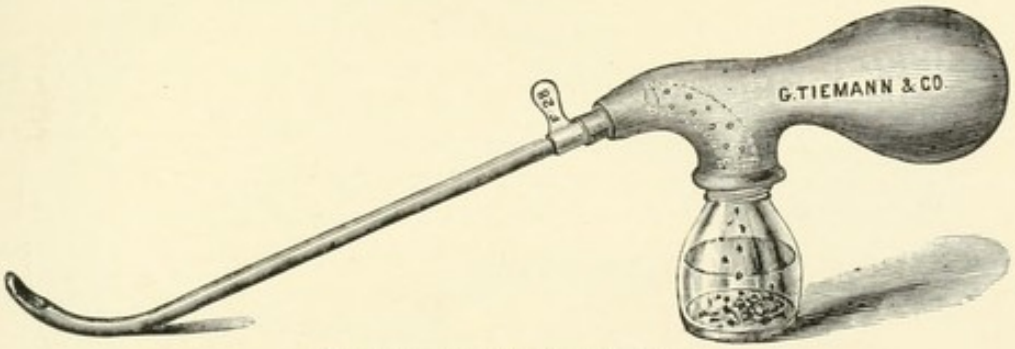


FIG. 174.—Chismore's evacuator.

of nitrate of silver of the strength of one grain to the ounce. Benzoate of sodium, salicylic acid, or salol given by the mouth will aid in bringing the urine into better condition. The patient's bowels should be moved by a laxative the night previous, and washed out with an enema four hours before the operation. The pubes and perineum should be shaved, scrubbed with soap and water, and prepared exactly as if the patient were about to undergo a cutting operation, and when placed upon the table sterilized towels should be arranged around the parts to guard against the possibility of carrying infection to the urethra by the lithotrite or hand of the operator. The limbs should be encased in flannel leggings and the patient kept warm while in the operating-room. If the prostate is large and the stone lodged in a pouch behind it, Harrison recommends turning the patient over on his belly after he is anesthetized and slightly concussing his body. Stones are thus made to fall out of a pouch into the cavity of the bladder. A small sponge, secured by a tape, is then placed in the rectum to prevent the return of the calculus to its pouch. Even the warmest advocates of ether will admit that chloroform should be given when there is disease of the kidneys. Another reason against the use of ether is the fact, first noticed by Lawson Tait, that it sometimes entirely arrests the secretion of urine. After being anesthetized the patient is placed with his pelvis on a pillow and the bladder given a final washing with Thiersch's solu-

tion, leaving six or eight ounces within it to facilitate the movements of the lithotrite.

The operator, standing at the patient's right side, introduces the instrument as he would a sound, and with the utmost gentleness begins his search for the stone. He may begin by pushing the instrument to the back wall and withdrawing the male blade until the neck of the bladder arrests it. In many cases the stone will fall directly between the blades at the end of this movement. The instrument is then made to grasp the stone, and after gently rotating it to make sure that the bladder-wall is not caught in the instrument, the work of crushing begins. Sometimes it is necessary to turn the beak of the lithotrite backward and pick up the stone from behind the prostate. The greatest care should be observed lest the bladder-wall be caught in the grasp of the instrument, and this is most likely to occur in cases complicated with enlarged prostate. Fig. 175 represents a condition which

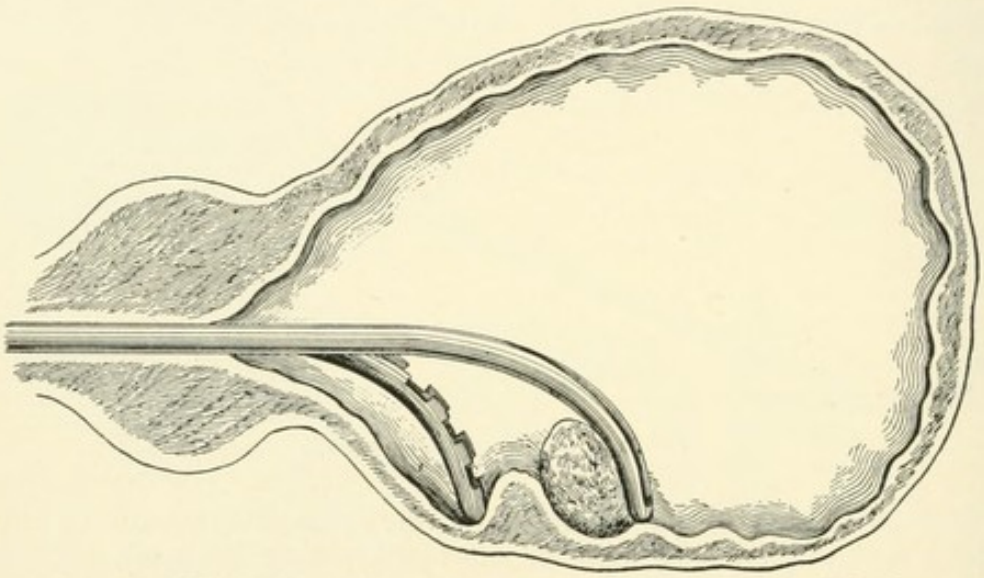


FIG. 175.—Wall of the bladder caught between the blades of the lithotrite.

is very apt to lead to an accident of this kind. The female blade is in proper contact with the stone, but the male blade is in a pouch behind the enlarged prostate. If the blades be brought together in this relation of the parts, the bladder will suffer. Gentle rotation before applying any crushing force is always sufficient to detect this false position. About fifteen or twenty minutes are sufficient for picking up and crushing the fragments of calculus. The blades are then brought closely together, the instrument withdrawn, and the evacuation begun. An evacuating catheter of about 28 (French) caliber is suitable for an adult. The bulb is attached, the stopcock turned, and the bulb compressed. If the tube becomes blocked with a fragment, the bulb will cease to expand, but a quick, forcible pressure readily brings matters right. The wall of the bladder may be sucked into the eye of the evacuating catheter, causing the "fish-bite," so called. Bigelow attributed this to want of sufficient fluid in the bladder, and advised the injection of several ounces more.

One of the mishaps likely to occur in the operation is clogging of the blades of the lithotrite with fragments and débris, so that the instru-

ment cannot be withdrawn. This is less likely to occur when the fenestrated instrument is the kind employed. If ordinary efforts fail to bring the blades together, the beak should be pressed up against the suprapubic region and cut down upon as in suprapubic lithotomy, or it can be made to protrude at the perineum and a lateral or median cystotomy performed. After the blades are freed and the instrument withdrawn, the evacuation of remaining fragments is effected by the incision. If during the employment of the lithotrite the bladder makes violent expulsive efforts, the operator should immediately suspend all manipulations until these contractions cease, lest injury be done to the bladder.

Accidents are liable to happen in the course of this operation, and it is well to be prepared for them. Reference has already been made to clogging of the blades so as to prevent their withdrawal. On account of this and similar dangers the operator should have everything in readiness to make a lithotomy. The lithotrite in contact with a very hard stone may break or one of its blades may bend, thus preventing its withdrawal. The eye of the evacuating catheter may be filled with stone fragments whose projecting sharp angles would lacerate the urethra in any attempt at withdrawal. A stylet is generally sufficient to dislodge the fragments, and should always be at hand.

Fragments of stone may be forced by strong contractions of the bladder into the deep urethra, and become so firmly impacted as to resist all attempts to push them back. In such a case a median cystotomy should be undertaken, using as a guide the fragment itself, or a small staff if it can be pushed past the obstruction into the bladder.

Injury to the soft parts by the lithotrite or by fragments of stone is always attended with danger, and should be most carefully guarded against. Rupture of the bladder has occurred in cases where the walls of the viscus were thin and under strong expulsive efforts. When the rent is recognized as involving the peritoneal side of the bladder, no time should be lost in making a celiotomy and stitching up the wounds in the bladder-wall.

After-treatment.—The last fragment having been removed, the bladder should be washed out with warm boric-acid solution until the fluid returns free from discoloration with blood. If the urine does not come away at proper intervals, the catheter should be judiciously employed. After a prolonged operation, and especially if the bladder is irritable, a suppository of morphin may be used with advantage. The case should be watched, and if any symptoms arise to indicate that the bladder still contains fragments, these should be dealt with immediately. Not until the urine is normal in character should the patient be dismissed as cured.

Lithotomy.—The field of this classical and time-honored operation has become so limited that it promises ere long to become only a memory. Although a few operators have practically abandoned lithotomy for the universal use of the lithotrite, the surgeons of Europe and America are likely for some time at least to accord this "master handwork of surgery" a place. The bladder can be incised for the removal of stone from two nearly opposite directions, the perineum and the suprapubic region.

1. *Perineal Lithotomy.*—When a cutting operation is decided on the perineal route has the following advantages: 1. It affords a ready and fairly commodious access to the bladder through structures that are tolerant of operative measures, and allows the surgeon to remove a stone of considerable size and satisfy himself that no stone or fragments are left behind. 2. It secures drainage, constant and complete, from the most dependent portion of the bladder. 3. It is attended with a low rate of mortality, especially in boys.

The size of the stone is about the only limit to the applicability of the operation: a rule which is almost universally approved of is that a stone over an inch and a quarter in diameter, if taken away whole, should not come out below the symphysis pubis; from this limit Keyes expresses his willingness to cut off the last quarter of an inch.

(*a*) *The Lateral Operation.*—The patient, having been prepared as for the operation of litholapaxy, is anesthetized and kept in the lithotomy position by Clover's crutch or by securing the hands to the feet by means of bandages, and then confided to two assistants, one standing on each side of the table. The staff is introduced and handed to an assistant, who holds it up with the right hand and the scrotum with the left. The bladder should contain three or four ounces of urine or boric-acid solution. The incision should commence in the raphé of the perineum one inch in front of the anus, and the knife should be pushed through the tissues steadily toward the staff, so as to touch it in the membranous portion of the urethra below the line of the bulb. The direction of the wound is downward and outward about midway between the anus and tuberosity of the ischium for two inches or more according to the size of the stone. The tissues are divided as the knife is withdrawn, and in such a way that the depth of the incision is gradually diminished until it reaches its posterior termination. The groove in the staff is now sought by the fore finger of the left hand. With this as a guide the operator inserts the point of the knife into the groove, and grasps the staff in his left hand to satisfy himself that it is exactly in the middle line close up against the pubis. He then returns it to the assistant, and cautiously pushes on the knife through the groove, keeping the edge directed obliquely outward so as to divide the prostate in its greater radius. The entrance of the knife into the bladder is announced by a gush of the fluid which the viscus contains. The operator next inserts his finger into the bladder, directs the assistant to withdraw the staff, and, using his finger as a guide, introduces the forceps. He searches for the stone with the blades closed, and having found it opens them very wide, depresses, and then closes them. By gently relaxing his hold and renewing it he shifts the position of the calculus if unfavorable for extraction, and with the assistance of his left fore finger proceeds to draw out the stone, not directly, but by a motion in alternate directions, so as to dilate the margin of the wound without tearing. Forcible efforts ought never to be used in doing this, and it is much better to introduce the knife again if the opening proves too small. After one stone has been removed the bladder ought to be searched for more with a sound introduced through the wound, and if any are detected they must be removed in the same way as the first.

Should the calculus be broken, its fragments must be carefully extracted with the scoop if small, or by the forceps if large (Syme).

The old operators were very expert in performing this operation, as it has been done in less than a minute. This was a desideratum only in preanesthetic days. Now-a-days our aim should be to take time to do an operation well; the few extra minutes saved at the operation may be lost at the funeral. After removal of the stone the bladder should be explored for the calculi, and the best instrument for this purpose is the finger aided by pressure over the hypogastrium. Failing to reach the distant parts of the bladder, an ordinary sound may replace the finger. All bleeding having been arrested, a drainage-tube is inserted into the bladder, through which a stream of warm boric-acid solution is allowed to flow until the fluid comes back clear. The wound is lightly packed with strips of iodoform gauze, to be changed at frequent intervals, and the patient placed in bed, lying on the left side with the knees and hips flexed. The arteries divided in the operation are usually the transverse perineal and the hemorrhoidal. These can be at once grasped with hemostatic forceps, and ligated later if necessary. The artery of the bulb may bleed freely, and should be ligated or compressed with forceps, which can be left in position for thirty-six hours. Sometimes a copious oozing takes place from the prostate, for which pressure may be required, either by packing around a catheter *en chemise* or by the dilatable tampon of Buckston Browne.

The deep portion of the urethra may bleed in a troublesome manner, but this can be arrested by distending the rectum with a plug or air-bag, care being taken not to interfere with drainage from the bladder. The drainage-tube may be removed at the end of two or three days. Urine begins to come through the urethra about the ninth day, and by the thirteenth or fifteenth day the flow by the perineum entirely ceases. During the after-treatment the food should be predigested as much as possible in order that no action of the bowel may be required for several days.

(*b*) *The Median Operation* (*Median Lithotomy*).—This is much the simplest of the cutting operations for stone, being merely an extension of the operation for drainage of the bladder. The patient is placed in the same position as for lateral lithotomy, and a staff grooved in the middle line is inserted and held up under the pubes. The incision is made in the raphé between the scrotum and the anus, and the parts divided until the membranous portion of the urethra is exposed. The point of the knife is then made to enter the groove in the staff, and the urethra is divided back for about three-quarters of an inch. Through this opening the finger is introduced, and by a boring or rotary motion the bladder is reached. The staff is now withdrawn and forceps conducted in to the stone, which is removed as in lateral lithotomy. The simplicity of this operation is its strongest point: no vessels of any consequence are divided, the ejaculatory ducts are not injured, and the probability of urinary infiltration is lessened. Its sphere is exceedingly limited (except as it forms a part of the operation of perineal lithotrity, next to be described). It is adapted to small stones, which can more easily be diposed of by litholapaxy. When it is deemed necessary to enlarge the opening into the bladder for the purpose of removing a large stone,

the following method can be adopted: Pass the finger through the wound into the bladder, and, using it as a guide, carry a curved probe-pointed knife through the membranous portion of the urethra; turn the blade directly backward, and cut in the middle line as much of the perineum as may be required. Still further room may be gained by carrying the probe-pointed bistoury well into the bladder, guided by the finger as before, turning the edge toward the rectum, and dividing the floor of the prostate from within outward, commencing at the depression which exists at the beginning of the urethra (Harrison).

2. *Perineal Lithotrity.*—This operation, introduced by Dolbeau of Paris in 1862, consists in opening the membranous portion of the urethra as in median lithotomy, dilating the prostatic opening and neck of the

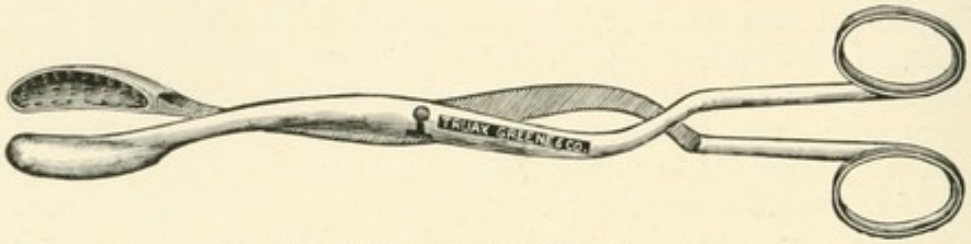


FIG. 176.—Dolbeau's straight crushing forceps.

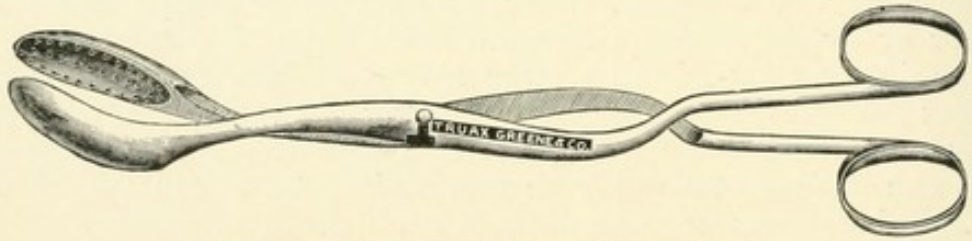


FIG. 177.—Dolbeau's curved crushing forceps.

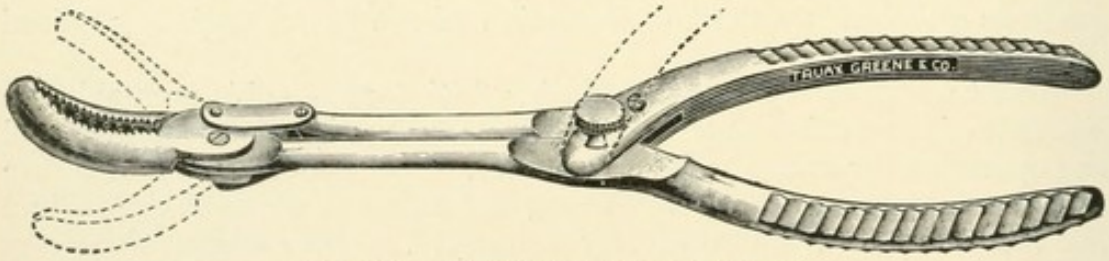


FIG. 178.—Gouley's double-lever lithoclast.

bladder, crushing the stone, and immediately extracting the fragments. Dolbeau's straight (Fig. 176) and curved crushing forceps (Fig. 177) may be used, or Gouley's double-lever lithoclast (Fig. 178). The fragments are removed by evacuating catheters passed through the wound.

This operation has met with a good deal of favor, and has the following points to recommend it: 1. It is less dangerous than other cutting operations, and is especially suitable for old and feeble persons. 2. It admits of the crushing and removal of large and hard calculi in a short space of time. 3. The route to the bladder being shorter and of larger caliber, catheters of greater size can be used than in litholapaxy, and more complete washing out and drainage of the bladder can be effected. 4 It enables the operator to deal with

cystitis, atony of the bladder, and some diseased conditions of the prostate. 5. There is less danger of a recurrence of calculus, owing to the ease with which the bladder can be kept free from ammoniacal urine.

3. *Suprapubic Lithotomy.*—The patient is placed in the ordinary recumbent position with the thighs slightly flexed, or the Tredelenburg position may be employed, the pubes shaved, and the field of operation disinfected. A rubber bag with a smooth surface and capable of holding about twelve ounces of water is inserted into the rectum and distended with warm water. For the majority of cases ten ounces is sufficient; for young patients a less quantity will suffice. This distention of the rectum is unnecessary if the Trendelenburg position is employed, and I cannot help thinking that its value is doubtful in any case. Theoretically it pushes the peritoneum above the bladder in front, and lessens the risk of wounding it. If the operator take the precaution to hook up the tissues at the upper angle of the incision, he will push the peritoneum out of harm's way and probably never see it. Whether the rectal bag is used or not, the bladder should be well washed out with warm boric-acid solution injected through a soft-rubber catheter connected with a fountain syringe or irrigator. At the close of the washing a few ounces of the boracic solution are allowed to remain in the bladder. The fountain is then handed to an assistant, who by lowering or raising can regulate the amount of distention as the surgeon directs. The incision is made exactly in the middle line, beginning just above the pubic symphysis and extending toward the umbilicus for two or three inches. After cutting through skin and subcutaneous tissue the sheath of the rectus is exposed and divided on a director; the layer of transversalis fascia bounding the prevesical space comes next to view. Immediately behind the posterior layer of this fascia is the perineum. The fore finger of the left hand should now hook up the tissues above the upper portion of the dissection in order to draw up the peritoneum toward the umbilicus. If it becomes visible, it can be pushed up directly by the finger. There is generally some loose adipose tissue in front of the anterior wall of the bladder; in separating this care should be taken not to wound any of the veins which ramify in it. After tearing an opening in the fat the assistant elevates the irrigator, and as the bladder dilates it will be seen to rise up into the wound. A needle carrying a stout silk thread should be passed through its wall, and then it can be opened by inserting the knife in the middle line and making the incision upward for about three-quarters of an inch. The finger is passed through this opening and the bladder explored. In making the incision care should be taken to pass the knife with a quick motion through the entire thickness of the bladder-wall, lest the mucous membrane be pushed before the point of the knife and the bladder be only partially incised. If the opening is found too small, the incision can be extended. Guided by the finger, a small pair of forceps is now introduced into the bladder and the stone extracted.

The treatment of the wound must depend upon the condition of the urine and the walls of the bladder. The opening can be immediately closed and an attempt made to obtain healing by first intention if the

patient is young, the urine healthy, and the bladder free from bruising or not thinned by disease. Two layers of sutures should be used—one through the muscular coat to bring the edges together, the other a row of Lembert sutures an eighth of an inch apart and going a slight distance beyond each end of the incision. The material used may be either silk or chromicized catgut.

It would be unwise to attempt immediate union of the bladder if the following conditions exist: ammoniacal urine, diseased kidneys, thin or bruised or fasciculated bladder-walls. Under any of these conditions the wound in the bladder should be kept entirely open, and if the abdominal wound is long, it can be shortened by one or two stitches at the upper end. The pressure of the abdominal organs keeps the bladder empty, and all the treatment necessary for the wound is the application of absorbent antiseptic dressings frequently changed; or Guyon's double drainage-tube may be used, which is simply two rubber catheters connected together, through one of which irrigations of boric acid or other mild disinfecting fluid can be made while the urine is carried off into a receiving bottle by the other.

The suprapubic operation is indicated when the calculus is believed to be too large for removal by the perineal route or too hard to be crushed with the lithotrite. It is also valuable when there is good evidence that the stone is sacculated. With an enlarged prostate, necessitating the use of a catheter, and the bladder containing a large body of residual urine, the suprapubic operation is valuable.

For the removal of stone from the female bladder suprapubic cystotomy has proved very satisfactory, and especially when the calculus has formed around some foreign body, as a hair-pin, introduced by way of the urethra.

The accidents that are liable to occur in the course of this operation are fewer than by the perineal incisions. The rectum has been lacerated and even ruptured by the rubber bag, and the bladder has been ruptured by excessive dilatation. Opening of the peritoneum should not happen in the hands of the surgeon who is in the habit of recognizing and dealing with this membrane in abdominal technique. When this accident has happened the operation has had to be postponed. An inconvenient and annoying sequel of the operation is a failure of the wound to completely close, resulting in the formation of a urinary fistula. This may be simply delayed healing, which can be rectified by the application of nitrate of silver or the touch of a cautery wire. When the opening is small the patient should be taught to close it with his finger during micturition. In intractable cases the bladder should be opened in the middle line at the membranous portion of the urethra and a rubber drainage-tube inserted. While the urine is being drained off in this manner the fistula can be made to heal.

A suprapubic operation is of great value in the removal of growths from the bladder and tumors of the prostate which encroach upon the bladder, in the removal of foreign bodies, and in all cases in which it is necessary to make a thorough inspection of the interior of the viscus.

Tumors of the Bladder.—The tumors which affect the bladder are the following:

1. *Papillomata.*—These deserve the first place, as they form a large

majority of the growths met with. Some authors object to the name, on the ground that the mucosa of the bladder contains no papillæ, and therefore it cannot be the seat of a papilloma. Virchow and others employ the term vascular papillomatous fibroma as more accurately describing their character. The name "villous tumors" is sometimes applied, and occasionally "villous cancer" is improperly used in describing them. Like warty growths elsewhere, the papillomata are found in the vicinity of the urethral and ureteral openings. The tumor is composed of long, delicate filaments forming a cauliflower-like growth, which is more or less dense according to the amount of fibrous tissue which it contains. The growth is confined to the superficial layers of the mucous membrane. There can be no doubt that a papilloma has a tendency to become cancerous if not freely removed at an early stage, or if it returns and becomes more and more fibrous in its structure.

2. *Myomata*, like those found in the uterus and prostate, are largely composed of unstriped muscular fiber. Sometimes fibrous tissue enters largely into their composition, so that the term fibro-myoma is more applicable.

3. *Fibromata* and myomata are practically the same, and constitute the bulk of the polypi found in the bladder.

4. The malignant growths are *sarcomata* and *carcinomata*. Sarcoma of the bladder is very rare. The tumor is usually small, although in one case reported by Mr. Eve the growth was large and partially filled the bladder. The round-celled variety is the form usually met with. *Carcinoma* is found in the form of epithelioma and glandular-celled carcinoma. Epithelioma is usually an infiltration of the bladder-wall, but it may occur in the form of one or more tumors. The disease is apt to spread to the prostate and neighboring tissues, not uncommonly showing itself in the perineum, especially when it recurs after an operation through the perineum, in which case the cicatricial tissue favors the recurrence of the growth.

Symptoms.—Two symptoms are prominent in tumors of the bladder —viz. irritability and hemorrhage. The presence of a fibrous or carcinomatous growth gives rise to frequent micturition, which after a variable time is followed by change in the urine and all the symptoms of well-marked cystitis; hematuria becomes a marked feature at a later period. In the case of papillomata hemorrhage may be a marked symptom from the first, for papillomata bleed easily. A sudden gush of bright blood at the end of urination is sometimes the first symptom, and it is very significant. After this it may not appear for a long time. The pain of a papillomatous tumor is not nearly so great as that of carcinoma, especially when the latter has reached the stage of ulceration. If after passing a sound into the bladder an unreasonable amount of blood comes away by the urethra, we may strongly suspect a papillomatous tumor, and its position is likely to be at one or more of the vesical orifices—viz. in the trigone, near the urethra, or at one of the ureteral orifices. Should we meet with a persistent cystitis without the presence of a calculus or without the history of infection, as by the passage of an unclean catheter, a diagnosis of fibrous or cancerous tumor would be reasonable. In the examination of the urine

careful microscopical search should be made for shreds or portions of a tumor.

Tissue for this examination may be obtained by washing out the bladder with a large-eyed catheter having sharp edges at its opening. After moderately distending the bladder the patient makes a violent effort to urinate with the idea that a portion of the growth might be caught in the eye of the catheter and brought away.

The cystoscope is often exceedingly useful in detecting papillomata. The manner of using the instrument is described in the Diagnosis of Stone in the Bladder.

Treatment.—The profuse hemorrhage and painful cystitis which frequently attend vesical tumors render it imperative that the growths

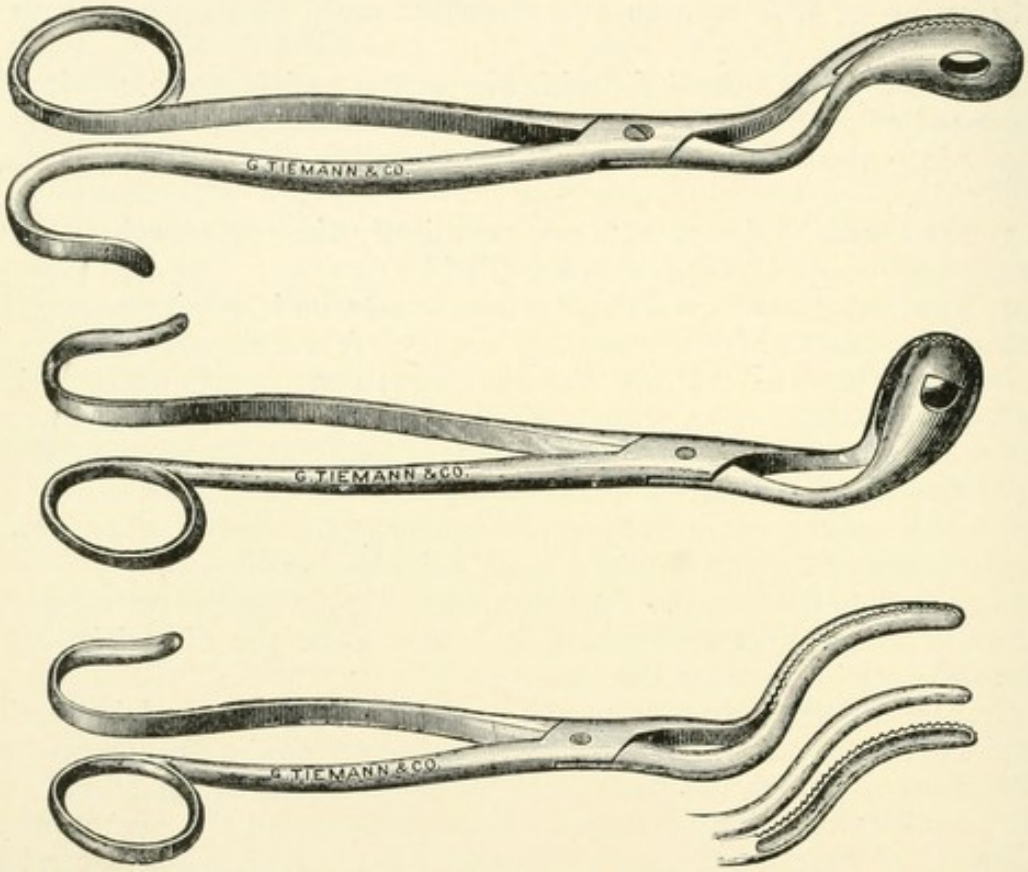


FIG. 179.—Thompson's vesical forceps for removing growths in the bladder. For growths close to the neck of the bladder, with separation of blades to avoid nipping the neck of the bladder.

should be removed at an early period when this is possible. The removal can be effected by the suprapubic or the perineal route.

The suprapubic operation gives a better opportunity of examining and dealing with the growth, and is applicable to almost every case. The technique of the operation has been already described (see Suprapubic Lithotomy, p. 403). Having opened the bladder, the edges of the wound should be held apart with retractors, and a strong light thrown into the viscus either by a forehead mirror or a small electric lamp. Papillomatous growths can sometimes be scraped off with the finger-nail or with a sharp curette. If the growth has a slender pedicle, it can be twisted off with one or other of the forceps devised by

Sir Henry Thompson (Fig. 179). Stout pedicles should be grasped by rectangular forceps close to the bladder-wall and firmly held, while a second pair of forceps grasps the pedicle close to the instrument and twists off the growth. The écraseur has been used to good advantage, and it may be necessary at times to transfix the growth with a needle of suitable shape on a handle and tie off the pedicle with a double ligature. When all the growths are removed the surface of the bladder is wiped off with soft sea-sponges to remove all blood-clots and particles of tumor. The after-treatment is the same as for suprapubic cystotomy as employed for the removal of stone.

Perineal cystotomy is advocated by many surgeons on account of the drainage facilities which can be secured by its employment. It, however, does not give free access to more than the neck of the bladder, is wholly inapplicable in cases complicated with enlarged prostate, and never admits of the full and direct examination of the interior of the bladder which can be obtained by the suprapubic operation. When it is resorted to the median incision is the one adopted.

When the tumor involves the bladder-wall a section of its entire thickness has been removed. Sonneberg excised the upper two-thirds of the bladder, including the peritoneum which covered it, and closed the wound with sutures. The patient died at the end of six weeks. Antal was more successful. In his case the tumor was about the size of a child's fist. He removed the growth and the portion of the bladder-wall from which it sprang. The patient survived, and was able to retain his urine for three or four hours. The incision was suprapubic, and the peritoneum was stripped up without being opened.

Deformities of the Bladder.—Absence of the bladder is a rare congenital deformity. In the cases which have been reported the ureters opened directly into the urethra without the intervention of a separate receptacle for the urine, into the vagina, into the rectum, or externally near the umbilicus. The subjects of this deformity generally have other defects, as imperforate anus, undescended testicle, etc.

There is no treatment worthy of mention, as all the attempts which have so far been made to construct a new bladder have proved unavailing.

Double or *multiple* bladder has occasionally been met with. The double bladders reported were produced by a septum which divided the viscus into two compartments. One of these, reported by Dr. Smith of Baltimore, is remarkable. The patient sought advice for frequent micturition, and on examination was found to have a double penis and a bladder divided into two compartments by a septum. One of these contained a stone, the removal of which cured his disease.

Extroversion or *exstrophy* of the bladder is one of the most distressing and loathsome conditions to which a human being can be subject. It is a failure of union of the sides of the uro-genital cleft, resulting in absence of the anterior wall of the bladder, a portion of the abdominal wall, and the symphysis pubis. Through the opening thus formed the bladder protrudes as a fungating mass covered with an unhealthy tenacious mucus, and discharging ammoniacal urine which irritates and excoriates the neighboring parts. The penis and prostate are usually rudimentary, and there is often a double inguinal hernia.

Treatment.—Of mechanical appliances designed to collect the urine in this distressing complaint, the best is that manufactured by Tiemann & Co. of New York, consisting of a metallic or hard-rubber shield which is applied over the exstrophied bladder. From the lower part of the shield a soft-rubber tube carries the urine to a rubber bag buckled to the thigh.

Operative procedures have not been very satisfactory. Wood's operation consists in turning down a flap from the abdomen between the opening and the umbilicus; two other flaps are taken, one from the groin on either side, and superimposed upon the first flap (Fig. 180).

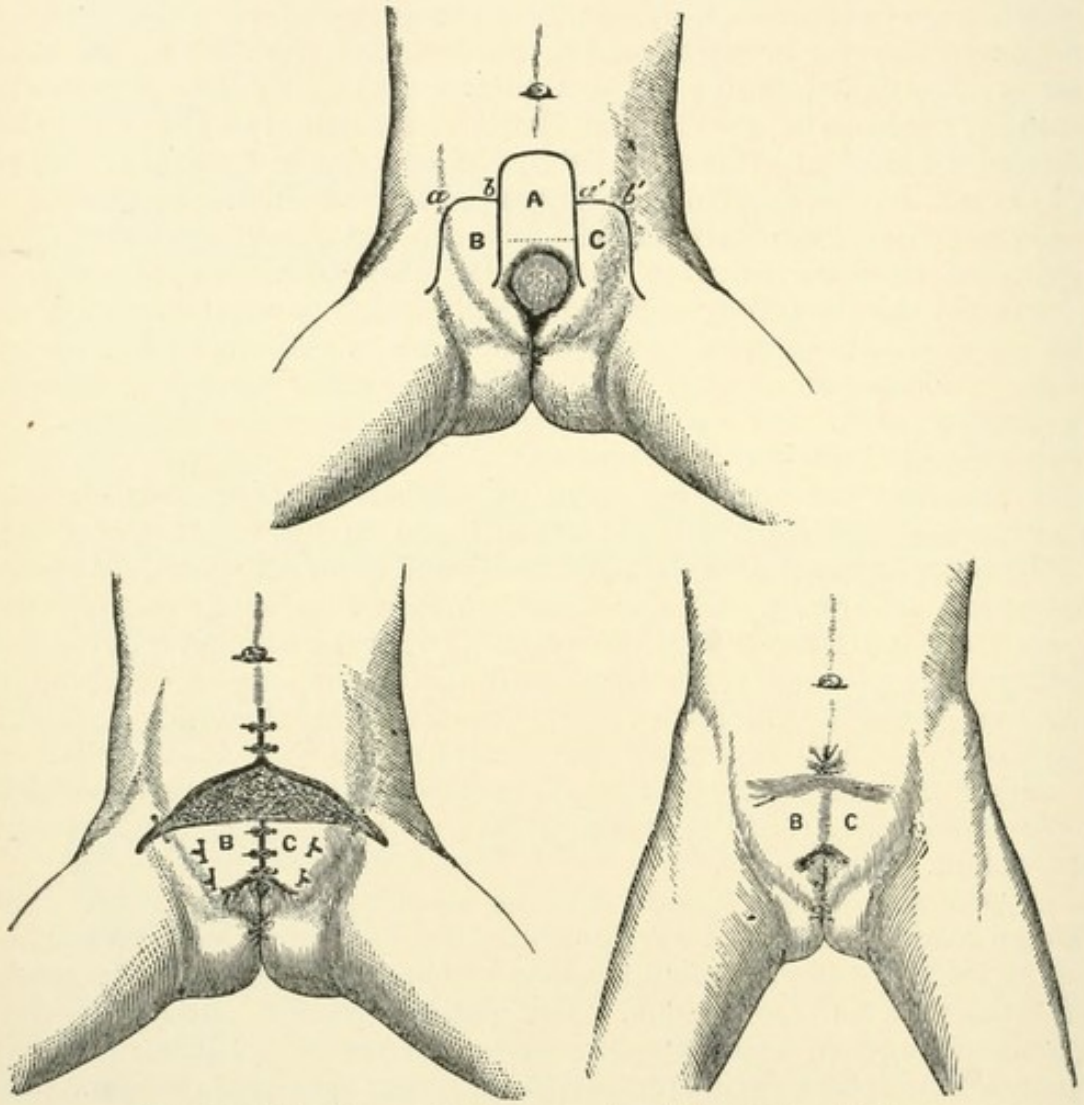


FIG. 180.—Wood's operation for exstrophy of the bladder (Ashhurst).

A represents the first flap dissected from the abdomen and turned down. *B* and *C* represent the lateral flaps, which are united in the middle line by their bases *a*, *b* and *a'*, *b'*. This operation is best suited to the female bladder, while the operation of Maury is adapted to exstrophy in males. It is performed as follows: A curvilinear incision is carried from the outer third of Poupart's ligament across the middle of the perineum to the corresponding point on the opposite side. A flap from the perineum and scrotum is dissected up until the root of

the penis is reached. An opening is then made in the center of the flap and the penis is pushed through it. A second flap is obtained by carrying a curvilinear incision across the abdomen. This flap is about an inch in length. The cutaneous surface is first vivified, and then pushed under the abdominal flap and secured by stitches.

So unsatisfactory have all plastic operations proved that Harrison concludes the best results will be obtained eventually in the following way: "By (1) the establishment of a lumbar fistula with one kidney, preferably the right one, and (2) the removal of the opposite kidney as soon as the urinary fistula has been rendered permanent. In this way the whole of the urine would be voided through one fistula, means being taken to collect the excretion as it escapes."

Cystocele and Hernia of the Bladder.—Repeated over-distention of the bladder and weakness of the abdominal wall sometimes result in the formation of a hernia of the bladder. The viscus may protrude in the linea alba, or, like a hernia of the intestine, it may follow the course of the cord or great vessels and appear at the inguinal or the femoral ring. In females the most common situation for cystocele is the vagina, the bladder protruding between the labia.

Symptoms.—The hernial tumor presenting at any of the openings mentioned is soft and fluctuating; it enlarges gradually as the bladder fills with urine, and suddenly diminishes with every act of micturition. In cases of doubt a small aspirating needle may be used to draw off the contents of the tumor.

Treatment.—When the hernia is reducible a truss can be worn with great advantage. For irreducible cystoceles a truss with a concave pad will prevent increase of the tumor. Vaginal cystocele is often greatly improved by a plastic operation, but in the other varieties operative measures have given no satisfaction.

IV. INJURIES AND DISEASES OF THE PROSTATE.

Surgical Anatomy.—The prostate (*προστατης*, standing before) is a body partaking of the nature of both a muscle and a gland. It owes its name to the fact that it stands before the bladder, being placed at the outlet of that viscus and surrounding its neck. The first inch of the urethra, measuring from the bladder, passes through the prostate. The average length of the prostatic urethra in adults is an inch and a quarter. It is situated behind the triangular ligament, and can be distinctly felt by digital examination of the rectum. The size of the prostate is about that of a horse-chestnut, or an inch and a half in breadth, three-quarters of an inch in thickness, and an inch anteroposteriorly. Much discussion has taken place as to whether the prostate is a muscle or a gland. It is both. Unstriped muscular fibers compose the bulk of its structure, and the action of these muscular fibers is to contract at the beginning of the sexual orgasm, and, as soon as the semen has distended the prostatic sinus, to force it out in successive jets or spurts. It also contains some glandular tissue, which is composed of a number of follicles lined with columnar epithelium, and which empty by fifteen or twenty excretory ducts into the floor of the prostatic portion of the urethra. These openings are marked by a

depression on either side of the floor of the urethra (the prostatic sinus), while between the two is a ridge of highly erectile tissue, the verumontanum, supposed to be the principal seat of sexual sensibility. The prostate is divided into two lateral lobes by a furrow on the upper and lower surfaces and by a deep notch behind. When a third or middle lobe is spoken of, it is pathological, being due to hypertrophy of the portion which lies between the two lateral lobes. It is held in position by the posterior layer of the triangular ligament, the pubo-prostatic ligament, and the deep perineal fascia. Its vascular supply is abundant and derived from the internal pudic, vesical, and hemorrhoidal arteries. The veins form a plexus about the organ, and freely inosculate with those which carry the blood from the rectum and anus. A study of the prostatic urethra is important from a diagnostic standpoint. In children it has a sharp curve and is quite short, increasing in length as years advance, so that in adult life its average length is one inch and a quarter. The length and direction of the curve are subject to important modifications by disease.

The prostate bears a close resemblance to the uterus in anatomical structure and physiological character. This is important to remember, and its significance will be apparent in the diagnosis and treatment of the diseases which we shall presently consider.

General Symptoms of Prostatic Disease.—As in the case of the bladder, our attention is directed to the prostate by three guiding symptoms—viz. pain, frequency of micturition, and hematuria.

Pain in prostatic disease is felt in the rectum and perineum. In cases of commencing prostatitis the pain may be felt simultaneously in the rectum, perineum, and urethra. It is felt during the act of micturition, for the distention of the urethra as the urine flows through it and the contraction of the bladder-wall in the act of expulsion cause pressure upon the inflamed prostatic tissue. For similar reasons pain is felt during defecation.

Frequency of micturition is usually most troublesome at night and while the patient is at rest. The urine, instead of coming away in a stream of considerable force, drops directly to the ground and the bladder contains more or less residual urine.

Hematuria.—The blood is discharged in clots, sometimes of considerable length, having been moulded in the urethra, and they are expelled before the urine.

Attracted by one or more of the symptoms just named, a systematic examination of the prostate should be made for the following diseases and injuries: *hypertrophy*, *prostatitis*, *calculi*, *malignant disease*, *wounds*, and *contusions*.

Hypertrophy is the most common of all the affections of the prostate. After middle life the prostate has a natural tendency to enlargement, and in about 10 per cent. of men over fifty-five years of age this enlargement is sufficient to cause inconvenience. The causes assigned for hypertrophy are almost as numerous as the writers on the subject; an enumeration of them would be of no practical value. It cannot well be denied that excessive functional activity is a predisposing cause, just as frequent childbearing leads to analogous changes in the uterus.

The prostate is generally enlarged in every direction, but it is not

uncommon to find local hypertrophy in the form of separate tumors like uterine fibro-myomata. The increase takes place in the muscular and fibrous elements, the glandular structure remaining, as a rule, unchanged. A general uniform enlargement may produce very little trouble, from the fact that the urethra is slightly if at all interfered with, while a localized hypertrophy or tumor, even if small, may change the course of the urethra and produce serious obstruction. The most common position for enlargement to begin is in the middle line posteriorly, giving rise to the so-called middle lobe. It can readily be understood that a small amount of hypertrophy in this situation can change the shape of the urethra (Fig. 181). The lateral lobes also are frequently enlarged, and by their encroachment upon the urethra that canal may be converted into a narrow slit or be rendered so tortuous as to make it exceedingly difficult to pass an instrument through it. In such cases also the prostatic portion of the urethra is generally in-

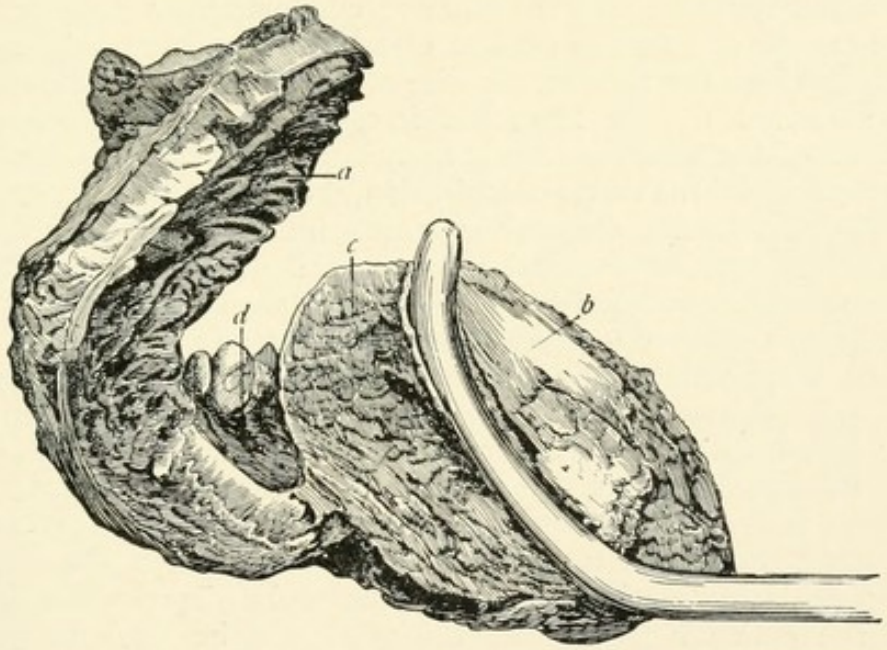


FIG. 181.—Perpendicular section through the bladder, median enlargement of the prostate and prostatic urethra: *a*, greatly thickened bladder-wall; *b*, left lateral lobe of prostate; *c*, middle prostatic lobe; *d*, bas fond of interior of bladder, the hypertrophied middle lobe containing small stone (Watson).

creased in length, so that instead of being an inch and a quarter it may measure three or four inches.

Symptoms.—Two conditions are responsible for nearly all the symptoms which mark the course of prostatic hypertrophy—viz. obstruction to the flow of urine and infection of the bladder with pyogenic organisms. Obstruction is generally first noticed by the fact that the stream is diminished in force, and the urethra is not so completely emptied at the end of micturition as in days gone by. Frequency of micturition soon follows, and the characteristic which distinguishes it from the same symptoms due to other causes is that it is worse while the patient is in bed. He has to get up at night, and this goes on with increasing frequency until it becomes a great annoyance. At the same time, the bladder-wall loses its tone, and is unable to expel the urine

with wonted force; the stream is sluggish, and may fall directly to the ground, scarcely clearing the patient's feet. In spite of the loss of force, the stream maintains its full size, thus distinguishing enlarged prostate from stricture of the urethra. The time comes when the bladder fails to empty itself, and if immediately after urination a catheter be passed, several ounces of "residual" urine can be withdrawn.

The observance of these symptoms naturally leads us to make a local examination of the prostate itself, and this can be done very satisfactorily by a digital examination in the rectum. The patient is placed on his back with the knees drawn up and separated to an extent that gives perfect relaxation. The bowel should be emptied by an enema; and in sensitive patients a suppository of morphin or cocain, introduced half an hour before the examination, will allay irritability.

The examiner having filled the space beneath the nail with hard soap and lubricated the finger, passes it into the rectum with the palmar surface directed forward. At a distance conveniently within reach the prostate can be felt and its outline clearly distinguished. The degree of projection into the rectum, the size of the lateral lobes, the existence of the so-called middle lobe, the irregularities of surface, and the dimensions of the whole prostatic body should be carefully considered. Having completed the rectal examination, the patient should be required to urinate, and then a catheter is passed into the bladder. This will settle the question of residual urine, and, if need be, the instrument may be used in combination with the rectal examination. With a metallic catheter on one side of the prostate and the finger on the other the surgeon can gain very accurate knowledge of the size and shape of the gland. Valuable information can be obtained from the manner in which the catheter passes into the bladder. If it goes in without the handle having to be depressed to any great extent, and the urine flows when the instrument has penetrated to a depth of seven or eight inches, there is no prostatic enlargement. When the prostate is enlarged the handle of the catheter has to be depressed well down toward the patient's feet before the point can be made to enter the bladder, and the instrument may have to be pushed in to a depth of ten inches before the urine begins to flow. This is why long catheters with a large full curve have been made expressly for prostatic enlargement.

The residual urine plays an important part in the course of the disease: not that the presence of urine of itself causes annoyance, for normal urine sets up no irritation and gives no trouble. It is when the fluid becomes infected with pyogenic bacteria that trouble begins. Cystitis follows, the frequency of micturition is increased, and the patient, unless properly treated, endures all the evils which attend chronic inflammation of the bladder. Mucus in large quantities is voided with the urine; gradually the fluid loses its normal acidity, becomes alkaline, ammoniacal, and foul-smelling. Hematuria comes, as a rule, in cases of long standing and is due to congestion of the affected parts. The blood is expelled before the urine, and is in the form of long cylindrical clots which have been moulded by the urethra. Sometimes the flow of this blood from the engorged tissues is followed

by a sense of relief and a temporary improvement in the general symptoms.

The effect of enlarged prostate upon the sexual function is often marked, leading to troublesome priapism and to abnormal sexual appetite, even in very old men. The opposite result, impotency, is sometimes observed. Incontinence of urine at night is a distressing symptom in some of the cases. It is due to loss of tonicity in the cut-off muscle. During waking hours the patient by his volition can compensate for this loss of tone; in sleep volition is in abeyance and the urine escapes.

Retention is a frequent complication, and is brought about by excessive sexual indulgence, by intemperate eating and drinking, and by exposure to cold and wet.

Calculus is apt to appear as one of the most distressing of all complications. The pain is not so severe, however, as when calculus occurs under other circumstances. It is most marked when riding in a jolting vehicle or on horseback. Sudden stoppage of the stream during micturition is not likely to occur, for the stone lies in a depression behind the enlarged prostate and is not forced against the opening of the urethra.

Diagnosis.—The conditions most likely to lead to error are stricture and calculus. The question of differential diagnosis should never be considered without a rectal examination, for, wanting this, the examiner is in no position to decide. The age of the patient has an important bearing: enlarged prostate is not commonly met with before the age of fifty-five; stricture is an affliction of young men. The stream of urine in prostatic enlargement is slow and weak, but of full size, while in stricture it is small or forked or a mere dribble. The size, shape, and contour of the prostate as determined by digital examination are the only infallible guides to a correct diagnosis. Acute prostatitis is recognized by the history of a gonorrheal infection, by heat and tenderness on local examination, and by pain in defecation.

Carcinoma of the prostate may be suspected if the hematuria is copious and the enlargement irregular in shape and of uniform consistence.

Tuberculosis of the prostate is generally secondary to disease in other parts, and can be disposed of by examination of the urine for tubercle bacilli.

Treatment.—The treatment of prostatic hypertrophy has until recent years been merely palliative. It is a fortunate thing that two-thirds of all persons with enlarged prostates go through life without the necessity of treatment. In the early stages, when frequent micturition is the only symptom, the patient is not likely to seek surgical aid, and when examined he is surprised to find that he has been unable to expel all the urine from his bladder. The amount of residual urine and the number of times the patient is disturbed at night must guide us in our treatment. If he is obliged to rise only once or twice a night, if the urine is normal, and the residual fluid not exceeding an ounce or two, no instrumental treatment is required. The patient should, however, strictly carry out the following general treatment: The body should be well clothed, so as to avoid chilling of the surface; the diet should be light and digestible; alcohol and malt liquors should be avoided: the bowels

should be carefully regulated; and the urine should be voided at stated intervals. When the patient is disturbed three or four times a night and the residual urine amounts to more than two ounces, and especially if it be ammoniacal or otherwise unhealthy, the use of the catheter is indispensable. The instrument should be soft and flexible. It should be thoroughly cleansed inside and out before and after using, and should be regularly kept in a weak solution of carbolic acid. When the residual urine is normal in character, although amounting to several ounces, it may be sufficient to use the catheter each night at bedtime. With ammoniacal urine and marked atony of the bladder two, three, or four passages of the instrument each day may be necessary. Too great care cannot be observed in getting the urethra and bladder accustomed to the passage of a catheter. The first attempt should be made while the patient is warm in bed, and he should remain there for twenty-four hours afterward, and keep his room for several days longer. When the use of the instrument has been continued for several weeks the patient can be taught to catheterize himself. Some men have treated themselves in this way for thirty years and passed their days in comparative comfort.

Besides the use of the catheter, the other means worthy of attention are the following:

(*a*) Massage of the prostate. This is carried out by the finger in the rectum, gently stroking the gland in the direction of the anus, continued for five minutes and repeated once a week. The vesiculæ seminales are in this way emptied.

(*b*) Bladder-gymnastics. Water at a temperature of 100° to 110° F. is injected into the meatus, and thence flows into the bladder by overcoming the weakened sphincter. The patient lies on his back with the head and shoulders well raised and the knees drawn up. When the bladder becomes moderately distended, it is allowed to empty itself, and on this, I presume, is based the unhappy term "bladder-gymnastics." The chief benefit of the method lies in the hot water, which reduces the edema and congestion of the mucous membrane and gives tone to the muscular structure of the bladder.

(*c*) Injections for the relief of cystitis. As already stated, the best of these is a solution of silver nitrate. Large quantities of a weak solution (gr. $\frac{1}{2}$ to $\bar{3}$j) can be employed, or a stronger solution can be thrown into the bladder and immediately washed out with sterilized water.

In very obstinate cases in which the catheter fails to afford relief drainage of the bladder is indicated. The simplest operation for this purpose is that recommended by Harrison: A straight trocar is pushed through the perineum in the middle line and one inch in front of the anus. Guided by the index finger in the rectum, the instrument is made to enter the bladder; the trocar is then withdrawn and a self-retaining catheter put in its place; after which the cannula is removed. Through the catheter irrigating fluids may be injected from time to time. Other methods of draining the bladder are the median incision, as for lithotomy, and the suprapubic incision. The latter has the advantage of allowing more thorough exploration of the bladder and prostate, and, if necessary, the employment of more radical measures.

The operative procedures designed to permanently relieve the symptoms resulting from enlarged prostate are—

1. *Double Castration.*—This operation has not advanced beyond the experimental stage, and yet the number of successful cases which have been reported is very encouraging. After numerous experiments on animals, White suggested the operation as likely to be followed by atrophy of the prostate. Ramm of Christiania also experimented on animals, and tested his theories by successfully operating on two old men. Over 100 cases have been reported, and as a rule the results have been satisfactory. The operation is safer than prostatectomy, it can be performed much more rapidly, and the patient is kept under anesthesia a much shorter time.

2. *Ligation of both vasa deferentia* has been tried in a few cases, and promises results as good as those obtained by castration.

3. *Prostatectomy.*—In dealing with the enlargement of the prostate which gives rise to serious bladder-symptoms McGill makes the following classifications: 1, a projection of the middle lobe, pedunculated or sessile; 2, an hypertrophy of the middle lobe and the two lateral lobes, making three distinct intra-vesical projections; 3, enlargements of the lateral lobes only; 4, a uniform collar-like projection encircling the orifice of the urethra.

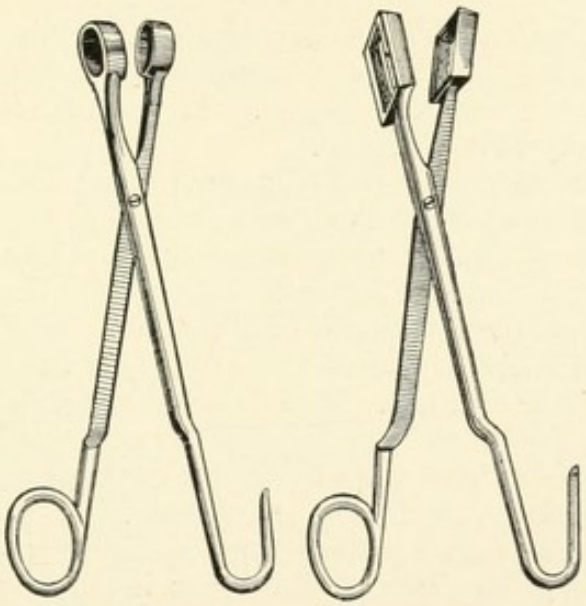


FIG. 182.—Jessop's prostate-scissors.

It is for the removal of one or other of these intra-vesical growths that prostatectomy is undertaken. The prostate can be approached by the suprapubic or the perineal route.

(*a*) *Suprapubic Prostatectomy.*—McGill's Operation.—The technique of opening the bladder is exactly as described under Suprapubic Lithotomy. The edges of the incision in the bladder are sutured to the abdominal wall by a stitch at each side and at the lower angle of the wound. The bladder is then explored for the projecting growth. When possible, enucleation with the finger, after first dividing the mucous membrane over the projection, is the safest manner of removal. A pedunculated middle lobe can be removed with curved scissors, or if

sessile it may be twisted off with forceps. Jessop of Leeds (Eng.) has invented an instrument (Fig. 182) for cutting away the projecting prostate either at once or piecemeal. If the orifice of the urethra is surrounded by a collar-like growth, this should be divided above and below and then enucleated with the finger or scissors. Hemorrhage is sometimes profuse, but can be controlled by irrigations with hot water. After the operation the large drainage-tube is left in the bladder for forty-eight hours, the wound above and below the tube being united by deep and superficial sutures. The bladder should be kept aseptic by irrigations of boric-acid solution.

Nicoll of Glasgow, after opening the bladder in the manner just described, makes a median perineal incision down to and through the prostatic capsule without cutting into the urethra or neck of the bladder. With one hand in the suprapubic wound the prostatic growth can be pressed down and steadied within reach of the fore finger of the other hand in the perineal incision. The perineal finger then shells out the growth.

(*b*) *Perineal Prostatectomy.*—The objection to this operation is the difficulty of reaching the prostatic enlargement with the finger and the small space available for manipulation. The median incision is the one which has generally been adopted.

(*c*) *Lateral prostatectomy* (Dittel's operation) has no advantage worthy of recommendation. A catheter is tied in the bladder, and the rectum filled with gauze for the purpose of enabling the surgeon to recognize and avoid these structures. The patient lies on his belly and his legs hang down over the end of the table. Beginning at the tip of the coccyx, an incision is carried to the right around the sphincter ani to the middle line in front. This lays open the ischio-rectal fossa; the rectum is held aside and one lobe of the prostate is exposed. Dissection on the other side of the middle line exposes the other lobe, and a wedge-shaped portion is removed from each.

All prostatectomies are unsatisfactory, and in the search for remedial aid perhaps nothing has been devised that is better than an artificial urethra. By the suprapubic operation, which is acknowledged to be the best, the mortality following prostatectomy is from 16 to 20 per cent. This is not to be wondered at when we consider that the patients are mostly old and enfeebled with suffering, their disease complicated with chronic cystitis, pyelo-nephritis, atony of the bladder, and not infrequently calculus. The formation of an artificial urethra was first devised by Harrison in 1884, and has been followed by happy results in the hands of many operators, notably Hunter McGuire in America and Poncet in France.

Instead of the perineal incision as first proposed by Harrison, a suprapubic urethra is now generally considered the best. The operation as practised by Hunter McGuire is as follows: The rectum is distended by a rectal bag or by sponges or cotton in order to press the bladder upward and forward and fix it against the anterior abdominal wall. Five or six ounces of water are then injected through a soft-rubber catheter. The opening into the bladder is the same as for suprapubic lithotomy. The bladder is then examined, first by the finger and then with a small electric light introduced through

the suprapubic wound, or an assistant with two fingers in the rectum may push the posterior wall of the bladder up toward the wound and thus facilitate its inspection. A large catheter is now introduced, and, as the rectal bag is allowed to drain away, the point of the catheter is made to follow the bladder as it sinks lower in the pelvis; otherwise it might slip out of the vesical incision. By the time the rectal bag is emptied the opening in the bladder will be found to be two and a half or three inches lower than the center of the abdominal incision. No stitches are employed, the wound being allowed to heal around the catheter, so that nothing is left but a fistulous tract about three inches in length communicating with the bladder at about the angle at which a spout is fixed to a coffee-pot. The patient is generally able to hold and expel his urine at will, and sometimes the stream can be forced as much as a yard from his body. When this expulsive force is lacking a small glass funnel can be fitted over the suprapubic opening during the act of micturition, as recommended by Dr. Lydston.

To prevent closure of the artificial opening, it is necessary to wear a plug which can be made of silver or aluminum. It is from two and a half to three and a half inches in length, and is kept in position by straps fastened around the hips. It is removed during micturition and afterward replaced.

Inflammation of the Prostate (Prostatitis).—Prostatitis may be confined to certain portions of the mucous membrane and the follicles connected with it, producing local inflammations and leading to abscesses which are generally small and rupture into the urethra. This variety is known as *follicular* prostatitis. *Parenchymatous* prostatitis is the name applied to an inflammation of the whole prostatic body; when suppuration takes place in this variety the pus burrows into the surrounding tissues and points in the perineum or the groin.

Follicular prostatitis is of two kinds—acute and chronic. The *acute* form is almost invariably connected with gonorrhea. Rarely, it is due to injury, either traumatic or the result of surgical procedures, to stricture, or to the use of caustics.

Symptoms.—If during the acute stage of gonorrhea, or when in the later stages instruments are passed into the urethra, the patient is seized with pain in the perineum, with or without a chill, the likelihood is that acute prostatitis is setting in. The pain is of an intense burning character and felt at the neck of the bladder. Micturition is painful and the desire is constant. Defecation also causes pressure on the prostatic body and is attended with suffering. The perineum throbs and the pain runs down the loins and thighs. Sometimes there is a chill, and there is always more or less fever, as indicated by the temperature and pulse. All of these symptoms are very characteristic, and they are fully corroborated by a digital examination through the rectum. The prostate is hot, swollen, throbbing, and intensely painful to touch.

Chronic follicular prostatitis may be a continuation of the acute form, or it may be milder and run a course of less intensity from the first. The only difference in the symptoms is that they have not the intensity of the acute form. Instead of the violent throbbing pain, there is a dull aching in the perineum extending down the thighs and across the loins. The passage of urine or feces adds greatly to this

discomfort by pressure upon the inflamed structure. Urination is attended with scalding, and toward the end it is not uncommon to find a few drops of blood. Rectal examination reveals an enlarged and tender prostate, without the heat and throbbing of the acute variety.

Treatment.—In acute follicular prostatitis the patient should keep his bed and live upon light diet. The bowels should be evacuated once, and then kept quiet for several days. Hot-water enemata or half a pint of hot water containing a dram of laudanum will give great relief. Fomentations to the perineum and hip-baths as hot as can be borne are also useful. Retention of urine will necessitate the use of a soft-rubber catheter. When suppuration occurs in the perineum free incisions are indicated. The rule, however, is that the abscess bursts into the urethra, and this takes place probably during the passage of the catheter. A free flow of pus with the urine is followed by a sensation of great relief, and, as the tension around the abscess is considerable, the cavity is soon emptied. Chronic prostatitis is difficult to manage and obstinately resists all treatment. Tonics and the best hygienic conditions are indispensable; over-exertion must be avoided, and the bowels should be kept relaxed to prevent straining at stool. In the majority of cases of chronic prostatitis there is either primarily or secondarily infectious inflammation of the prostatic portion of the urethra and the glands and ducts connected with it; hence antiseptic treatment, both local and general, is indicated. The internal remedies are those that disinfect the urine, such as quinin, the various balsams, and eucalyptus. Urethral injections carried to the affected part are often valuable: they may consist of nitrate of silver, solution of tannic acid, permanganate of potash, or bichlorid of mercury. When there are collections of pus about the perineum, these should be evacuated and drained.

Parenchymatous Prostatitis.—The causes of this form of disease are traumatism, gout, tuberculosis, and possibly syphilis. Clinically, we may set down all cases connected with gonorrhea as follicular, and all other forms of prostatitis as parenchymatous. The whole substance of the prostate is involved, and in many cases profuse and long-continued suppuration causes destruction of the tissue. Operations for stone, the use of large instruments while the bladder is in an unhealthy condition, and chronic kidney disease are responsible for a large proportion of the cases of parenchymatous prostatitis. Frequently the disease is ushered in with a chill and deep-seated pain in the perineum. The enlargement, heat, and tenderness are found on rectal examination as in the follicular variety. Suppuration is apt to follow, and the pus may burrow into the recto-vesical fascia, and thence to the pelvis, or it may form an abscess in the perineum.

Treatment.—As soon as it is evident that suppuration is about to take place or has already begun, an incision in the middle line down to and through the capsule should be made without delay. The general treatment is the same as for the preceding forms.

Gouty prostatitis is found in persons who have other manifestations of the gouty diathesis. The disease is congestive and irritable rather than inflammatory, and rarely does it end in suppuration. The symp-

toms are the same as those already mentioned, with a greater tendency to bladder-complications.

The *treatment* is that of gout in general.

Tubercular Prostatitis.—This is nearly always secondary to tuberculosis in other parts, especially those contiguous to the prostate, as the testicles and bladder. In some cases it occurs as a primary disease, the bacilli being engrafted upon an inflammatory condition of the prostatic urethra.

Symptoms.—Tubercular prostatitis closely resembles the symptoms of stone in the bladder. If we fail to find a stone, and find more or less marked evidence of prostatic inflammation, a suspicion of tuberculosis may be entertained. In tubercular prostatitis the patient is a young or middle-aged man, the enlargement as felt per rectum is nodular, the epididymes are enlarged, and the bladder is inflamed. To corroborate this diagnosis the detection of bacilli in the urine is necessary. This cannot be done before ulceration has taken place. When there is evidence of tuberculosis in the lungs, glands, or other parts of the body, the diagnosis can be made positively.

Treatment is not very satisfactory. The general treatment is that of tuberculosis in any part of the body. Local treatment is of little value except when the disease is primary. Abscesses when they occur should be opened, their walls curetted and packed with iodoform gauze. Iodoform emulsion injected into the prostatic urethra is believed to have a restraining influence on the growth of the bacilli, and the hypodermic use of iodin and chlorid of gold in the form of Clark's solution is worthy of trial. Under any circumstances the prognosis of tubercular prostatitis is highly unfavorable; when it is secondary to tuberculosis elsewhere, the patient's chances are simply *nil.*

Malignant Disease of the Prostate.—Encephaloid cancer and sarcoma are the two forms of malignant disease found in the prostate. The two extremes of life furnish nearly all the cases. Sarcoma occurs in children below ten years of age and carcinoma in men beyond the age of fifty: 85 per cent. of all cases are carcinomatous.

Diagnosis.—Very naturally, prostatic hypertrophy and tuberculosis of the prostate are the two affections which are likely to be mistaken for malignant disease. The most difficulty in making a diagnosis is met with when an enlarged prostate becomes the seat of cancer. Besides the symptoms which arise from enlargement of the prostate, pain, especially at night and referred to the rectum, is significant. Hemorrhage is often profuse, and a purulent discharge from the urethra is common when there is ulceration. The rapidity of growth, the extension of the disease to the rectum and pelvis, the involvement of lymphatic glands in Scarpa's triangle, and the development of a cancerous cachexia leave no doubt of the nature of this terrible disease when once it has become fully established.

Treatment.—Radical treatment has frequentiy been attempted, but for obvious reasons without success. The palliative measure most likely to give rest to the affected part and lessen suffering is the formation of an artificial urethra by the suprapubic operation, as suggested by Lydston.

Calculus of the Prostate.—Like the tonsil, the prostate is liable

to be the seat of calculi composed of its normal secretions which have become inspissated. These sometimes occur in large numbers, which may remain each in a separate cavity, or they may finally be collected in one receptacle by the breaking down of the septa between the cavities. It is not uncommon for a vesical calculus to become arrested at the prostatic portion of the urethra, and, sinking into the substance of the gland, become encysted, a portion remaining in the urethra.

The *symptoms* of prostatic calculus are very similar to those of stone in the bladder. The sound may be found to strike the stone before the instrument reaches the bladder; measurement of the distance from the meatus will be a guide to the part of the urethra involved. Stone in the prostate is never found to change its position with movement of the patient. With a sound in the bladder and a finger in the rectum the examiner may be able to locate the stone in the prostate between his finger and the instrument. Numerous small calculi can sometimes be felt to rub against each other when the finger is pressed against the prostate.

Treatment.—If the stone communicates with the urethra, a large sound may push it back into the bladder. Small calculi may be removed with forceps. When the stone is firmly encysted a median perineal section is the best operation for its removal.

Wounds and Injuries of the Prostate.—The prostatic body is so well protected by the pubic and ischiatic bones that injury is exceedingly rare. When injured, therefore, it is usually a complication of a severe traumatism of the pelvis in which prostatic injury plays but a minor part. The treatment of prostatic wounds must be carried out on general principles, the most important point to keep in view being the avoidance of urinary infiltration. The same caution applies to wounds of the gland happening in the course of operation.

V. INJURIES AND DISEASES OF THE MALE URETHRA.

Surgical Anatomy.—The urethra is the tube, partly muscular and partly membranous, which extends from the bladder to the meatus urinarius. It is divided into three portions, as follows: the prostatic, the membranous, and the spongy, penile, or pendulous. Of each portion we shall give a brief description.

The *prostatic* portion passes through the prostate body nearer to the upper than to its lower surface. It is about one and a quarter inches in length, and is the most dilatable part of the whole urethra. Along its floor extends an elevation, broad behind and narrow in front, called the *veru montanum* or *colliculus seminalis*. Immediately in front of this is the *sinus prostaticus*, into which open the ejaculatory ducts.

The *membranous* urethra is that part which extends from the posterior to the anterior layer of the triangular ligament, and is about three-fourths of an inch in length. It lies about an inch below the symphysis pubis, from which it is separated by the dorsal vessels and nerves of the penis and some connective and muscular tissue. It is surrounded by the compressor urethræ muscle, and below it, and on either side, are Cowper's glands. It is the narrowest part of the entire canal.

The *spongy*, pendulous, or penile portion begins at the anterior layer

of the triangular ligament and extends to the meatus urinarius at the end of the penis. This part of the urethra is very important surgically, owing to the persistence with which the gonococcus maintains its position there. This is accounted for by the abundant supply of mucous glands and ducts in this part of the canal. Once infected, the ducts become dilated, their orifices obstructed, and the glands themselves filled with infective products. The spongy portion of the urethra is movable; the membranous and prostatic portions are fixed and form a curve. This curve extends from just in front of the triangular ligament to the neck of the bladder. It is represented by an arc of a circle three inches in diameter, and subtended by a chord two and three-quarters inches in length.

Rupture of the Urethra.—In the pendulous portion, owing to its freedom of motion, this accident is rare. Many of the cases met with are produced during coition, and are readily recognized by the immediate swelling, pain, and ecchymosis of the whole organ. The membranous portion is much more frequently ruptured, and the common cause is a fall astride of a hard or resistant body, such as a timber, a plank, or a ship's spar, by which the urethra is forcibly compressed between such object and the triangular ligament or possibly the pubic arch. Other causes are injuries produced by the use of instruments, the giving way of the urethra behind a tight stricture, and fracture of the pubic bones.

Symptoms.—Four leading symptoms may be relied upon in forming a diagnosis of ruptured urethra—viz. pain, disorder of micturition, hemorrhage, and the formation of a urinary tumor.

Pain is seldom wanting: it may be so slight as to give little inconvenience, or it may be sudden and so intense as to cause fainting. It is most marked at the seat of rupture, but may spread over a considerable area. The first intensity having passed away, a more constant form of pain is produced by the passage of urine over the lacerated membrane.

Micturition is interfered with in nearly every case, but the variations of this symptom are numerous. In one case there is but slight difficulty in urinating; in another there is complete retention. Sometimes there is retention for a short time, after which the flow of urine is perfect. These changes are explained by the local conditions. The urethra may be completely divided, the ends separated, and the mucous membrane curled up. Inflammation in and around the urethra may occlude its lumen, and thus cause retention at a late stage of the disease. Clots forming at the seat of injury may cause a temporary retention which passes off as soon as the coagula have been expelled.

Hemorrhage may appear at the meatus urinarius or beneath the skin at the seat of injury, or in both situations. The quantity of blood is subject to great variation. As a rule, it appears immediately after the accident. There may be but a few drops of blood or there may be a continuous oozing. In severe cases, in which mucous membrane is lacerated and the corpus spongiosium freely opened into, the bleeding may be so profuse as to cause death. Ecchymosis is generally present, of varying intensity according to the depth of the rupture and severity

of the traumatism. It is most marked when the rupture is in the spongy portion or in the perineum. It is wanting or appears at a late period when the rupture is caused by fracture of the pelvis.

Formation of a Tumor.—This is best seen in ruptures in the perineum. The tumor is in the middle line, and at the outset is not larger than a pigeon's egg. Later it increases in size to almost any extent. By pressure it can be diminished, and at the same time blood or urine, or both, escape from the meatus. In the pendulous portion the tumor may appear as a small node or it may surround the organ like a collar.

When all of these symptoms are present there is no difficulty in arriving at a diagnosis, but in the absence of one or more the condition may be obscure. The history of the injury should be carefully considered, and rupture of the urethra suspected in cases of severe traumatism about the perineum or pelvis. The part of the urethra involved can usually be made out by passing an olive bougie, when extreme sensitiveness at one particular spot will indicate the rupture. Injuries of the perineum are followed by rupture of the bulbar portion of the urethra, while fracture of the pelvis usually causes rupture of the membranous portion.

Treatment.—In mild cases, attended with slight hemorrhage and no extravasation of urine, it may be sufficient to pass a soft-rubber catheter from time to time, keeping the patient at perfect rest and watching for complications. In more severe cases, attended with considerable hemorrhage and more or less extravasation of urine, it will be necessary to make free incisions in the extravasated area and retain a catheter constantly in the bladder.

In the most severe type of cases, in which it is impossible to pass a catheter, perineal section should be made without delay, the divided ends of the urethra found, and the catheter passed through into the bladder and retained there. This is sometimes a difficult matter, and it may be utterly impossible to find the proximal end of the urethra. In that event it is advisable to make a suprapubic cystotomy and relieve the bladder by retrograde catheterization. When it is possible the divided ends of the canal should be stitched together. The best material is catgut; the sutures should not include the mucous membrane, and care must be taken lest the edge of the membrane gets folded into the wound. A danger of ruptured urethra not to be lost sight of in treatment is its tendency to be followed by stricture.

False Passages in the Urethra.—Unskilful, rough, or careless use of a catheter or sound may rupture one or more of the coats of the urethra from within, and produce what is known as " false passages." Their position may be at any part of the urethral tract, but most frequently in the neighborhood of the bulb. They may be produced in a healthy urethra if care be not taken to lower the handle of the catheter when the point of the instrument reaches the cul-de-sac of the bulb, for if it be pushed straight on it will pierce the lower wall of the canal and pass under the membranous portion between the prostate and the rectum. If, on the other hand, the operator lower the handle too soon, the point perforates the anterior wall of the urethra and passes behind the symphysis pubis. False passages, however, are much more commonly met with when there is some abnormal condi-

tion of the urethra. Stricture is a very common cause, and so is enlargement of one or other of the lobes of the prostate.

Diagnosis.—If during the passage of a catheter or sound an obstruction be met with, which is suddenly overcome and attended with a tearing sensation, which the surgeon can feel and the patient can also appreciate; if on withdrawal of the instrument there is no grasping of it by the urethra; and if, moreover, a few drops of blood escape after the catheter is withdrawn,—it is pretty certain that the instrument is making a false passage. Should the operator under these conditions be so foolhardy as to insist upon pushing the instrument to its destination, he will find that it progresses with a series of jerks, instead of a smooth, steady motion; and if the finger be inserted into the rectum, the instrument will be found to have travelled to one or other side of the middle line, and can be felt too close to the rectal wall.

Old false passages are sometimes confusing. You may pass a catheter to a certain point, and there it becomes arrested. The question naturally arises, Is this obstruction due to a stricture or to a false passage? If the patient can urinate *at any time* with ordinary freedom, there is no stricture. If in the passage of the instrument it is found to deviate to one or other side of the median line, it is evidence that there is a false passage.

Treatment.—Minor lacerations made with a small instrument seldom require any active treatment. False passages made by a large instrument and involving considerable extent of tissue require careful attention.

A catheter should be passed into the bladder and retained for several days. This will serve the double purpose of relieving retention and of exerting pressure upon the walls of the false passage, and thus favoring its repair. If it is impossible to pass a catheter, and the patient is still able to micturate, perfect rest and antiphlogistic treatment are sufficient. If, however, there be complete retention and the catheter cannot be passed, external urethrotomy or suprapubic cystotomy with retrograde catheterization is indicated.

Foreign Bodies in the Urethra.—These may come from the bladder, as fragments of calculi, or they may be pushed into the urethra from without, or may occur by accident, as when a catheter or other instrument is broken during its passage. In any case the diagnosis is not difficult. The stream of urine is more or less interfered with, and may be suddenly stopped, as when a small calculus from the bladder completely blocks the passage. Palpation along the course of the penile portion of the urethra will reveal the presence of a foreign body, not only by the sense of touch, but by the localized tenderness. The deep urethra may be palpated by the finger in the rectum, and the diagnosis may be completed by passing a metallic instrument into the urethra.

Diagnosis of Calculus coming from the Bladder and becoming Lodged in the Urethra.—A calculus may be arrested at any portion of the urethra, but the commonest situations are the two narrowest portions of the canal—viz. the neck of the bulb and the fossa navicularis. If the stone be very small, it may produce only a difficulty in passing water; if large enough to block the urethra, an abrupt retention may result. This is more common in children; the rule in adults is, that

pain is first felt in the region of the kidneys, followed by the expulsion of gravel. The degree of pain varies with the size and shape of the stone. It may be almost wanting when the calculus is small, round, and smooth, while in the case of a large stone with roughened surface the suffering may be intense. After palpating the urethra as already mentioned a sound should be passed. A calculus of considerable size will check the passage of the instrument, and a distinct click will leave no doubt as to the character of the obstruction. Some idea may also be gained of the consistence of the stone and the character of its surface. A small stone may allow the sound to pass by without giving any indication to the hand which holds the instrument, but in the vast majority of cases there will be felt a sensation of rubbing or grating.

It may happen that the stone lies in a pouch or pocket, and is not touched by the instrument. Palpation must be depended upon to find a tumor in the neighborhood of the penile or deep urethra, and while the palpating finger is kept in close contact with the tumor a sound can be passed and its end directed against the suspected spot.

A stone in the prostatic or membranous portion of the urethra may be confounded with a tumor of the prostate or with a urinary abscess. The history of the case must be carefully considered. If the patient has habitually passed gravel, the presumption, *ceteris paribus*, is very strong in favor of the idea that the body is a calculus. If the sound click against a stone very deep in the urethra, the question may arise as to whether the calculus is in the urethra or at the neck of the bladder. To settle this point a digital examination of the rectum should be made and the membranous and prostatic portions of the urethra carefully palpated. With the finger still in the rectum lift the prostate well up toward the pubis and pass a catheter having an opening at its tip. Watch for the first flow of urine. If the stone can be touched without the escape of urine, the calculus is in the urethra. If urine begins to flow the moment the stone is touched, it is in the bladder.

Treatment.—The stone may be removed by one of three different routes :

1. By the meatus. The fossa navicularis, being one of the narrow parts of the urethra, sometimes contains a calculus, which can be readily removed through the meatus with or without enlargement of the orifice by incision. When the stone is farther back its removal is attended with more difficulty. A probe should be passed in and the calculus loosened from its position, after which the meatus is pinched between the fingers while the patient is asked to micturate and strain with all his might. In this way the stone may be passed or brought within reach of forceps. A number of instruments have been invented with the view of either removing the foreign body or crushing it *in situ ;* but as their employment is attended with considerable laceration of the urethra, it is better to use only a fine pair of forceps (Fig. 183). Should it be found impossible to grasp and remove the stone, an external urethrotomy will be found less hazardous and more satisfactory than persistence in the use of instruments.

2. By the bladder. When the stone is in the membranous or prostatic portions of the urethra a full-sized metallic sound may be inserted with the object of pushing it back into the bladder. It is then a vesical

calculus, and can be crushed with the lithotrite and removed immediately or at some future time.

3. By an urethral incision. The most suitable cases for this operation are those in which the stone is in the spongy portion of the urethra. It is also applicable when the stone cannot be pushed back into the bladder. The operation is done as follows, Steady the stone with the thumb and finger and cut down upon it, making the incision just large enough to extract the stone. After its removal pass a soft catheter into the bladder and retain it there. The wound may be closed with several sutures or allowed to heal by the open method. When stone in the urethra is complicated with a stricture, one of several procedures must be adopted according to circumstances:

(*a*) If the calculus be small and the patient can pass water, the stricture should be dilated and the stone removed by the force of the urine or by the aid of urethral instruments.

(*b*) When the patient is unable to urinate and it is necessary to remove the calculus immediately, the stricture can be disposed of by an internal urethrotomy, when the stone, if sufficiently small, can be

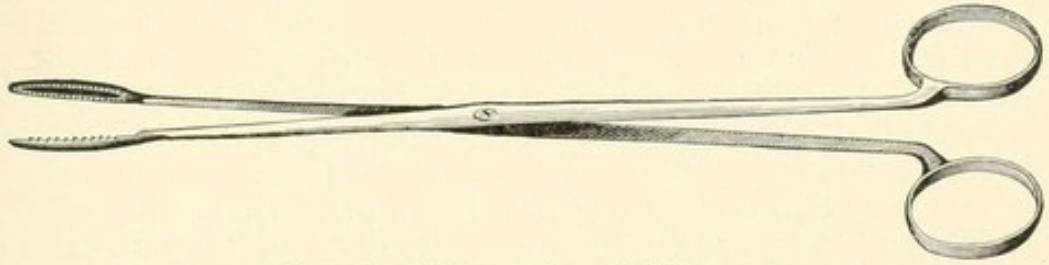


FIG. 183.—Thompson's urethral forceps.

withdrawn, or the urethra can be opened from without (external urethrotomy) and both stricture and stone disposed of. The latter procedure is in the majority of cases to be preferred.

Foreign bodies introduced into the urethra by the meatus afford practically the symptoms described under Calculi in the Urethra, and their removal is effected on the same principle.

Urethritis, or Inflammation of the Urethra.—All inflammations of the urethra may be divided into two great classes—those due to a simple inflammation of the mucous membrane, and those the result of infection by a specific germ, the gonococcus.

Simple urethritis may arise from any traumatism to the urethra, as the rough passage of a catheter, the laceration of the tissues by calculi, or the exposure to irritating and unhealthy discharges, as those which come from a cancerous uterus or a metritis or cervicitis. Inflammation arising in this way is scarcely to be distinguished from a specific gonorrhea, except, perhaps, that it is of shorter duration and of less severity. It is well to remember, in diagnosis, that such a disease as simple urethritis exists, and not every case of purulent discharge from the urethra need reflect upon the character or virtue of the person so affected.

Gonorrhea.—Urethritis due to the presence of the gonococcus is very conveniently classified under three varieties: 1. Acute inflammation, or typical gonorrhea; 2. Subacute or catarrhal gonorrhea; 3. Irritative or abortive gonorrhea.

Acute inflammatory or typical gonorrhea is the variety most frequently met with, and is therefore very important as a clinical study. A patient suffering from this disease may be compared to a man climbing a steep hill, then crossing a broad tableland, and finally descending to the plain on the other side; for the disease has three stages—viz. the first or increasing stage, the second or stationary stage, and the third or stage of subsidence.

Like other contagious diseases, gonorrhea has a period of incubation varying from a few hours to fourteen days, but it is safe to say that the disease begins to manifest itself within a week after exposure to the virus.

The first symptoms to attract the patient's attention is a drop of thin milky fluid appearing at the meatus; there is also an itching or tickling sensation, and the lips of the meatus are red, everted, and slightly swollen. Micturition is attended with a sense of warmth at first, which speedily increases to scalding, and within forty-eight hours or even sooner the first or increasing stage is so fully developed as to leave no possible doubt as to the nature of the disease. During this stage the following symptoms become pronounced: The meatus is red, everted, swollen, and sometimes eroded. The swelling may be sufficient to almost close the opening, so that the urine is passed in drops. Pressure on the penis along the course of the urethra is painful, and if it be made in the direction of the meatus, a thick, yellowish, purulent discharge escapes. This is a good way of testing the veracity of persons who deny that they have been exposed to infection. My memory reverts to an honored teacher who in his wards often met with cases of this character. With no gentle touch he was in the habit of grasping the penis between his finger and thumb and sliding them along toward the meatus, causing the fluid to exude. If satisfied that the patient was lying, he turned upon his heel and silently walked away, leaving the man's feelings and urethra literally crushed.

Scalding attends every act of micturition.

Chordee, or painful erection, is not a symptom in every case, but is quite common. It generally comes on at night, and just about the time the patient is ready to fall asleep. The organ is usually curved downward, rarely upward or laterally or twisted. The erection or priapism is very painful and persistent. The dangers of chordee are rupture and hemorrhage, which may terminate in organic stricture or in abscess.

Frequent urination and vesical tenesmus are sometimes present in this stage of the disease, and may be taken as indications that the inflammation has spread along the urethra toward the bladder.

During the first or *increasing stage* complications are likely to supervene. The inflammation may extend from the meatus to the surface of the glans penis, producing redness and other signs of inflammation, and sometimes ending with exfoliation of the epithelium, leaving the glans eroded or ulcerated. This complication is known as *balanitis*. When the erosions or ulcerations are pronounced it is possible to mistake the condition for chancrous erosion. In the latter, however, there is no urethral discharge, there is induration at the base of the ulcer, the sore itself is clearly defined and not acutely inflamed, and the lymphatic glands are involved.

From the glans penis the inflammation may spread over the inner surface of the prepuce. This complication is called *balano-posthitis.* The swelling of the prepuce and its infiltration with inflammatory products result in the third complication, which is

Phimosis.—In this troublesome condition the prepuce covers the glans penis (Fig. 184), and cannot be retracted; discharges are retained, making it exceedingly difficult to keep the parts clean or to give them proper treatment. If the patient is in this condition when he first presents himself for advice, the diagnosis may be somewhat difficult. The existence of phimosis is clear enough, but how are we to say whether the primary disease is gonorrhea or chancroid beneath the

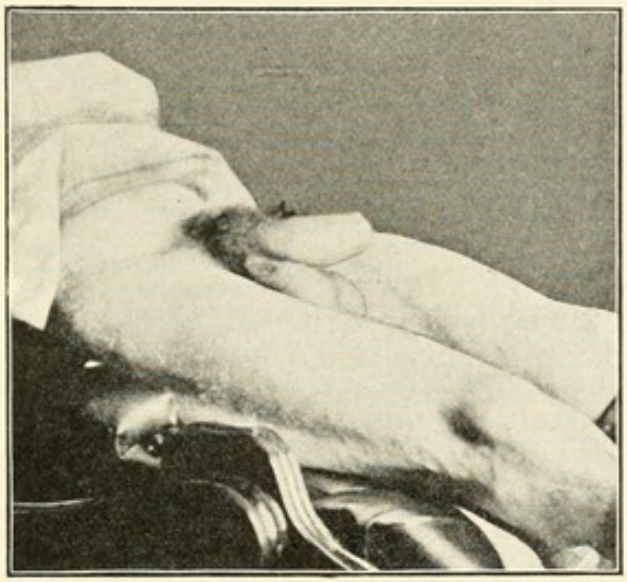


FIG. 184.—Phimosis with hidden chancre (from a photograph in the collection of Dr. Lincoln).

prepuce? Attention to the following points will generally clear up the question:

1. *History.*—In gonorrhea there is a history of simple scalding during micturition, but no sore.

2. The discharge in gonorrhea is purulent; in chancroid it is often mixed with blood.

3. Chordee is sometimes present in gonorrhea, but is never a marked symptom in chancroid.

4. Scalding is felt along the course of the urethra in gonorrhea; only at the prepuce in chancroid.

Treatment of Phimosis.—A lotion containing acetate of lead and tincture of opium should be used to allay the inflammation in the prepuce. The part beneath the prepuce should be syringed with soap and water and afterward washed with the lotion. In most cases this treatment will allay the swelling sufficiently to allow of the prepuce being drawn back.

When all other means have failed circumcision is indicated.

Another complication of this stage of gonorrhea is *paraphimosis.* It also is a result of inflammation in the prepuce. If, in its swollen condition, it should happen to be retracted and become caught behind the corona glandis, the constriction increases so rapidly that the prepuce cannot be

brought forward. The glans become swollen; the prepuce, puffy and edematous, forms a collar behind the corona; and a little farther back is a tight, unyielding ring formed by the orifice of the prepuce.

Treatment of Paraphimosis.—Oil the parts and, placing your two thumbs on the glans, with the fore fingers above and behind the corona glandis and the middle fingers below and beneath, make gentle pressure upon the glans until its congested vessels are emptied and it can be pushed back within the prepuce and the latter drawn well forward.

Or the end of the penis may be wrapped in a piece of moist lint two inches in width and extending a little in front of the glans. Around this, from before backward, is wound a piece of round elastic ligature. In this way the glans is so compressed that it can be pushed back within the prepuce (Eddowes).

Strapping the glans and prepuce with adhesive plaster and leaving them under pressure for twenty-four hours will often bring the parts into proper condition.

Failing in all of these measures, the constriction should be divided. This is done by passing beneath the prepuce or the dorsum a thin knife and turning its edge upward against the furrow which lies between the mucous membrane and the skin. If unrelieved, ulceration and sloughing are sure to follow; the pain throughout is severe, and altogether the condition is troublesome and dangerous. Thus, the patient toils wearily up the hill, which represents the first or increasing stage, tormented by day with frequent calls to urinate and dreading the scalding which attends the act; tortured by night with painful priapism; disgusted with the filthy discharge which continuously escapes from his meatus; and filled with remorse for the folly which led him from the path of virtue. The duration of this stage is variable, but if properly treated it should not exceed a week, and the second or stationary stage begins.

Symptoms of the Second or Stationary Stage.—During this stage the inflammation is extending backward along the urethra. The symptoms of the first stage continue unchanged, and as deeper portions of the urethra become involved new complications arise, depending upon the part or tissue to which the inflammatory action spreads. Attacking the follicles which open upon the surface of the urethra, it causes swelling of their lining membrane, occluding their orifices and converting them into small abscesses. These can be felt as small round tumors along the under surface of the urethra. They usually open internally, rarely through the skin. Extending beyond the follicles, the connective tissue which surrounds the urethra may become involved, giving rise to periurethral abscesses, especially at the fossa navicularis and the anterior part of the membranous urethra.

Bubo is a complication frequently met with. It is the result of the inflammatory process extending to the glands of the groin. The first manifestation is a small painful tumor just below Poupart's ligament, and which is one of the superficial glands. It becomes swollen and inflamed, but under proper management subsides before suppuration takes place.

Treatment of Bubo.—Simple pressure or the application of iodin is often sufficient to prevent suppuration. This, failing, fomentations of

hot sublimate solution should be kept constantly applied, and when an abscess forms it should be lanced and treated in the usual way.

Extending to the prostate and bladder, the symptoms characteristic of prostatitis and cystitis respectively must be sought for. They have been already discussed.

The Third Stage, or Stage of Subsidence.—The second stage lasts from one to two weeks, when, one by one, the troublesome symptoms begin to subside. The discharge becomes scanty or entirely disappears, the urine is voided without inconvenience, chordee becomes a thing of the past, and there is a gradual return to healthy conditions. The patient has ascended the hill, crossed the tableland, and is descending to the plain on the other side. Still, he is beset with dangers from which he has to be carefully guarded. The slightest indiscretion may start up the discharge; the inflammation may take a new course, passing along the ejaculatory ducts and invading the testicle. This is a troublesome complication, and may come on as late as the end of the second or even the third month. This is known as *epididymitis*, or *gonorrheal swelled testicle*. The symptoms begin with pain in the groin (usually the left), followed by a dull aching in the testicle itself. When the cord is palpated it is found to be swollen and tender. The testicle soon begins to swell and may attain an immense size, the scrotum assumes a purple color, and the patient constantly complains of a nauseating pain. All these symptoms are aggravated if the large and heavy testicle is allowed to hang down and cause dragging by its weight. Sometimes the induration in the cord and neighboring tissues, combined with nausea and vomiting, simulate hernia—a point which is worth keeping in view, as errors in diagnosis may thus occur.

Gonorrheal rheumatism is a complication which may occur at any time and in any form of gonorrhea. The patient may or may not be predisposed to rheumatic affections. The symptoms are frequently ushered in with a chill, followed by slight fever, and the appearance of pain and swelling in one of the joints, notably the knee, ankle, wrist, or elbow. The pain on movement is intense, and the synovial fluid is increased, amounting in some cases to a marked synovitis or even a general arthritis. Besides the joints, the disease may involve the muscles, the tendons, tendon-sheaths, and, more rarely, the sheaths of nerves. The course of this variety is generally more mild than that of ordinary articular rheumatism, from which it differs in the following particulars: Gonorrheal rheumatism is associated with urethritis; the fever is slight; there is no sweating; the urine remains unaltered; and antirheumatic remedies do no good. It is almost sure to return with each subsequent attack of urethritis.

Ophthalmia and *conjunctivitis* are also complications of gonorrhea.

Subacute or Catarrhal Gonorrhea.—The first attack of urethritis due to the gonorrheal virus is nearly always acute. A person having passed through one is liable to subsequent attacks, which may be brought on by simple irritants, such as contact with leukorrheal secretion or a fresh infection. These recurrences are much milder and assume a catarrhal or subacute character. The pain during micturition is slight; chordee, if a symptom, is never of the painful kind which attends acute attacks, and complications are wanting. The discharge is never so profuse as

in the acute variety, and it rapidly diminishes under treatment. It is not uncommon, however, to have the discharge linger along for an indefinite period, and only visible in the morning—the so-called "morning drop."

Irritative or Abortive Gonorrhea.—In this variety the symptoms are of the mildest kind, confined to the meatus and fossa navicularis, and stopping there. There is little if any scalding in micturition; the discharge is slight and transparent, and if let alone stops within a week. These are the cases which give glory to the so-called abortive treatment and to the charlatans who promise "a perfect cure in three days."

Treatment of Gonorrhea.—A great deal has been written upon the treatment of gonorrhea, and an endless list of remedies might be compiled which from time to time have been lauded as certain and speedy cures.

Two lines of treatment must be considered:

1. *The Abortive Treatment.*—With the idea of destroying the gonococci and cutting short the urethritis which results from their presence various remedies have been employed. These are antiseptics and caustics. At first sight the idea seems quite feasible. Infection begins at the meatus and extends backward along the urethra. If the germs can be destroyed before they have had time to proliferate and thoroughly infect the tissues, the disease is aborted. This is "a consummation devoutly to be wished," but, unfortunately, clinical experience goes to prove that the attempt is rarely, if ever, successful. About all that we can say in favor of the treatment is that it is free from danger, and in well-selected cases may be given a trial; but he who tries it will probably use it but once. Nitrate of silver is the favorite remedy, and it can be used in a weak or strong solution. When a strong solution is employed, it is with the idea of destroying the virus at one injection; when a weak solution is chosen, it is with the hope that by frequent injections the same purpose may be accomplished. The method of using the strong solution is as follows: A small syringe with a long nozzle is filled with a solution of silver nitrate (fifteen grains to the ounce), and passed into the urethra to a depth of two inches; as the instrument is slowly withdrawn the fluid is injected and held for a few seconds. A weak solution of bicarbonate or of chlorid of sodium is then injected, and the patient directed to expel the whole by urinating.

The weak solutions are used of a strength of one half-grain to the ounce, and the injections are made every two hours until pronounced smarting is felt during micturition.

Prolonged and systematic irrigation of the anterior urethra with a solution of permanganate of potassium in a strength of 1 : 10,000 to 1 : 5000, as first practised by Janet of Paris and improved by the apparatus devised by Valentine of New York, is an excellent method of treatment. The fluid is injected as warm as can be comfortably borne, and the irrigation kept up for a half or three-quarters of an hour at a time, twice daily during the first three or four days, after which time it is given once a day for two or three weeks. If this treatment is employed, it must be kept up for several weeks, even if the discharge stops after the first twenty-four hours.

The danger attending the employment of caustics is the production

of stricture and the possibility of converting a simple irritative or abortive attack of urethritis into an acute inflammatory form of the disease.

2. The second method of treatment is based upon the belief that the disease is self-limiting, and may be called the *rational treatment.* We have already seen that an acute inflammatory urethritis has three stages—the *increasing*, the *stationary*, and the *subsidiary*—each of which occupies about a week. If instead of making a desperate attempt to avert the disease, we resort to mild remedies which will diminish the severity of the symptoms, avert complications, and prevent unpleasant after-effects, we will secure better results than have ever been obtained by the more heroic modes of treatment.

Rest, as in every other inflammatory affection, is entitled to the very first consideration. The ideal way for a patient to act during the course of acute urethritis would be to remain perfectly at rest in bed. This, however, is not practicable, and the most we can insist upon is that the patient take as much rest as possible, lying down when he has an opportunity, sitting instead of standing, and riding instead of walking. Sexual excitement must be avoided. The urine should be kept as unirritating as possible by attention to diet and by the use of remedies to correct abnormal conditions. With this end in view alcoholic and malt liquors, tea, coffee, and highly seasoned articles must be avoided, and meat of all kinds used most sparingly. As much as it is possible for him to do so the patient should live upon bread and milk, and if he can confine himself to these two articles, so much the better. Alkaline mineral waters are valuable in diluting the urine and causing it to produce less irritation as it passes over the inflamed urethral surface. For similar reasons plain water may be freely consumed. Tobacco seems to have a very deleterious effect and should as far as possible be avoided.

The discharge from the urethra demands careful attention, and the utmost cleanliness should be insisted on. Frequently soaking the penis in warm water not only tends to keep it clean, but allays inflammation and pain and palliates chordee. As a dressing the simplest contrivance is a small stocking or muslin bag pinned to the underclothing, and in which the penis hangs without touching the lowest portion, this part being filled with absorbent cotton, which retains the discharge as it drops from the meatus.

Internal Remedies.—If in the early stage of acute inflammatory urethritis the febrile symptoms play a prominent part, aconite or veratrum viride is useful. To render the urine bland and unirritating alkaline diuretics and diluent drinks should be given throughout the increasing stage. Balsamic preparations have long been held in high esteem. The best of these is the oil of sandalwood, which can be given in capsules containing ten to fifteen minims four times a day. Cubebs is an old-time favorite, and may be given in doses of one dram of the powder three times a day or in the following mixture:

℞. Ol. cubebæ, ℥ss;
Ol. cinnamom., ♏x;
Spt. eth. nit., ℥ss;
Mucil. acaciæ, ad ℥viij.
Sig. One tablespoonful three times a day.

For the relief of chordee the patient should avoid sexual excitement, his room should be cool and well ventilated, food should not be taken late in the evening, and the bowels should be kept relaxed. For the relief of the painful erection bromide of potassium, 30 to 40 grains at bedtime, is valuable. A suppository containing a quarter-grain of morphin or morphia with hyoscyamus, or a hypodermic of morphia in the perineum, given at bedtime, will usually secure a night's rest should other measures fail, care being taken to keep the bowels from becoming constipated.

Urethral Injections.—The possibility of treating the urethra on antiseptic principles has received a great deal of attention. The question is a difficult one from the fact that there is almost invariably a double infection—viz. the gonococcus of Neisser and the germs of suppuration. The difficulty is further increased from the fact, now well established by experiment, that a germicide which readily destroys pyogenic organisms has no effect upon the gonococcus. A list of the drugs that have been used as injections and lauded as specifics would fill a volume. In the first few days of the increasing stage only the mildest injections can be borne. The following is a sedative injection suitable under such conditions:

℞. Acid. boric.,	ʒj;
Morph. acetat.,	gr. iss;
Cocain. muriat.,	gr. x;
Aquæ dest.,	℥vj.

When the more acute symptoms have subsided mild astringents and antiseptics may be used to abate the discharge:

℞. Zinci sulphocarbolate,	gr. xv;
Hydrarg. bichloridi,	gr. $\frac{1}{10}$;
Aqua dest.,	℥iv.

Before using any injection it is necessary to wash out the urethra with warm water, which of itself is of decided benefit, not only on account of its cleansing effect, but also owing to its soothing properties.

During the stationary stage, if the discharge shows no signs of abating, a weak solution of nitrate of silver may be employed:

℞. Argenti nitratis,	gr. iv;
Aquæ destillatæ,	℥iv.

In the stage of subsidence the injections may have to be increased in strength; care, however, must be taken to discontinue their use as soon as they cause smarting in the urethra.

Chronic Urethritis.—After every other symptom of gonorrhea has disappeared it is not uncommon to have the urethral discharge continue for an indefinite length of time. To such chronic discharge the name "gleet" has been commonly applied, but this term is applicable to only one form of chronic urethritis, as we shall presently see. Cases of chronic urethral discharge can be conveniently divided into three classes:

1. **Catarrhal Urethritis.**—This is a continuation of the acute form, and in many instances exists more in the patient's mind than in reality. It is often little more than a moisture of the urethra. The patient, worried by the idea that he has not recovered from the discharge, constantly "strips" the urethra to see what can be pressed out. The only time he succeeds is in the morning, when a drop or two of clear albuminoid liquid can be expressed. If let alone this discharge ceases in a few days or weeks, and it is best to allow it to do so.

2. **Chronic Gonorrhea.**—After inflammatory symptoms have subsided along the course of the urethra, and the patient has passed through all the stages of an acute attack, one spot in the canal may continue to give trouble. It is usually the seat of granulations or of ulceration, and the most common situations are the fossa navicularis and the anterior portion of the membranous urethra. The discharge is milky or creamy in character, and can be pressed out of the meatus in the morning or during the day, provided the trial be made a few hours after urinating. The diagnosis of the part of the urethra which is affected is arrived at in three ways:

(*a*) "Stripping" the urethra. Pressure of the penis between the thumb and finger should be systematically tried. The first trial should be made a little behind the fossa navicularis, and by taking an inch or so at a time the point is at last reached from which a discharge can be passed along the urethra to the meatus.

(*b*) By the use of the bulbous bougie. The instrument, several sizes smaller than the urethra, is passed very slowly and any painful point carefully noted. Having passed beyond the sensitive point, the instrument is withdrawn, and the discharge which has been brought away by the shoulder of the bulb is carefully noted.

(*c*) By the urethroscope. The urethra is red and slightly swollen, there is an aching sensation felt during erection, and any compression of the urethra during micturition causes pain.

Treatment.—Having located the granulated spot, it is necessary to make local applications to its surface. About 6 to 8 minims of a 2 to 10 per cent. solution of nitrate of silver should be introduced by means of a prostatic syringe or applied with an applicator through the urethral speculum. For a day or two the irritation caused by the caustic will increase the discharge. After this injections of sulphate of copper, sulphocarbolate of zinc, or other astringents are applied in the same manner, gradually increasing their strength as the conditions require.

3. **Gleet.**—In this form of chronic urethritis the discharge is of a muco-purulent character. It is commonly met with after repeated attacks of gonorrhea or in a first case which has been of long duration. The edges of the meatus are found in the morning to be glued together and retaining a few drops of a whitish fluid. At the end of micturition there is usually a dribbling of urine. This indicates a stricture of large caliber.

Treatment.—Gleet so commonly depends upon commencing stricture of the urethra that the treatment is really that of stricture. By examination with olive-pointed bougies the position and caliber of the stricture can be ascertained, and it can afterward be dilated by the passage of sounds. Even should there be no lessening of the lumen of the

canal, the stimulation of the mucous membrane by the pressure of a metallic instrument will have a good effect in setting up a healthy action and arresting the discharge. It is seldom that injections are called for in the treatment of gleet.

Stricture of the Urethra.—By stricture is meant an abnormal diminution of the caliber of the urethra at one or more points or throughout its whole extent, attended with changes in the mucous, submucous, and muscular structures of the canal. It is customary to speak of three varieties of stricture—spasmodic, inflammatory, and organic.

Spasmodic Stricture.—This depends upon spasm of the accelerator urinæ and compressor urethræ muscles, and may either be temporary or chronic. It is brought on by sexual excess, by the presence of the uric- or phosphatic-acid diathesis, by intemperance, by exposure to cold, etc. It is a common result of organic stricture. The spasm occurs usually at two points—viz. the point of irritation and in the musculo-membranous urethra.

Diagnosis.—The diagnosis is not difficult. Retention of urine occurring suddenly in a person whose urethral stream was previously of fair size, and as suddenly passing off, leaving the passage as free from obstruction as before, would be an indication of spasmodic stricture. A bulbous bougie passed into the canal will be found to meet with obstruction, which by gentle and steady pressure may be overcome, or the instrument, having passed the obstructed point, may be grasped by the urethra as it is withdrawn.

Treatment.—A warm bath or the administration of morphia or atropia is frequently sufficient to overcome the spasm. Failing with these measures, a soft-rubber catheter should be introduced with the greatest gentleness, and this should be done while the patient is in the bath, or, if still further relaxation be needed, he can be placed under an anesthetic. The conditions which cause the stricture should be carefully treated.

Inflammatory Stricture.—Inflammatory and spasmodic strictures are closely allied. It is doubtful if pure spasmodic stricture exists without the presence of more or less inflammatory action, and it is equally doubtful if a pure inflammation of the urethra can cause retention without the element of spasm. Be this as it may, it is a clinical fact that in acute anterior urethritis obstruction, amounting in some cases to retention, is a frequent occurrence.

The *treatment* is the same as for spasmodic stricture, combined with the proper treatment of the urethritis which is the exciting cause.

Organic Stricture.—This is the most common form of urethral stricture. It is acquired in the vast majority of cases, but may also be congenital. It is due to some injury of the urethra, and of all causes urethritis is by far the most common.

The cases of urethritis most liable to be followed by stricture are those which have been unusually severe or have had a protracted course.

A mild urethritis has little effect upon the urethra, simply causing tenderness of its surface and hypertrophy of its papillæ. A severe attack or one which is prolonged results in abundant proliferation

beneath the mucous membrane, and the formation of cicatricial tissue, which causes constriction of the canal. This may occur at any part of the urethra except one—the prostatic portion. The constriction may be very limited, forming simply a ring, as if a cord were tied around the canal at that point. To this form the name *linear* stricture has been given. When the strictured portion is broader the name *annular* is applied, and when it involves two or three inches of the canal and is crooked and irregular it is called a *tortuous* stricture. The most frequent situation is in front of the triangular ligament for a distance of one inch. Next in liability is the portion of the urethra extending from the meatus to a distance of about two inches, and the least liable is the middle of the spongy portion.

Symptoms.—The attention of the patient is first directed toward his condition by some interference with urination. The stream is forked or there may be several streams. Simple twisting of the stream is of little account, as this may be due to the shape of the meatus. At the end of micturition the urine dribbles away, owing to a want of the normal contractile wave of the accelerator urinæ muscle. After a time the stream becomes small and there may be complete retention. This, however, is not due to total closure of the canal, but to spasmodic action. Besides these symptoms indicating obstruction, there is generally evidence of inflammation, as a gleety discharge noticed especially in the morning or after exercise. Inflammatory thickening may be felt on palpation of the urethra, and pain may be present to a greater or less degree.

To prove the existence or non-existence of stricture an examination with instruments is necessary. The same precautions against infection and urethral irritation must be observed as in catheterism or in sounding the bladder for stone. The best instrument is Otis's bougie à boule (Fig. 185) or Guyon's bougie exploratrice; the former has an unyield-

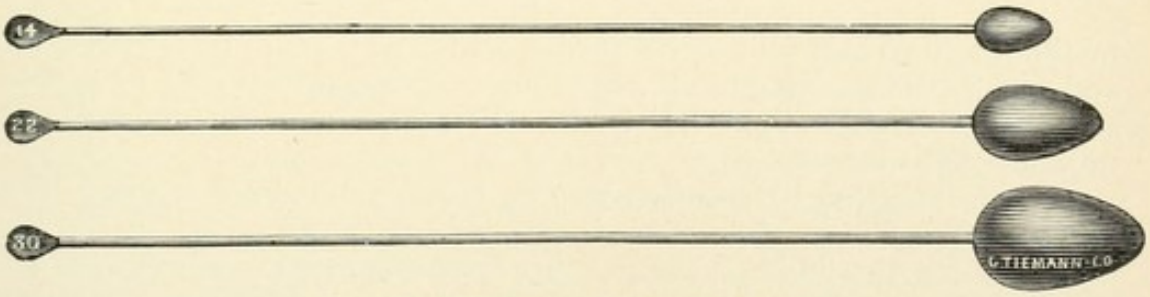


FIG. 185.—Otis's metallic bougie à boule.

ing, the latter a flexible, stem. By means of these instruments the urethra can be explored and the following data obtained:

1. The position of the stricture. Before using the instruments a fair idea of the normal size of the individual urethra may be obtained by the method recommended by Otis, who found that the circumference of the flaccid penis bore a direct relation to the normal size of the urethra. A table based upon these measurements has been formulated, which White has somewhat extended. The measurements are taken at the middle of the spongy portion, and the table is as follows:

Circumference.	Size of sound.
3 inches	26 to 28 French scale.
3¼ "	28 to 30 " "
3½ "	30 to 32 " "
3¾ "	32 to 34 " "
4 "	34 to 36 " "

This table, however, must not be looked upon as strictly accurate: the circumference of the penis is subject to considerable change, and a too rigid adherence to the theory would result in the passage of a sentence of stricture on almost every urethra. If the meatus is abnormally small, it must be incised by means of a probe-pointed knife.

The instrument first selected should be of moderate size, say 15 to 16 Fr.; if this can be passed without resistance, No. 20 or 21 may be tried. If you succeed in passing this without resistance, you may reasonably infer that there is no stricture.

A source of error must be guarded against in this examination, for it frequently happens that as soon as the bulb of the instrument passes the fossa navicularis it is grasped by spasmodic action of the urethra and firmly held; in a minute or two the muscular fibers become fatigued and the bulb can be passed onward without resistance. This spasm may occur at any part of the urethra, and is most apt to take place in patients who are examined for the first time, or in those of nervous temperament, or in those who are the subjects of uric-acid diathesis.

If the bulb meet with sudden resistance (which is not due to spasm

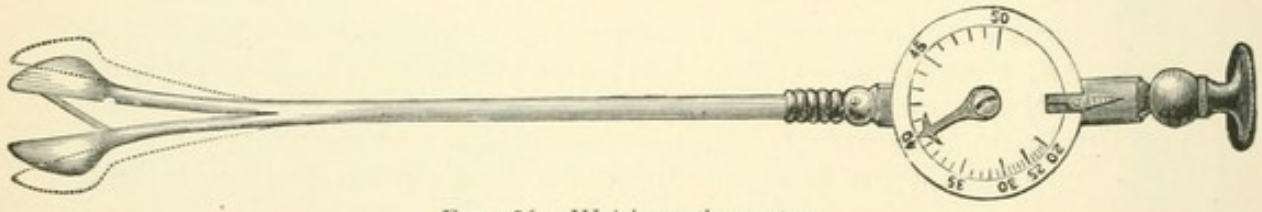


FIG. 186.—Weir's urethrometer.

of the urethra) and cannot be passed farther, it should be withdrawn, and smaller sizes introduced until one is found which will pass the stricture with only slight resistance. The position of the stricture is now carefully noted.

2. The length of the stricture. By passing the bulb beyond the stricture, and then withdrawing it, the base of the cone can be felt to catch against the limit of the stricture farthest from the meatus. The nearest point has already been ascertained, and the distance between the two will represent the length of the stricture. In many cases the resistance of the stricture can be felt during its whole length as the instrument is withdrawn.

3. The degree of contraction or size of the stricture. This can be estimated by the size of the bulb which can be passed with a slight resistance, but more accurately by the urethrometer of Otis, Weir (Fig. 186), or Gross.

4. The number of strictures. This may be difficult to determine by the aid of bougies, but the urethrometer, being adjustable to the caliber of each contraction, is the proper instrument by which to solve the question.

5. The condition of the urethra behind the stricture. As the bougie is withdrawn it carries with it the urethral secretion which collects against the shoulder of the bulb, an examination of which will afford some idea of the state of the urethra.

Classification of Organic Strictures.—For convenience in selecting a mode of treatment strictures are divided according to the degree of contraction into—

1. Those of lage caliber. No. 15 French is taken as the limit; any stricture which admits a larger bougie is said to be of large caliber.
2. Those of small caliber (less than No. 15 French).
3. Strictures permeable only to filiform bougies.
4. Impassable strictures.

In reference to the situation, the following classes are convenient:

1. At the meatus or fossa navicularis.
2. In the pendulous portion of the urethra.
3. In front of the bulbo-membranous junction.
4. At or behind the bulbo-membranous junction.

Treatment.—Before considering the surgical procedures which have been devised for relief of stricture attention should be paid to some points in the general treatment which have much to do with the success of operative procedures. The patient who is the subject of a stricture should pay the closest attention to sexual and genito-urinary hygiene. Exposure to cold should be avoided, as well as everything approaching excess in eating and drinking. When cystitis is present, as is frequently the case, this condition must be treated and remedies used which will prevent decomposition of the urine. Quinin, salol, salicylate of soda, naphthalin, boracic acid, and creasote are all useful drugs for this purpose. When retention of urine occurs it is usually due to spasm of the urethra and can be overcome by a hot bath.

Operative Treatment.—Many modes of treatment have been devised and practised for the relief of stricture, a large proportion of which have been abandoned as barbarous, useless, and unscientific. The methods now in use and meeting with more or less general approval are—1. Gradual dilatation; 2. Continuous dilatation; 3. Urethrotomy and dilatation combined; 4. Internal urethrotomy; 5. External urethrotomy with a guide; 6. External urethrotomy without a guide; 7. Electrolysis; 8. Excision; 9. Subcutaneous section.

Let us now consider the operative treatment suitable for the various forms of organic stricture:

1. *Stricture of the Meatus.*—The meatus may be abnormally contracted as a congenital malformation or it may be the result of disease. In either case the treatment consists in making an incision with a probe-pointed knife, the blade being directed downward and care being taken to divide the fibrous bands which are the cause of constriction. Bougies should be passed every second day after the operation to keep the orifice dilated until healing shall have taken place.

2. *Stricture of the Pendulous Portion.*—Gradual dilatation should be given a fair trial. Internal urethrotomy is with some authors the favorite operation for strictures in this portion of the canal. The operation is almost free from the dangers which attend its use in the deep urethra, and if carried out under aseptic precautions these dangers may

practically be disregarded. And yet discretion is necessary in a choice of method even here. If the stricture be recent and soft, gradual dilatation may give good results, and should first be tried. If there be gleet or the stricture be unyielding, urethrotomy should be chosen, owing to its freedom from danger and the probability of its effecting a permanent cure.

Internal urethrotomy combined with dilatation is a very satisfactory method of treatment, and can be well carried out by the aid of Otis's urethrotome. Whatever instrument is employed, the preparations for the operation should be aseptic in every detail. The urethra should be irrigated with a bichlorid solution of a strength of 1 : 10,000. The hands of the operator and the instrument should be as carefully disinfected as in a major operation. It is not always necessary to employ general anesthesia, as a solution of cocain (4 per cent.) is sufficient. The incision is made in the roof of the urethra, and it is essential that all the strictured tissue be divided, from the normal urethra behind to the normal parts in front. In very small strictures a preliminary incision may be necessary. A filiform bougie is passed through the stricture to serve as a guide; over this a Maisonneuve urethrotome (Fig. 187) is

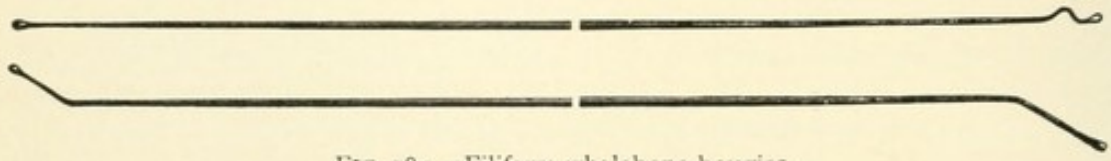


FIG. 187.—Filiform whalebone bougies.

passed through the stricture, and an incision made which allows the passage of a dilating urethrotome and division of the stricture from behind forward.

About the third day the passage of sounds should be commenced to prevent recontraction during the healing of the wound. This should be repeated once or twice a week for six weeks or longer.

Strictures at or behind the Bulbo-membranous Junction.—These are the most difficult of all strictures to treat, for it may be laid down as an axiom that the seriousness of stricture increases with its distance from the meatus. When of large caliber, simple, and soft, gradual dilatation is indicated. Great care is necessary in the use of steel instruments, as the urethral mucous membrane is soft and easily lacerated. In treatment of strictures of small caliber the choice lies between dilatation and urethrotomy. Good results are obtained by using continuous dilatation for twenty-four or forty-eight hours, and gradual dilatation every second day thereafter. Traumatic strictures in this situation demand external urethrotomy as a rule. Sometimes the stricture is so contracted as to render it impossible to pass a steel sound of any size. Filiform bougies are employed in such cases with good effect. The opening may not be in the center of the stricture, but at some part of its circumference. If the filiform bougie cannot be passed, withdraw it and bend the point of it over the thumb-nail to an angle of 45°, as seen in Fig. 188. By persevering efforts the instrument can usually be made to enter the stricture, and when once passed it should be left there for twenty-four hours, when it will be found that others can be inserted by its side.

Having succeeded in passing a filiform bougie, the proceeding will vary according to circumstances. First, an attempt should be made to pass a tunnelled catheter or grooved staff over the filiform into the bladder, after which gradual dilatation can be employed. Or the filiform can be used as a guide to a Maisonneuve urethrotome, and internal urethrotomy performed, followed by gradual dilatation. In most cases, however, the best course is to use the grooved staff as a guide and perform external urethrotomy.

In spite of the most persevering efforts it is sometimes impossible to pass even a filiform bougie. A stricture of this kind is called *impassable*. The condition is attended with serious consequences. Retention of urine is complete, and in powerful efforts to force it through the stricture the urethra may give way and extravasation follow. The only remedy is perineal section or external urethrotomy without a guide. Extravasation of urine presents symptoms which depend upon the part of the urethra which has suffered the urine to escape through its walls. In the penile urethra the swelling will be found to extend from the meatus to the scrotum, and will be most marked at the seat of rupture. Rupture between the attachment of the scrotum and the anterior part of the bulb is late in showing itself by swelling; the urine, being restricted by the deep layer of the superficial fascia, first appears in the scrotum, whence it escapes between the pubic spine and symphysis and reaches the abdomen. If the rupture lies between the two layers of the triangular ligament, the urine will be imprisoned until suppuration and sloughing allow it to break through and appear in some part of the perineum. In the prostatic urethra extravasation finds its way along the rectum to the perineum near the anus, or, passing through the pelvic fascia, it may spread through the subperitoneal connective tissue.

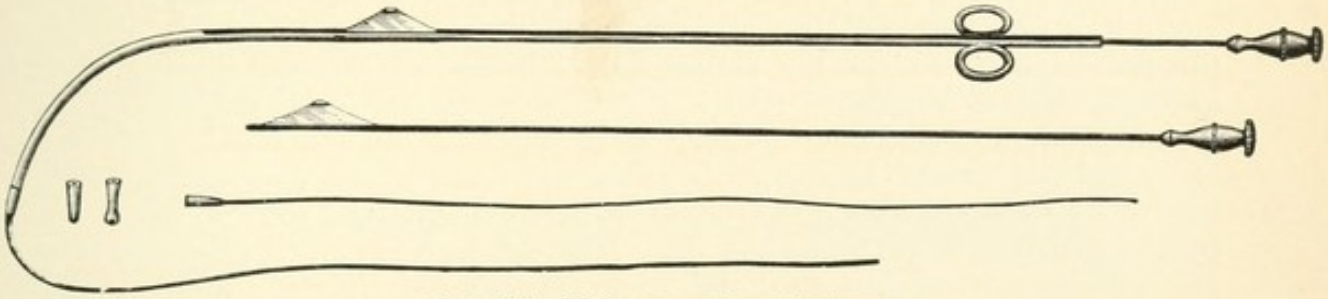


FIG. 188.—Maisonneuve's urethrotome.

Another result of extravasation is *urethral fistula*. The urine may escape drop by drop through a break in the urethral wall, and set up suppuration, resulting in an abscess which opens externally. According to its location a fistula of this character is spoken of as *urethro-penile*, *urethro-perineal*, and *urethro-rectal*. There is little or no difficulty in the diagnosis, as the escape of urine through a fistulous opening is sufficient evidence. To corroborate this sign pass a steel sound into the bladder and probe the fistula from its external opening. In the vast majority of cases urethral fistulæ are caused by strictures. The treatment consists in curing the stricture, after which the fistulous tract is laid open or curetted. During the healing process the urine is drawn off at regular intervals or a catheter is retained in the bladder.

External Urethrotomy.—The operation of incising the urethra from without is indicated in complete retention due to stricture, in extravasation of urine, and in several forms of stricture as already described. The terms external urethrotomy with a guide and external urethrotomy without a guide are self-explanatory. The term perineal section is best reserved for those cases which are impermeable to all instruments.

Operation with a Guide.—To the late Prof. Syme is due the credit of reviving this operation, and its performance has been greatly facilitated by the staff which he invented as a guide (Fig. 189). It consists



FIG. 189.—Syme's staff.

of a sound having two parts of different diameters; for the last two and a half inches it is of the size corresponding to No. 2 English, and this portion is grooved on its convexity. The rest of the staff is equal in size to No. 10 English. At the junction of the two parts there is a shoulder which is intended to rest on the face of the stricture. The instrument is passed carefully along the urethra and the slender portion through the stricture, the finger meanwhile inserted into the rectum to guard against the making of a false passage. The staff is then given to an assistant, who holds it steadily and during the incision presses the convexity of the instrument downward against the perineum. The patient is placed in the lithotomy position. The operator inserts his left fore finger into the rectum, and, cutting exactly in the middle line, makes an incision about an inch in front of the anus and cuts down upon the groove in the staff. Having found this, he uses it as a guide and freely divides the stricture. Through the perineal wound a grooved director or gorget is passed into the bladder and the staff removed. The next step is to pass a full-sized catheter by the urethra into the bladder, the grooved director or gorget (Fig. 190) serving as a

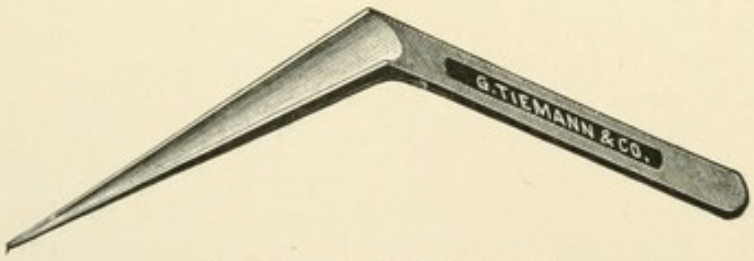


FIG. 190.—Teale's probe-gorget.

guide. If the bladder will tolerate it, the catheter can be retained, but this is not necessary. At the end of a week a full-sized *bougie à boule* should be passed, keeping close to the roof of the urethra. This is rendered painless by the injection of a 4 per cent. solution of cocain,

and should be repeated every second day for the first week, after which the intervals may be gradually lengthened.

Operation without a Guide.—When a stricture is impermeable even to a filiform bougie, the operation of external urethrotomy without a guide is indicated. The operation of Wheelhouse of Leeds is the best. A special staff is employed which has a groove throughout its entire length except the last half inch (Fig. 191). The operation is thus described in the eminent surgeon's own words: "The patient is placed in the lithotomy position, with the pelvis a little elevated, so as to let the light fall well upon it and into the wound to be made. The staff is to be introduced with the groove looking toward the surface, and brought gently into contact with the stricture for fear of tearing the tissues of the urethra and causing it to leave the canal, which would mar the whole after-proceedings, which depend upon the urethra being opened *a quarter of an inch in front of the stricture.* Whilst an assistant holds the staff in this position an incision is made into the perineum, extending from opposite the point of reflection of the superficial perineal fascia to the outer edge of the sphincter ani. The tissues of the perineum are to be steadily divided until the urethra is reached. This is now to be opened in the groove of the staff, not upon the point, so as certainly to secure a quarter of an inch of healthy tube immediately in front of the stricture. As soon as the urethra is opened and the groove in the staff fully exposed, the edges of the healthy urethra are to be

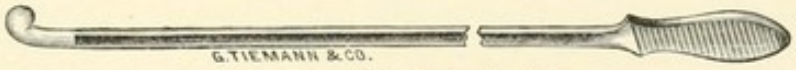


FIG. 191.—Wheelhouse's staff.

seized on each side by the straight-bladed nibbed forceps and held apart. The staff is then gently withdrawn until the button point appears in the wound. It is then to be turned around so that the groove may look to the pubes, and the button may be hooked into the upper angle of the opened urethra, which is thus held stretched open at three points —at two by the forceps, and at the third by the hook of the staff. The operator looks into it immediately in front of the stricture, inserts the director into the urethra, and, if he cannot see the opening of the stricture, which is often possible, generally succeeds in very quickly finding it, and passes the point onward through the stricture toward the bladder. The stricture is sometimes hidden among a crop of granulations or warty growths, in the midst of which the probe point easily finds the true passage. The director having been passed on into the bladder (its entrance into which is clearly demonstrated by the freedom of its movements), its groove is turned downward; the whole length of the stricture is carefully and deliberately divided on its under surface, and the passage is then cleared. The director is still held in the same position, and the straight probe-pointed bistoury is run along the groove to ensure complete division of all bands or other obstructions. These being thoroughly cleared, the old difficulty of directing the point of a catheter through the divided stricture is to be overcome. To effect this the point of the probe-gorget is introduced into the groove of the director, and, guided by it, is passed onward into the

bladder, dilating the divided stricture and forming a metallic floor along which the point of the catheter cannot fail to pass securely into the bladder. The short catheter is now passed from the meatus down into the wound; is made to pass once or twice through the divided urethra, where it can be seen in the wound, to render certain that no obstructing bands have been left undivided, and is then, guided by the probe-dilator, passed easily and certainly along the posterior part of the urethra into the bladder. The gorget is now withdrawn, the catheter fastened in the urethra and allowed to remain three or four days, the elastic tube conveying the urine to a vessel under or by the side of the bed. After three or four days the catheter is removed, and is then passed daily or every second or third day according to circumstances until the wound in the perineum is healed, and after the parts have become consolidated it requires to be passed still from time to time to prevent recontraction."

Great difficulty is sometimes experienced in finding the proximal end of the urethra, especially in traumatic strictures. If the bladder contain considerable urine and pressure be made over it, a jet of the liquid may reveal the opening of the urethra. The same result may be obtained by bimanual palpation, with the fingers of one hand over the bladder and those of the other hand in the rectum. Failing in this, the parts should be douched with hot water, when the urethra will become prominent by its being paler than the other tissues. Every effort to find the urethra having proved futile, the best way out of the difficulty is to perform a suprapubic cystotomy and make retrograde dilatation.

Choice of Operation.—Gradual dilatation is the simplest and safest operation, and is generally successful. It may fail in tight strictures close to the meatus, and then internal urethrotomy should be resorted to. Tight strictures of the bulbo-membranous region may resist all efforts at gradual dilatation; external urethrotomy is then to be chosen, especially if the stricture is of traumatic origin. Impassable strictures leave no choice, and must be treated by external urethrotomy.

Urinary Pouches.—A stricture or the presence in the urethra of a calculus sometimes causes a pouching or rupture of the urethra behind the obstruction, and the formation of a reservoir which holds a quantity of urine that is not expelled in micturition. This condition may be mistaken for urethral abscess, the preliminary to urethral fistula already mentioned.

Symptoms.—Urinary pouches appear as round or ovoid tumors along the course of the urethra. There is absence of pain and redness, but there is fluctuation. The swelling becomes more tense and prominent during the act of micturition, after which it is more relaxed, but does not disappear. The patient, having learned by experience that the tumor can be prevented from filling, makes pressure with the fingers of his right hand while he holds the penis in the left during urination. The urine which remains in the pouch in spite of this or other precautions dribbles away later on, soiling the clothing of the patient and causing great annoyance. In some cases the urethra is merely dilated, and then the urine contained in the pouch is always normal; in another class of cases there is a breach of continuity in

the urethral wall; a pouch forms in the same manner, but the urine is likely to contain pus or blood, and frequently ends in urinary fistula.

Treatment.—When the urethra is simply dilated the whole treatment must be directed against the obstruction which is the cause of the pouch. A calculus if present must be removed or a stricture remedied. When there is perforation of the urethra it is sometimes sufficient to retain a catheter and use mild compression externally. When there is an abscess it should be opened, and a catheter kept in the urethra to prevent the formation of a fistula.

VI. INJURIES AND DISEASES OF THE MALE GENERATIVE ORGANS.

Diseases and Malformations of the Penis.

The meatus, instead of opening in its normal position, in very rare cases is found to open at the side or in the dorsum of the penis. In absence of the bladder the ureters have been found to empty into the urethra, and the rectum has in very rare instances been known to have a similar outlet.

These malformations are of little practical value, but there are two others which require more extensive notice—viz. *hypospadias* and *epispadias.*

Hypospadias is a malformation the distinctive feature of which is an absence of the lower wall of the urethra, so that the canal opens on the under surface of the penis. The opening may be in the glans or in the spongy portion, or the urine may be expelled at the scroto-perineal junction. When the hypospadic opening is at the scroto-perineal junction there is a fissure in the scrotum, giving it the appearance of the external genitalia of the female; the penis is bound down to the fissure and may be very much atrophied. In the penile variety the opening may be at any point on the floor of the pendulous urethra, and an almost constant complication is a downward curvature of the penis. An opening within an inch of the normal position of the meatus may be attended with little inconvenience, and requires, as a rule, no treatment, but a penile, scrotal, or perineal hypospadia is one of the most distressing of abnormalities and requires operative interference.

Of the *diagnosis* there is little to be said, as the condition is self-evident.

Treatment.—Several operations have been devised, but the method of Duplay is the only one that has met with success. It consists of three stages:

1. *Straightening the Penis.*—This is done by making a transverse incision of the ridge which unites the hypospadic opening to the glans, the incision being carried to a depth which will secure complete straightening of the penis (Fig. 192, *A*). In this incision it may be necessary to go deeply into the corpora cavernosa, but this can be done without risk. When the organ is straight or but slightly curved this step of the operation is not necessary.

2. *The Formation of a New Canal from the Meatus to the Hypospadic Opening.*—The first point to demand attention is the formation of a meatus. The position of this opening is indicated by a depression in the

glans penis. The two lips of this depression are vivified as in Fig. 192, *B*. Between them is placed the tip of a catheter, and over this the edges of the freshened surfaces are secured by several catgut sutures. If the depression is too shallow, more room can be gained by making

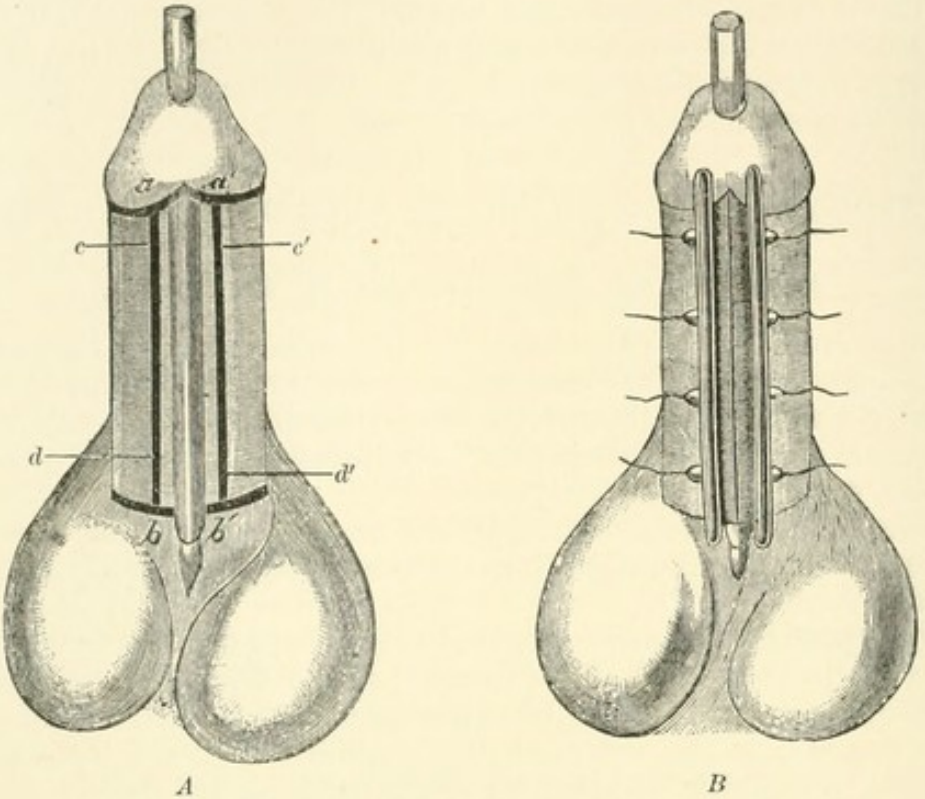


FIG. 192.—Duplay's operation for hypospadias (Duplay and Reclus).

two small lateral incisions, *a*, *a'*, or a single median incision in the substance of the glans. Next comes the formation of the new canal. Along the lower surface of the penis on each side of the middle line two incisions are made from the corona glandis to within a quarter of an inch of the hypospadic opening (Fig. 193). The internal lip at *a b* is dissected up and turned inward over the catheter, but not entirely covering it. The external lip, *c*, *d*, *c'*, *d'*, is freely dissected so as to separate the skin from the subjacent tissues, and so as to allow the skin of the sides of the penis to be drawn toward the middle line. The cutaneous surface of the lips at *a' b'* are turned toward the cavity of the canal, and their raw surfaces toward the outside and covered by the raw surfaces of the outer flaps. The edges of the flaps are united in the middle line by quilled sutures of silver wire, silkworm gut, or silk, and fastened with perforated shot.

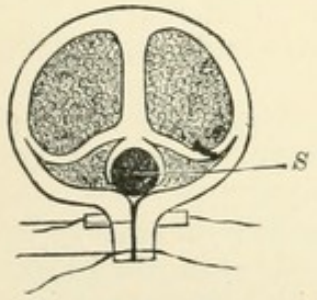


FIG. 193. — Transverse section of the penis after operation: *S*, the new urethra (Duplay and Reclus).

3. *Junction of the Two Portions of the Canal.*—This consists in closing the fistulous opening which still remains at the hypospadic orifice by freshening the edges and bringing them together by quilled sutures over the catheter. A retained catheter is employed to carry off the

urine during the healing process. The whole process of the cure of hypospadia is long and tedious. Three, four, or five operations may be necessary, and the treatment may extend over six or eight months.

Epispadias is a much rarer abnormality, and consists in a deficiency of the upper wall of the urethra. The operation for its cure is similar to that just described.

Phimosis is characterized by an unnaturally elongated condition of the prepuce, with so small an opening that it is impossible to uncover the glans. The condition may be congenital or acquired. The acquired form has already been described as a complication of balanitis and balano-posthitis. The congenital variety is important on account of the continual irritation kept up by it, leading in extreme cases to chorea, epilepsy, and other nervous affections. The glans is often adherent to the prepuce in whole or in part; the preputial orifice is usually small, sometimes little larger than a pinhole, and during micturition the prepuce become distended with urine. The secretion collects inside, and the danger of infection is greatly increased should the patient be exposed to venereal diseases.

Treatment.—When a corona glandis cannot be completely exposed without difficulty circumcision should be performed. The parts having been carefully disinfected, the prepuce is drawn well forward and grasped by a pair of forceps in front of the anterior extremity of the glans. The blades of the forceps should be an inch and a half in length, so as to grasp the whole width of the prepuce. With ordinary care there is no risk of wounding the glans, although this has happened in the hands of incompetent operators. With a sharp knife the foreskin in front of the forceps is removed. The prepuce is now allowed to retract, when it will be found that while the skin recedes to the corona or behind it the mucous membrane forms a hood over the glans. This membrane is slit in the middle line up to the corona, and then cut off all around at a distance of one-sixteenth of an inch from the point of reflection. This will be found to follow the line of the corona. The frenum should be spared unless there is marked hypertrophy at that point. The edges of the skin and mucous membrane should be approximated by interrupted catgut sutures. The most convenient dressing is a thin layer of absorbent cotton covering the incision and sealed over with iodoformized collodion. The end of the penis can be protected from irritation by absorbent cotton and a T-bandage.

Paraphimosis.—Should the glans be forced through a prepuce too narrow to admit it, constriction is sure to follow. The glans becomes swollen, congested, and edematous; the orifice of the prepuce forms a constricting ring, while the part of the prepuce behind falls forward like an edematous collar. Unless relieved, this condition ends in ulceration and sloughing. The glans should be pushed back in the manner described under Phimosis due to Gonorrhea. Failing in this, a director should be passed beneath the constricting ring and the constriction divided.

Carcinoma of the Penis.—Epithelioma of the squamous variety is the only form found upon this organ. It begins as a warty growth upon the glans or the inner surface of the prepuce, and it is said that phimosis is a predisposing cause. The wart soon breaks down and forms

an ulcer with very hard margins. The disease rapidly spreads by infiltration of the surrounding parts, and sooner or later the corpora cavernosa, the glans, and, secondarily, the lymphatics of the groin, become involved. The only disease with which it is liable to be confounded is syphilis. The ulceration of epithelioma is recognized by attention to the following points:

1. It is a chronic ulcer, with an irregular hard base and a foul, watery, or bloody discharge.
2. The growth infiltrates the tissues of the penis, and at the same time grows from its surface.
3. Antisyphilitic treatment has no effect upon the disease.
4. The inguinal glands become involved sooner or later.
5. Microscopic examination shows cancerous elements.

Treatment.—The only remedy is amputation, and in view of the rapidity of the growth this treatment should be resorted to at an early period. The operation was formerly done by a simple sweep of the knife, or at most by the formation of a flap of the skin to cover the surface of the wound. This method was followed by stricture of the orifice of the urethra and frequently by recurrence of the disease.

The best results are obtained by amputation of the entire penis, and the operation of Pearce Gould is now generally adopted. The method of its performance is thus described by Treves:

Operation.—"The patient having been placed in the lithotomy position, the skin of the scrotum is incised along the whole length of the raphé. With the finger and the handle of the scalpel the two halves of the scrotum are then separated quite down to the corpus spongiosum. A full-sized metal catheter is now passed as far as the triangular ligament, and the knife is inserted transversely between the corpora cavernosa and the corpus spongiosum.

"The catheter having been withdrawn, the urethra is cut across. The deep end of the urethra is then detached from the penis quite back to the triangular ligament. An incision is next made around the root of the penis continuous with that in the median line; the suspensory ligament is divided and the penis separated, except at the attachment of the crura. The knife is now laid aside, and with a stout periosteal elevator each crus is detached from the pubic arch. This step of the operation involves some time, on account of the very firm union of the parts to be severed. Four arteries—the two arteries of the corpora cavernosa and the two dorsal arteries—require ligature.

"The corpus spongiosum is slit up for about half an inch, and the edges of the cut stitched to the back part of the incision in the scrotum.

"The scrotal incision is closed by sutures, and a drainage-tube is so placed in the deep part of the wound that its ends can be brought out in front and behind. No catheter is retained in the urethra.

"In Gould's case—the operation was performed for epithelioma in a man aged seventy-three—there was no complaint of pain after the operation. The temperature reached the normal line on the fourth day, and on the sixth day the patient had regained complete control over the bladder. The skin-wound healed by first intention, the deeper

wound by granulation. The parts were completely healed in forty-six days."

Diseases of the Scrotum.

Edema and Inflammation.—Owing to the looseness of the tissues which form the scrotum, swelling may occur rapidly and attain an enormous size. Edema is recognized by its doughy feel, by its pitting on pressure, by the disappearance of the normal scrotal folds, and by the glossy character of the skin. It is commonly the result of dropsy in the lower extremities due to cardiac or kidney disease, but it may follow any acute inflammation of the part. Inflammation of the scrotum is common, but, like inflammation in other loose tissues, such as the eyelid, the swelling is out of proportion to the other symptoms, and need give no great uneasiness, as it is likely to disappear as rapidly as it came on. The most serious form of scrotal inflammation is that due to extravasation of urine. This is about the only form which is really dangerous, and it demands the most prompt and vigorous treatment of the extravasation. Eczema and the irritation of dribbling urine are also common causes of mild forms of inflammation.

Epithelioma of the scrotum differs little from this form of carcinoma in other situations. In the scrotum, however, it is almost invariably due to a definite cause—the irritation of soot, hence the name "chimney sweep's cancer." It appears as a wart with hard edges raised above the surrounding skin and irregular in shape. It spreads from the margin and ulcerates in the center. In the early stages it is confined to the skin and is freely movable, but later it becomes attached to the deeper tissues, spreads to the glands of the groin, and involves the penis. Removal of the growth by operation is very satisfactory if resorted to in time. It would be wisdom to remove any warty growth with hard edges and showing a disposition to spread. Even after the disease has invaded the glands removal is followed by a good percentage of recoveries.

Elephantiasis of the scrotum is common in some Eastern countries as *elephantiasis Arabum*. It is characterized by enormous hypertrophy of the skin and subcutaneous cellular tissue. It is often associated with repeated attacks of inflammation, such as attend urinary fistula, or it may depend upon lymphatic destruction and inflammation. From the scrotum it may extend to the penis, but never to the testicles.

Swellings of the Scrotum.—There is no part of the body in which so great a variety of swellings is met with as in the scrotum. In most of the cases presenting themselves for examination the patients consult the surgeon for the purpose of ascertaining the nature of some enlargement of these parts. A systematic examination should cover the following ground:

A. The swelling is confined to the scrotum. It is either edema, elephantiasis, epithelioma, or other tumor. Edema is associated with dropsy of the lower extremities, but it may be a result of extravasation of urine. Elephantiasis is a tropical disease, or it may be the result of repeated attacks of inflammation. Tumors found in connection with the scrotum are lipoma and epithelioma; other growths are rare.

B. The swelling is connected with the testicles or their coverings. It must be one of the following: orchitis, malignant disease, benign tumor, hydrocele, hematocele.

C. The swelling is connected with the spermatic cord. It is either an inflammation, a hydrocele of the cord, a varicocele, or a tumor.

Orchitis, or Inflammation of the Testicle.—This is easily recognized by pain, tenderness to touch, and its association with traumatism, gonorrhea, tuberculosis, or syphilis. It is convenient to divide orchitis into two varieties, acute and chronic. Acute orchitis is generally the result of traumatism, but may also be an extension of the inflammatory process from the epididymis or it may be metastatic, as in mumps. The pain is acute and the organ is very sensitive to the slightest touch. Swelling comes on rapidly, and the skin over the affected gland is red and glistening. Suppuration is not an uncommon result, especially in patients of low vitality.

Treatment.—The pain is kept up and greatly aggravated by the weight of the testicle; hence the first point in treatment is to support the scrotum and its contents by the use of a suspensory bandage or by a small pillow placed beneath the parts while the patient lies on his back. A brisk purgative often produces an immediate effect upon an acute orchitis, and should come in as a part of the routine treatment. In the early stages of the inflammatory process cold applications afford relief, especially in the form of lead-and-opium lotion; later the same application as warm as can be conveniently borne will be more successful. When there is great tension and the case resists the above remedies, an incision should be made into the tunica vaginalis.

Chronic orchitis is generally a complication of syphilis, and especially if confined to the body of the testicle. In gonorrhea and tuberculosis the swelling is likely to be confined to the epididymis. There is one character which distinguishes the syphilitic testicle, and that is its weight. It is remarkably heavy as compared with the normal organ or with the weight of the organ under any other diseased condition. Chronic orchitis of any kind is likely to produce atrophy of the testicle, or if suppuration begins the organ soon becomes riddled with sinuses and is finally destroyed. The diagnosis of chronic orchitis is very plain, but the variety of the inflammation—that is to say, whether it is syphilitic, tubercular, gouty, or malignant—is very necessary to determine.

Syphilitic testicle has an even, smooth surface when the deposit is distributed through the whole of the fibrous tissue of the gland. The organ retains its normal shape, but it is enlarged, hard, and heavy. When the condition is due to a single gumma or several separate gummata the swelling is uneven and nodular. It comes on slowly, is free from pain, and generally attacks both testicles simultaneously. A history of other manifestations of syphilis and the readiness with which the enlargement responds to antisyphilitic treatment need leave no doubt in the minds of the examiners. The form of testicular enlargement with which it is most likely to be confounded is the gouty, but the previous history will usually be clear enough to differentiate them.

Treatment.—Iodid of potassium acts speedily upon the swelling up to a certain point, when improvement ceases and a hard mass remains

as a permanent deposit. Mercury cannot be applied to the scrotum, but has a very good effect when rubbed into the skin of the inside of the thigh. It can be given internally in the form of the bichlorid. When every other form of treatment has failed and the testicle is disorganized, it should be removed by castration.

Tubercular Orchitis.—In many cases tuberculosis in the testicle is a manifestation of constitutional disease. The enlargement begins usually as a hard nodule at the back of the testicle or in the epididymis. Like syphilitic orchitis, it is frequently bilateral. In the advanced stages caseous degeneration causes a breaking down of the tissues, and should the infection of suppuration be superadded the whole organ may become riddled with abscesses.

Treatment.—The treatment must be carried out on the principles which govern the treatment of tuberculosis elsewhere. Residence at the seaside or a long sea-voyage is especially to be recommended. When the disease is confined to one testicle and has advanced to the destructive stage, the organ being riddled with sinuses, castration is advisable, care being taken to divide the vas deferens as high up as possible.

Gouty orchitis is exceedingly rare, and closely resembles the syphilitic form. It is not always easy to trace its connection with the gouty diathesis. The enlargement is confined to the testicle itself, the epididymis remaining unaffected. Like other manifestations of gout, this form of orchitis is painful, and in some cases the inflammation is severe.

Malignant Disease of the Testicle.—Carcinoma of the testicle appears as the encephaloid or soft variety. A peculiarity of cancer in this situation is that it attacks men comparatively young, the majority of cases being between twenty and forty. It is usually confined to one testicle, and appears as one or more small hard nodules in the body of the testis, the epididymis becoming involved later. At first the surface of the tumor is smooth and even, but as the growth increases and breaks through the tunica albuginea it becomes uneven, with hard and soft areas alternating. The progress of the disease is characterized by the horrible features which are inseparable from cancer. The growth is steady and may attain an enormous size; large veins traverse its surface; the skin becomes adherent, just as it does in cancer of the female breast; it ulcerates, and a fungous mass breaks forth covered with unhealthy granulations, foul smelling, and throwing off sloughs of connective tissue and even parts of the gland itself. This fungous mass is very vascular, bleeding on the slightest irritation, and sometimes threatening life by profuse hemorrhage. The epididymis has suffered early, the cord falls a victim later on, and the destroyer passes on to the glands and to distant organs till the life of the patient goes out in exhaustion.

Sarcoma may occur at any age, not even the unborn infant being exempt. The most of the cases are below ten or between thirty and forty. Following a law of sarcoma, the round-celled variety is the most malignant, and sometimes it is an impossibility to distinguish it from soft cancer; but practically it matters little, for both are terribly malignant, the same treatment is demanded, and, unfortunately, the

resources of our art are set at defiance by one as well as by the other.

In the other forms of sarcoma, the spindle-celled and the giant-celled, cysts are frequently met with, and sometimes cartilaginous formations. Sir Astley Cooper called these cysts "hydrated testicles." They must be distinguished from hydrocele and hematocele, and generally this can be done without difficulty, for the cystic testicle is heavier than a hydrocele and is opaque. Hematocele is more apt to cause confusion, but if a trocar be inserted the hematocele will be found to contain blood more or less altered, while the cystic growth produces little or no blood. Cartilaginous growths must always be looked upon with suspicion; theoretically they are benign, clinically they are almost sure to be associated with sarcoma. The features that distinguish sarcomatous from other enlargements of the testicle, according to Jacobson, are—1. Continuously progressive solid enlargement without inflammation; 2. Unequal resistance of the swelling at different parts; 3. Entire absence of translucency; 4. Tendency to become adherent; 5. Increasing aches or painfulness; 6. Enlargement of the cord and, *a fortiori*, of the lumbar glands.

Treatment.—No hope can be held out to a patient suffering either from carcinoma or sarcoma of the testicle, except by early removal of the gland. Even then the prospect of permanent cure is not bright. The operation, however, is attended with but slight danger, and, as it is almost sure to prolong life and lessen suffering, its performance should not be delayed.

Operation.—Castration is performed as follows: The parts having been shaved and disinfected, the skin is steadied by the thumb and fingers of the left hand, and an incision made from the external abdominal ring along the course of the cord and down to the lower end of the scrotum. This incision, however, is not advisable when the skin is adherent to the adjacent parts. An eliptical incision meeting above and below the adherent portion is the best under such circumstances. Layer by layer is divided; all are freely movable until the tunica vaginalis is reached, when it will be found to be immovable. The first layer, then, which is immovable is the tunica vaginalis. This should be opened for diagnostic reasons, and if necessary to reduce the size of the tumor. The cord having been separated from surrounding tissues and the tumor shelled out by the finger, aided here and there by touches of the knife, moderate traction is made upon the cord, and it is then tied off. This can be done in several ways: 1. The cord is grasped with a clamp, divided below the instrument, and the vessels tied separately. This is the safest and best method. 2. The whole cord may be tied *en masse* by a stout chromicized catgut or silk ligature, the ends cut off short and allowed to slip up into the canal. 3. A double ligature may be passed through the substance of the cord and the two halves tied separately (Jacobson). Some operators place a rubber drainage-tube in the inguinal canal in contact with the stump of the retracted cord, but this is unnecessary. The utmost care should be taken to ensure complete hemostasis before losing sight of the cord or closing the wound, for even the oozing of a small vessel may cause troublesome hemorrhage for days after the operation. In closing the

wound a blunt hook placed in each angle should be made to stretch the edges of the skin and prevent their turning inward by the action of the dartos.

Benign Tumors.—These may be cystic or solid. Hydatid and dermoid cysts are difficult to diagnosticate except by removal and examination of their contained fluids. Cystic adenomata grow slowly, are free from pain, and rarely appear before puberty. The solid tumors are fibromata and enchondromata. While cysts present a nodular appearance, these solid growths are smooth. The testicle is hard and heavy, thus simulating the syphilitic testicle.

Abnormalities of the Testicles.—The testicle sometimes fails to reach the scrotum, and remains at some point in the inguinal canal, in the abdominal cavity, or just outside the external abdominal ring. This abnormality is known as retained testicle. Its chief inconvenience consists in the liability of the organ to inflammatory attacks. It sometimes, when complicated with hernia, prevents the wearing of a truss, and is probably a predisposing cause of malignant disease.

Treatment.—Unless the retained organ gives trouble it is best to let it alone, no operation for placing it in its proper position having so far proved satisfactory. When it is producing trouble and the other organ is normal, castration is the proper course.

Absence of both testes is rare, but it is not very uncommon to find an individual who only possesses a single gland.

Hydrocele is a term applied to any collection of fluid about the

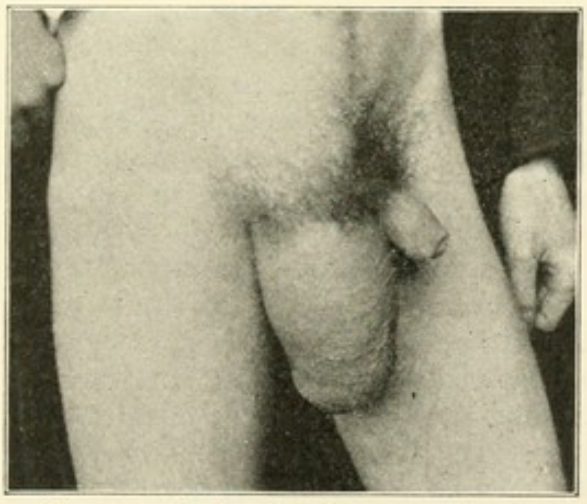


FIG. 194.—Hydrocele (Keen and White).

testicle or spermatic cord, but, as a rule, this fluid is confined in the tunica vaginalis. It occurs at any age, and may vary in size from a barely perceptible enlargement of the scrotum to a tumor of enormous dimensions. Traumatism, violent muscular effort, and relaxation of the scrotum by residence in tropical climates have been assigned as causes.

In the congenital form of the disease the peritoneal cavity communicates with the tunica vaginalis, thus allowing the abdominal serum to trickle down along the cord to the testicles.

The *diagnosis* of hydrocele is generally easy. The swelling is first observed at the lower end of the scrotum; it is smooth, tense, fluctu-

ating, and increases slowly. It is free from pain and other inflammatory symptoms. All these symptoms are not sufficient to differentiate hydrocele from other enlargements in the scrotum, but there is one sign which is pathognomonic, and that is the translucency of the tumor. If the patient be examined in a darkened room and the scrotal swelling held between the surgeon's eye and a lighted candle, the tumor will allow the light to pass through it; all other scrotal swellings are opaque. This test, however, is interfered with if the tunic is greatly thickened, as is sometimes the case, or if the serous fluid is mixed with blood. The aspirating needle should be employed in cases of doubt.

Inexperienced examiners are liable to mistake hernia for hydrocele, and *vice versâ*, and the writer has more than once been consulted because a truss for inguinal hernia could not be made to fit over a hydrocele. With ordinary care and a study of the symptoms this error need not occur. Except when strangulated a hernia has an impulse on coughing, and the swelling can be traced up to and into the inguinal canal. Both hernia and hydrocele may be present, but even then an impulse can be felt when the hernial portion of the swelling is grasped between the thumb and finger.

Hydrocele of the cord is recognized by its sausage shape and by its being connected with the cord.

Treatment.—Congenital hydrocele may be cured by a truss, which prevents the flow of serum from the abdominal cavity into the tunica vaginalis; failing in this, the neck of the sac should be ligated.

The treatment of other forms is palliative or radical. Palliative treatment consists in tapping the tunic as often as it becomes over-distended. The radical operation aims to obliterate the sac by the injection of iodin or carbolic acid or by incision. Tapping is thus performed: The position of the testicle having been ascertained, the skin and trocar disinfected, the left hand grasps the tumor so as to render the skin tense. The trocar is grasped by the thumb and finger of the right hand so as to form a guard which will prevent the instrument being thrust in too far, and is then by a quick movement made to perforate the scrotum. If the object is simply palliative, the trocar is withdrawn and the fluid allowed to escape through the cannula. In the radical operation the fluid is withdrawn, and then the cavity is injected with five or six drams of the undiluted tincture of iodin, which should be caused to permeate every part of the sac by shaking up the scrotum or gently kneading it. The opening made by the trocar is closed by iodoformized collodion. Instead of tincture of iodin, some surgeons use from five to ten drops of pure carbolic acid in sufficient water to keep it in a liquid state. It produces less irritation than iodin.

For the first two days after injection the swelling may return to its former size and the parts become violently inflamed, but this soon subsides and a cure may be expected at the end of three or four weeks.

Incision is an effectual method of dealing with hydrocele. It consists in laying open the tunica vaginalis for a distance of about an inch and a half and stitching the edges of the tunic to the skin. A drainage-tube is inserted or the cavity packed with iodoform gauze and allowed to heal by the open method.

Hematocele is a condition in which the tunica vaginalis is distended with blood. It sometimes occurs after tapping a hydrocele or it may follow a traumatism or inflammation of the tunic. The tumor is ovoid in shape, but broader at its most dependent part. It does not fluctuate, but is hard, opaque, and heavy. Difficulty may arise in distinguishing it from an old hydrocele with thickened walls, and from tumor of the testicle. In some cases this point can only be decided by exploration or incision.

Traumatic hematocele is easily recognized by the rapidity with which the symptoms develop, a tumor of considerable size forming in a few minutes or a few hours at most.

Treatment.—In acute traumatic cases the patient should lie in bed with the scrotum supported on pillows, while cold and moderate pressure are employed to check the extravasation of blood. Failing to get rid of the hematocele in this manner, and especially if the case is of long standing, the proper course is to lay the part open by an incision, turn out the clots and fibrinous deposits, examine the testicle, and remove it if diseased or disorganized, pack the cavity with iodoformized gauze, and allow it to heal by granulation.

Inflammation of the spermatic cord very rarely occurs as a primary affection, but as a sequel of gonorrheal or syphilitic orchitis it is not uncommon. The cord is hard, tender to the touch, and painful, especially when the weight of the testicle drags upon it. The constitutional symptoms are often well marked, but it is seldom that the disease proceeds to suppuration. The treatment is that of other local inflammations, with attention to the specific disease which may be acting as a cause.

Hydrocele of the Cord.—Two varieties are recognized—*diffused* and *encysted*, the latter being the more common.

Diffused Hydrocele.—This variety arises as follows:

In its descent to the scrotum the testicle carries with it a double layer of peritoneum, which goes to form the serous sac lining the inguinal canal: one layer is in contact with the spermatic cord and the tunica albuginea, the other with the inner surface of the cremaster muscle and the scrotum. Between these two layers, as they surround the testicle, is the space known as the tunica vaginalis. In normal development the space between the two layers becomes obliterated at the lower end of the inguinal canal, so that the two become blended into one as they invest the spermatic cord. Sometimes, however, this blending does not take place, and the layers remain separate in the inguinal canal. If serum accumulates in this space, it forms a tumor resembling a sausage and extending from the internal abdominal ring almost to the testicle. It is readily recognized by fluctuation and by its shape. When the patient stands up, the fluid, gravitating to the lower end of the canal, gives the tumor a pyriform appearance. The same effect can be produced by pressure downward along the course of the cord. The similarity of this tumor to omental hernia is likely to mislead the unwary, especially when it has an impulse on coughing, as is sometimes the case. Care should be taken to note the change in shape brought about by the position of the patient, the fluctuation at the lower end of the tumor, and its bulging when pressure is

made downward along the course of the cord. It must also be remembered that both hydrocele and omental hernia may coexist.

Treatment.—The tumor can be aspirated and injected with iodin as an ordinary hydrocele.

Encysted Hydrocele.—When the two layers of the covering of the cord are blended in several places, the intervening spaces remaining separated, and when these spaces become distended with serum, the condition is known as encysted hydrocele (Fig. 195). While the patient stands erect the symptoms resemble those of the diffuse form of hydrocele, but on assuming the recumbent posture the tumor disappears slowly. This distinguishes it from hernia, for the latter goes up quickly and has its peculiar gurgle.

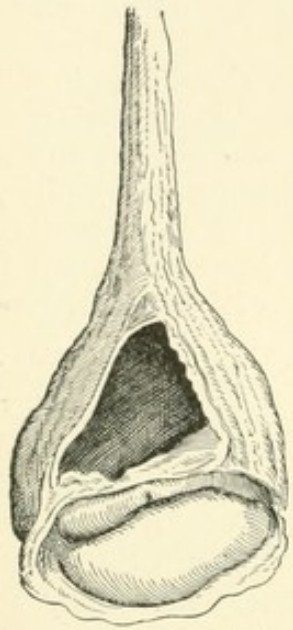


FIG. 195.—Encysted hydrocele.

Treatment.—This form can usually be cured by wearing a truss. In infants simple puncture is often sufficient. Failing in this, a silk thread should be passed through the tumor, loosely knotted, and left to act as a seton for forty-eight hours. This operation should be carried out with aseptic care and the part covered with an aseptic dressing. A sufficient amount of inflammation is thus established to cause obliteration of the sac.

Varicocele.—The term varicocele is applied to a dilated and tortuous condition of the veins of the spermatic cord. Two groups of veins exist in the cord—the anterior, accompanying the spermatic artery and forming the pampiniform plexus; it is this group which is most commonly involved in varicocele. The posterior group attends the spermatic artery and surrounds the vas deferens. Occasionally this group also becomes varicose. Varicocele occurs almost universally on the left side, and for this clinical fact the following reasons have been assigned: 1. The left vein as it enters the renal vein has no valve. 2. It is longer than the corresponding vein on the right side. 3. It enters the renal vein at a right angle to the current of the blood. 4. It passes behind the sigmoid flexure and is subject to occasional pressure.

Symptoms.—No great skill is required for the diagnosis of varicocele. The scrotum contains a soft mass resembling a bunch of worms. There is usually no acute pain, but a dull aching is commonly present. The scrotum hangs down loosely and is of a purplish color, and the tortuosities of the veins can be seen through the skin. Perspiration on that side of the scrotum is usually present. The testicle is generally soft and sometimes atrophied. Like many other disorders of the sexual system, varicocele is apt to produce a form of melancholia, and many patients erroneously get the idea that they are impotent.

Treatment.—Palliative treatment consists in wearing a suspensory bandage, and nearly every patient who consults a surgeon for varicocele comes clothed in this regalia. For mild cases attended with no pain or inconvenience this is satisfactory, but when pain and constant aching are present, when the testicle is gradually wasting away or the

patient's mental condition threatening to prove serious, something of a more radical nature is demanded. Two operations are in common use, either of which can be recommended.

I shall mention first the operation of incision of the veins, with shortening of that side of the scrotum, as it is the most thorough and satisfactory when properly performed.

In any operation upon the cord the vas deferens must be located and kept out of harm's way. It lies at the posterior and inner aspect of the cord, and is recognized by its tough, leathery feel. It has a persistent way of slipping out of the grasp of the thumb and finger.

Operation.—The parts having been shaved and thoroughly disinfected, an assistant locates the vas deferens and keeps it out of the way, while at the same time he makes tense the skin of the scrotum. The operator then makes an incision for about two inches over the most prominent part of the varicocele. The group of veins is exposed, but not separated from one another, and at the lower end of the incision an aneurysmal needle is passed beneath the group, carrying a short catgut ligature. This is securely tied and one end cut short. A ligature is applied in a similar manner at the upper angle, and one end cut short as before. The portion of the plexus lying between the ligatures is then removed by scissors. The two long ends of the ligatures are next tied together, thus shortening the cord and raising up that side of the scrotum. The incision in the skin is closed with a continuous catgut suture and a proper dressing applied.

The second operation is that of Keyes. The vas deferens being kept well in the background, a needle armed with stout aseptic silk is passed through the scrotum between the vas and the group of veins, and left in position; a second needle, threaded with the free end of the same thread, is entered beside the first needle, and, after passing through the skin and dartos, is carefully made to surround the veins and emerge beside the first needle at the opposite side of the scrotum. Both needles are now drawn through, thus placing a loop around the veins. The silk is securely tied in a single square knot and the ends cut short. The two layers of scrotal skin are now separated, and the knot slips within the dartos, where it becomes encapsulated. The small openings made by the needles can be sealed with iodoformized collodion: the patient should remain in bed one day and keep in-doors for four or five days longer.

CHAPTER VIII.

INJURIES AND DISEASES OF THE HEAD.

I. CEREBRAL TOPOGRAPHY.

INJURIES of the scalp and of the bones of the cranium would have no special importance were it not for the danger of brain-complications, which danger is ever present in such traumatisms. A wound of the scalp heals as readily as a wound of the soft parts in any other portion

of the body, but unless the greatest care be taken in its treatment such a wound may become infected, and the infection may thence be carried to the brain or its membranes. A fracture of the skull, as far as the bone itself is concerned, is unimportant, for union readily takes place, and there is not so much thickening at the point of union as is usually found in repair of other bones. But fractures of the skull are exceedingly grave injuries, from the fact that the fragments almost invariably cause direct compression of the brain or produce hemorrhage, which is a source of danger no less grave. Before proceeding to the injuries of the head the brain itself must claim our attention.

An organ so essential to the economy, so highly developed, so exquisitely delicate and sensitive, must of necessity be well protected. The skull is the strong casket which contains this precious jewel, and to this end it is admirably adapted. It is formed of strong bones, with additional strength where most exposed to violence, presenting a convex surface from which blows glance and missiles are deflected. Within the cranium cushions of cerebro-spinal fluid support the brain and break the force of shocks and jars to which it would otherwise be exposed.

The strong and unyielding skull, however, is, under certain conditions, a source of danger to the brain. When inflammation attacks the organ or its membranes, when pus accumulates or blood is extravasated, there is no room for expansion; brain-pressure soon follows, showing its presence by paralysis or by other manifestations of functions impaired or entirely destroyed. Dangers from this source are not only immediate, but remote, assuming at more or less distant periods the form of epilepsy or insanity.

Although the functions of the various regions of the brain are still imperfectly understood, a wonderful amount of light has been thrown upon this subject in recent years. For our knowledge in this interesting field of study we are indebted to Broca in France, Fritsch, Goltz, and Hitzig in Germany, and Ferrier and Horsley in England. Their investigations have demonstrated the fact that different parts of the brain preside over different motions of the body. The functions of certain areas are pretty definitely understood, while other parts are still a *terra incognita*.

There are five areas whose functions have been demonstrated; they are—1. The sensori-motor area; 2. The area which presides over speech; 3. The area of vision; 4. The area of hearing; 5. The area of sensations of smell and taste.

1. **The Sensori-motor Area.**—To comprehend the limits of these areas let us examine the outer surface of the left hemisphere of the brain (Fig. 196).

The cerebrum is divided into two hemispheres, the right and the left. The gray covering or cortex of each hemisphere presents three surfaces—the lateral, the median, and the basal. The most interesting to surgeons is the lateral surface, in the study of which we recognize certain fissures, lobes, and convolutions. It has four lobes—the frontal, parietal, occipital, and temporal. Each lobe is furrowed by certain fissures or sulci, and between these lie the convolutions or gyri.

The frontal lobe (*F*) contains two sulci, the superior and inferior (f_1 and f_2). It also contains the following convolutions: the superior,

median, and inferior frontal (F_1, F_2, F_3), and the ascending frontal or anterior central convolutions (A).

The Parietal Lobe.—Between the frontal and the parietal lobe is the fissure of Rolando (c). This lobe contains the posterior central convolution (B) and the superior and inferior parietal lobules (P_1, P_2). The inferior parietal lobule is subdivided into the supramarginal convolution at the posterior limit of the fissure of Sylvius, and the angular gyrus bending round the posterior limit of the temporo-sphenoidal fissure (P_2).

The temporal lobe lies between the fissure of Sylvius and the cerebellum. It contains the first and second temporal fissures and the first,

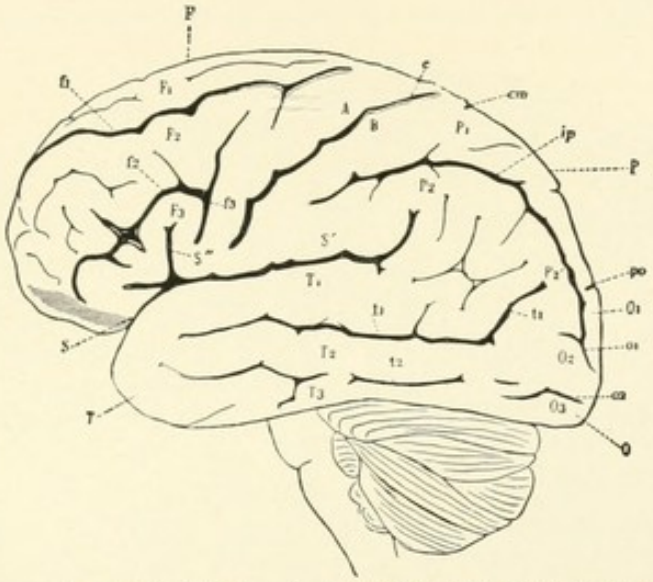


FIG. 196.—Outer surface of the left hemisphere (Ecker): A, anterior central or ascending frontal convolution; B, posterior central or ascending parietal convolution; c, sulcus centralis or fissure of Rolando; cm, termination of the calloso-marginal fissure: F, frontal lobe; F_1, superior, F_2, middle, and F_3, inferior frontal convolutions; f_1, superior, and f_2, inferior frontal sulcus; f_3, sulcus præcentralis; ip, sulcus intraparietalis; O, occipital lobe; O_1, first, O_2, second, O_3, third occipital convolutions; o_1, sulcus occipitalis transversus; o_2, sulcus occipitalis longitudinalis inferior; P, parietal lobe; po, parieto-occipital fissure; P_1, superior parietal or postero-parietal lobule; P_2, inferior parietal lobule—viz. P_2, gyrus supramarginalis; P_2', gyrus angularis; S, fissure of Sylvius; S', horizontal, S'', ascending ramus of the same; T, temporo-sphenoidal lobe; T_1, first, T_2, second, T_3, third temporo-sphenoidal convolutions; t_1, first, t_2, second temporo-sphenoidal fissures.

second, and third temporal convolutions, or the superior, middle, and inferior convolutions, as they are sometimes called.

At first thought one might expect to find that the boundaries of these areas would follow the lines of the lobes and convolutions, but such is not the case. It is interesting to note that the relative positions of the motor centers correspond with the relative positions of the parts over which they preside. Instead of inscribing the names of the parts controlled, I have had drawn upon the brain itself the figure of the body (see Fig. 197), showing at a glance the whole field of cerebral localization and adding new interest to this absorbing study. It looks as if the Almighty had traced his own image upon the masterpiece of his handiwork, and recorded the crowning triumph of creation in a language which we are just beginning to learn, and in characters which we hope soon to decipher.

The first landmark to which we must direct our attention is the

fissure of Rolando (*c*). It may be compared to a ravine, one bank of which is formed by the anterior central convolution, the other by the posterior central convolution. In the cortex of this area and in the adjacent cortex in front and behind is located the sensori-motor area. The left hemisphere of the brain presides over the right side of the body, and the right hemisphere over the left side. Roughly speaking, the upper one-third of the sensori-motor area controls motions of the lower extremity of the opposite side, the middle third controls the upper extremity of the opposite side, and the lower third presides over the movements of the face (see Fig. 197).

To be more precise: let us first examine the upper third or the area of the leg. The fissure has in front of it the anterior central convolu-

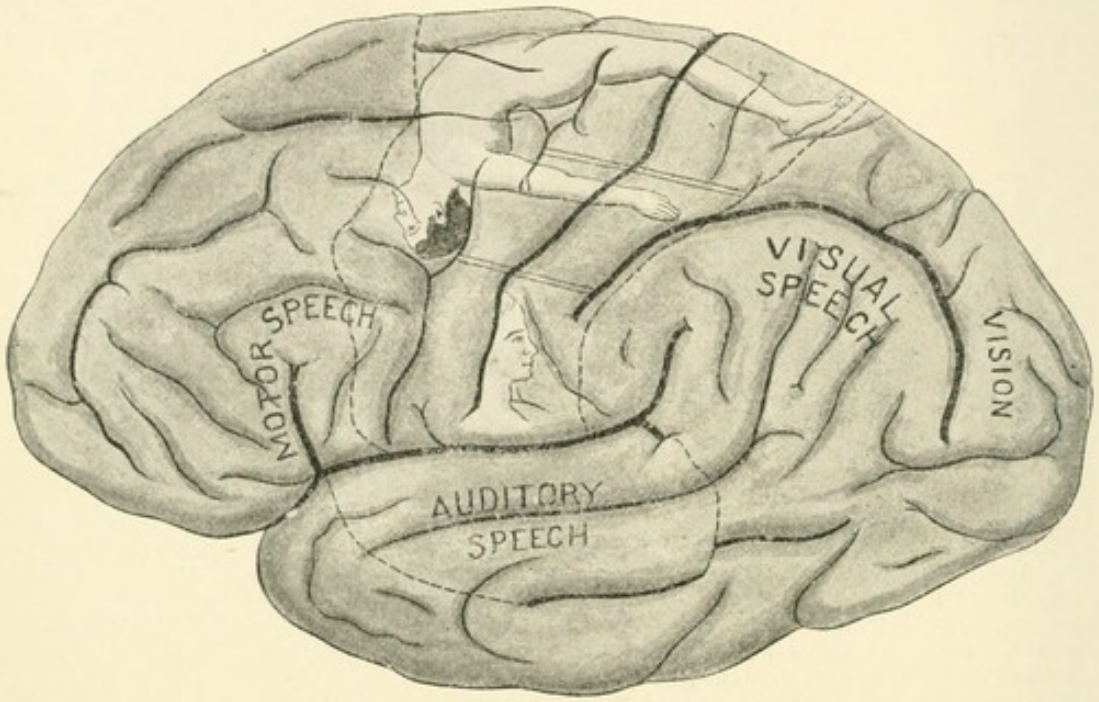


FIG. 197.—Cerebral localization.

tion, and posterior to it is the posterior central convolution. Proceeding from before backward, we find that the anterior central convolution controls motions of the thigh, and the posterior central convolution controls movements of the leg, foot, and toes. In front of the thigh district is supposed to be the region which controls movements of the trunk (Fig. 197).

In the *middle third* of the fissure of Rolando and in the convolutions on each side of it is the *arm center*. Well forward in the posterior part of the second frontal convolution is the area which governs the movements of the head and eyes. Proceeding backward, we find the area for the shoulder and elbow in the anterior central convolution, and, crossing over the fissure, we come upon the district of the wrist, fingers, and thumb in the posterior central convolution.

In the *lower third* of the fissure and the anterior and posterior central convolutions is the area which governs the face, tongue, pharynx, and larynx. The upper and anterior portion of this area controls the eyebrows and cheeks, the lower and forward part the tongue and

larynx, and the posterior part the mouth, pharynx, and platysma myoides.

When we say that a given area controls a certain motion or a certain part of a limb, we must not assume that the area in question ends abruptly. This is in accordance with Nature's laws. The colors of the rainbow are not sharply defined, but beautifully blended. The light of day does not suddenly cease and the darkness of night begin, but the atmosphere catches the departing rays, and, refracting them to the earth, changes day into night through the mellow light of the gloaming. So it is with the brain: each motion or each part of a limb has a special point which controls it in a pronounced manner, but shading off from this point the neighboring cortex controls it also, the power lessening as we go away from the special focus. If, for instance, the portion of the brain which controls the motion of the thumb be removed, paralysis of the digit will not follow, for the thumb is represented, although in a less degree, in the neighboring areas. It is interesting to note that the coarser movements, such as motion of the head, the shoulders, the trunk, and the thighs, have their centers in the anterior portions of the motor area, and as we proceed backward the movements which are represented are of a more and more delicate character. Thus the delicate movements of the face, the lips, the fingers, and the toes have their centers in the posterior part of the motor area. Proceeding backward, the centers of sensation probably occupy the region next in order (Fig. 197), and lastly, the most delicate of all, the seat of vision.

2. **The Area of Speech.**—Speech has a wide representation and occupies four areas in four different locations—viz.:

(*a*) *Motor speech*, or the movements required in the production of speech, is represented in the posterior part of the third frontal convolution, on the left side in right-handed persons and on the right side in those who are left-handed. Just behind the coronal suture and running parallel to it is the precentral or vertical sulcus (f_3, Fig. 196). It is the anterior boundary of the motor area. It lies in front of the fissure of Rolando, and is separated from it by the width of the anterior central convolution. Around the lower end of this sulcus the anterior central convolution makes a bend, and lies in the hollow formed by the limbs of the fissure of Sylvius. This area is called the operculum, and in it is Broca's center for speech. The symptoms produced by disease in this area are loss of the use of language and the power of speech. The loss of power to convey our thoughts by writing is called agraphia. The center representing this power is not definitely settled, some cases going to show that it is in Broca's center, others that it is near the area of the hand and wrist.

(*b*) *The Auditory Speech-area.*—In the first and second temporal convolutions is the area which receives the sounds of words and retains the memories of these sounds. Disease in this region causes the person to lose the memory of words, to be unable to recollect the names of the most familiar objects, and to fail to understand language when he hears it.

(*c*) *The Area of Visual Speech.*—A person may be able to see the words of printed language, but may not understand them, and is

thereby unable to read. Such symptoms would indicate disease in the inferior parietal region.

3. **The Area of Vision.**—This centre is situated in the cuneus and the occipital lobe of the brain. Disease here causes blindness in half of both retinæ, and to this condition the name hemianopsia has been applied. From the right half of each retina impressions are conveyed to the left side of the brain, and from the left half of each retina to the right cerebral hemisphere. Disease of the visual area therefore causes blindness of the right or left half of each retina according as the left or right side of the brain is affected.

4. **The area of hearing** is located in the first and second temporal convolutions. Disease of this area, if confined to one side of the brain, does not produce deafness, for the reason that each ear has a connection with both hemispheres. If both sides of the brain are diseased, deafness is complete.

5. **Smell and taste** are represented at the tip of the temporal lobe (Fig. 196), but the clinical value of changes in these senses is not very great. In the first place, both are easily blunted or modified from trifling causes, and, in the second place, each is represented on both sides of the brain.

The surgeon, in order to deal with injuries and diseased conditions of the brain, must be able to locate the various areas on the outer surface of the skull. For finding the fissures certain rules have been laid down, which we shall now consider:

1. *The fissure of Bichat*, which lies between the cerebrum and cerebellum, is readily located by drawing a line from the external auditory meatus to the external occipital protuberance. This line, continued around the occiput to the opposite meatus, corresponds to the lateral sinus.

2. *The fissure of Rolando* is the most important of all the fissures from a surgical standpoint, for on each side of it lies the sensori-motor area. The upper limit of the fissure is thus located: Measure the distance from the glabella to the external occipital protuberance; at a point which represents 55.7 per cent. of this distance is the beginning of the fissure. For all practical purposes a point a half-inch behind the middle of this line is sufficiently accurate. The fissure runs downward and forward at an angle of 67°; the next point, therefore, is to find that angle, and for this purpose several expedients have been adopted. The simplest and readiest is that of Mr. Chiene of Edinburgh. A square piece of paper (Fig. 198) is so folded as to bisect one of its angles, B A D. The result is an angle of 45°, B A C. The angle D A C is again bisected by folding the paper on the line A E, and the result is an angle of 22½°. The angle B A C (45°), plus the angle C A E (22½°), makes an angle of 67½°, which is near enough for all practical purposes. The side A B is then applied to the middle line of the scalp,

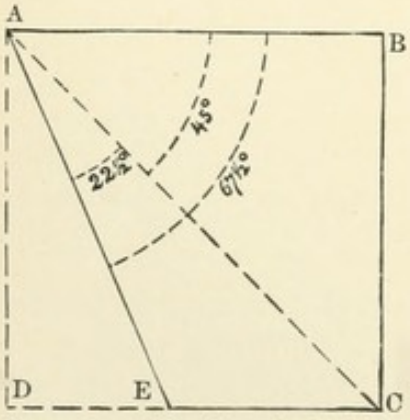


FIG. 198.—Chiene's method of fixing position of Rolandic fissure.

so that the point A is half an inch posterior to the middle of the line between the glabella and the external occipital protuberance.

The line A E will represent the position of the fissure of Rolando.

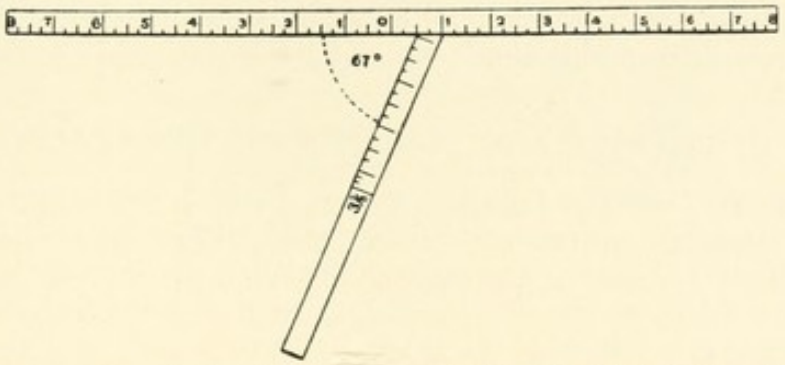


FIG. 199.—Horsley's cyrtometer (as modified by Dr. Morris J. Lewis).

The length of the fissure is $3\frac{3}{8}$ inches. The upper third of this line will indicate the position of the leg area, the middle the arm area, and the lower the face.

Another method of finding the angle of the fissure of Rolando is that recommended by Horsley. He has devised a cyrtometer consisting of two strips of metal or parchment-paper, as represented in Fig. 199, the long arm of which is 14 inches in length; to this a lateral arm is attached at an angle of 67°. The long arm is graduated each way from a zero point half an inch in front of the short arm. The long arm is applied to the middle line in such a way that the glabella and the external occipital protuberance will each mark the same distance from the zero point. The short arm, being half an inch behind this point, will correspond with the fissure of Rolando, and the figures $3\frac{3}{8}$ on the scale will represent the length of the fissure.

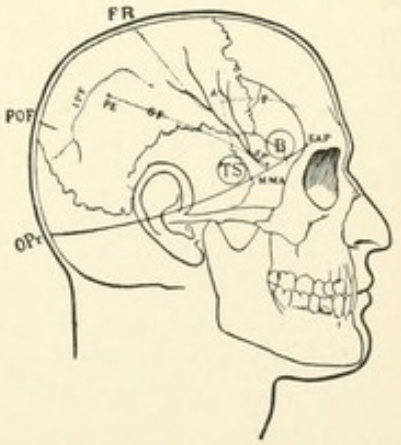


FIG. 200.—Head, skull, and cerebral fissures (adapted from Marshall by Hare): *B* corresponds to Broca's convolution; *EAP*, external angular process; *FR*, fissure of Rolando; *IF*, inferior frontal sulcus; *IPF*, intraparietal sulcus; *MMA*, middle meningeal artery; *OPr*, occipital protuberance; *PE*, parietal eminence; *POF*, parieto-occipital fissure; *SF*, Sylvian fissure; *A*, its ascending limb; *TS*, tip of temporo-sphenoidal lobe. The pterion (to the left of *B*) is the region where three sutures meet—viz. those bounding the great wing of the sphenoid where it joins the frontal, parietal, and temporal bones.

3. *The fissure of Sylvius* is found as follows: First draw a base line from the lower margin of the orbit to the auditory meatus; draw a line parallel to this from the external angular process running backward one inch and a quarter and then upward one quarter of an inch. This point represents the beginning of the fissure of Sylvius. From it to the parietal eminence draw another line, and it will represent the course of the fissure, which is four inches in length. The anterior limb of the fissure is two inches behind the external angular process. Another method of finding the fissure of Sylvius is as follows: From the external angular process (Fig. 200), E A P, to the external occipital

protuberance draw a line passing about half an inch above the auditory meatus. At a point upon this line one and one-eighth inches from the external angular process draw another line to the parietal eminence, P E; this corresponds with the main branch of the fissure of Sylvius. The anterior ascending branch follows the squamoso-sphenoidal suture for its entire length and ascends about half an inch higher.

II. INJURIES AND DISEASES OF THE SCALP.

Contusions.—Bruises of the scalp are frequently met with, and claim special attention owing to one peculiarity—namely, the resemblance of their symptoms to those of fracture of the skull. When a blow is received upon the head, swelling begins almost at once, and is due to extravasated blood and effused serum. The swelling is soft in the center, and is sharply defined at the circumference, instead of blending with the surrounding parts. These features give the appearance of a depressed fracture, and should there chance to be a small ruptured vessel in the center, pulsation of the brain is very closely simulated.

The *diagnosis* between this and depressed fracture is made by pressing firmly with the finger at the bottom of the depressed area. If it is a simple contusion, the surface can be still further indented and the smooth bone can be felt beneath. The surrounding swelling "pits" on pressure. This is not the case in fracture. When the bone is depressed there is also compression of the brain, as a rule, while this is absent in contusion, unless there is at the same time rupture of a vessel within the skull which is forming a clot of blood on the cerebral surface. Compression caused in the last-mentioned manner does not come on immediately after the receipt of the injury.

The treatment of contusions consists in moderate pressure and the application of lead-and-opium lotion.

For the relief of swelling and pain massage acts most satisfactorily. If a slight abrasion of the skin is made by the blow, suppuration may follow and an abscess form beneath the scalp, which must be promptly evacuated.

The most important part of the treatment consists in guarding against complications; for symptoms of inflammation of the brain may set in or inflammation may extend over the whole scalp, or a traumatic aneurysm may form beneath the scalp, any of which must be met with its appropriate treatment.

Cephalhematoma, or **caput succedaneum,** is readily recognized as a soft tumor seen on new-born infants, and generally at the parieto-occipital region. It is the effect of prolonged pressure during labor. In most cases no treatment is required, the swelling disappearing at the end of two or three days. Should it prove unusually obstinate, as I have seen in two cases, the fluid may be aspirated and pressure applied.

Wounds of the scalp would not need special mention were it not that they are liable to be followed by serious consequences which do not threaten wounds of other parts. Patients suffering from scalp-wounds are usually taken to the nearest drug-store, where an artistic dressing of strips of sticking plaster is arranged in a stellate or a tessellated pattern. Of all dressings, probably sticking plaster is the worst; it is

not aseptic, and it confines the pus which is sure to form in a wound so treated. From the scalp the pyogenic germs may find their way along the vessels which perforate the skull, and thus reach the brain itself.

In dressing a wound of the scalp the greatest care should be taken to cleanse the injured part. The hair should be shaved for some distance around the incision; all impurities should be got rid of by washing with sterilized water and then with sublimate solution. In lacerated wounds an attempt should be made to save even flaps of skin which are only attached by narrow pedicles, for the blood-supply of the scalp is so abundant that the vitality of these pieces is likely to be maintained. The edges should be brought together and held by stitches of catgut or silkworm gut, and an antiseptic dressing applied. For small wounds here or elsewhere iodoformized collodion forms a simple and easily applied dressing.

Tumors of the Scalp.—The most common by far of scalp-tumors are *sebaceous tumors*, or *wens* (Fig. 201). They are readily recognized

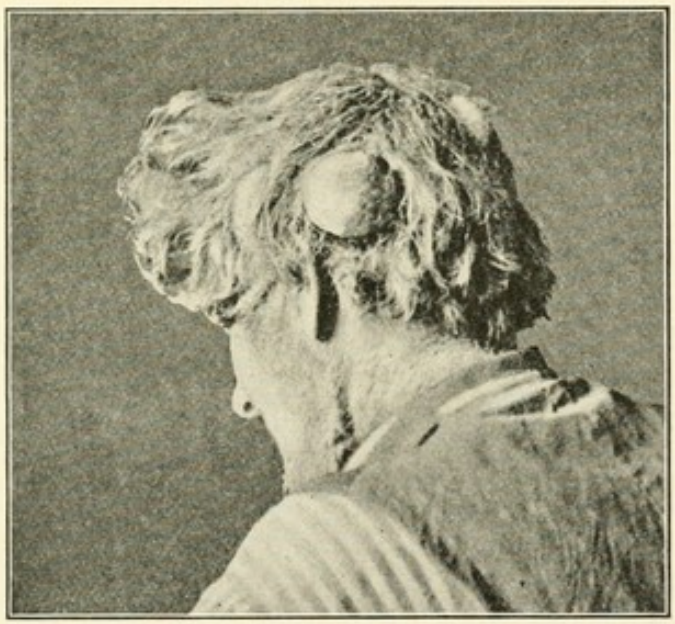


FIG. 201.—Sebaceous cysts of scalp (from a photograph in the collection of Dr. Lincoln).

by their rounded, even shape and their being painless. They cause inconvenience simply by their awkward position, the patients complaining that the tumors annoy them when combing their hair or interfere with the headgear. They are usually single, but frequently multiple, and their growth is slow.

The *treatment* is extirpation. After disinfecting the scalp the hair can be parted over the tumor and an incision made through the skin down to the cyst, which can generally be dissected out without evacuating the contents. Or the whole tumor may be transfixed with a scalpel and the cyst-wall grasped with forceps and pulled out. In any case the cyst-wall must be totally removed. The skin is brought together with sutures and a dressing applied.

Fatty tumors are sometimes seen on the scalp, and they may be confounded with wens. They are, however, flatter and more deeply seated. An error in diagnosis is of no consequence, as the treatment of both is extirpation.

Horns and **warts** are easily diagnosed. Horns should be removed by an incision including their base. Warts, if showing a tendency to rapid growth, are probably malignant, and should be extirpated.

Pneumatocele, or a tumor containing air, has been found on the scalp in 10 cases reported by Treves. The tumor is recognized by its being painless, smooth, elastic, and tympanitic. It is produced by erosion of the osseous tissue, allowing escape of air from the mastoid cells into the subcutaneous tissue.

The *treatment* is pressure after evacuation of the air by a hypodermic needle.

III. INJURIES OF THE SKULL.

Contusions.—In other parts of the body a contusion of bone is liable to be followed by osteo-myelitis, and such is the case in bones of the skull; but the mischief does not end here, for a chain of symptoms may follow such an injury, showing that the inflammatory process has spread from the bone to deeper structures. The blow which causes contusion of bone may produce hemorrhage between the pericranium and the skull. The effusion of blood and the inflammation which follow strip the periosteum from the bone and necrosis is the result; or the blow may crush the cancellous tissue or rupture the veins of the diploë, or the vessels which run between the dura mater and the inner surface of the skull may be ruptured, and hemorrhage occur in that situation. The effects of a contusion of the skull may be summed up as follows:

1. Osteo-myelitis with separation of the pericranium. The symptoms here are local pain and tenderness, inflammation, and perhaps the formation of an abscess. There is dull headache, but the constitutional symptoms are slight. The osteitis may be acute or may continue for years. A very characteristic symptom of osteo-myelitis of the skull is the so-called "puffy tumor" of Pott. It is a flattened, circumscribed swelling over a spot which is very tender on pressure.

2. The inflammation may extend to the dura mater. If blood has been poured out at the time of the injury, so as to separate the dura mater from the bone, the condition is thereby rendered more serious. The symptoms are still local. Inflammatory products or a collection of pus may produce pressure-symptoms, but, as a rule, it is only when the third step is reached that these signs appear.

3. The inflammation extends to the arachnoid. Up to this point the inflamed area is localized, but now it extends over the surface of the membrane. From this membrane the extension to the pia mater and the brain itself is unimpeded. The symptoms change accordingly. The patient complains of malaise, headache, stiffness of the muscles of the neck, giddiness, chilliness, nausea, and vomiting. The temperature rises, and the senses of sight and hearing become abnormally acute. The location of the disease and its gradual advance can, in some cases, be followed by noting the effects upon the motor areas. Thus a loss of motion of the arm, followed by a similar loss in the leg, would indicate a spread of the inflammation upward along the sensori-motor area, and would also be an indication to trephine the skull over the part of the brain suffering pressure. If the disease advances, stupor, drowsi-

ness, paralysis, and coma supervene, and the patient dies. After a blow upon the head we should watch carefully for cerebral symptoms, not feeling that the patient is safe until three weeks shall have passed without appearance of this complication. The second week is probably the most critical period.

Treatment.—The smallest breach of skin upon the head should be dressed with great care, lest septic germs should gain an entrance to the contused bone and its coverings. The treatment must aim at preventing osteo-myelitis, meningitis, and inflammation of the brain itself. Perfect quiet should be maintained and the simplest diet enjoined. The bowels should be kept freely open by calomel or other purgatives. Cold applications to the head are required when there is the slightest indication that the inflammation is taking a direction inward. Sedatives are necessary to relieve headache, and for this purpose the bromids are the best. When symptoms of pressure appear in the form of localized paralysis, such as of the arm, leg, or face, the part of the motor area of the brain indicated should be exposed by a large trephine opening with the view of getting rid of pus.

Fractures of the Skull.—As far as the bones themselves are concerned, there is nothing remarkable about fractures of the skull. Union takes place as readily here as in other parts of the bony framework, and, as a rule, the repair is such as to leave little if any thickening or deformity. The traumatism, however, which is severe enough to break the skull is almost sure to injure the brain, or the displaced fragments may be driven in upon the brain and its meninges, leading to the most serious consequences.

Fractures of the skull are divided into those of the vault and those of the base.

Fractures of the Vault.—If a force applied to a limited area of the skull is sufficient to make the bone yield, the effect will be (*a*) a fissure or crack in the skull, and it may extend for a considerable distance from the point to which the force has been applied. It is not uncommon to find a fissure which has run across sutures from one bone to another or has even extended so as to involve the base itself. (*b*) The bone may be comminuted at the point of contact. (*c*) The fracture may be opposite to the point of contact, the so-called fracture by *contre-coup* or counter-stroke. (*d*) To the above I shall add a fourth class, in which the force may cause fracture at a part of the skull which is distant from the point of contact, but not opposite to it. This is well seen in Fig. 202. The wounds of entrance and exit of a bullet are seen at opposite sides of the calvarium, while between them is a fissure extending nearly the whole length of the vault from the frontal to the occipital bones.

Symptoms.—In examining the skull for fracture pass the fingers gently over the vault to ascertain the existence of any depression or sharp edges of bone. In many cases the fracture is compound, and the examination is made at the bottom of the scalp-wound. The wound itself should be carefully examined for splinters of bone or portions of brain-tissue. The finger, carefully disinfected, can now explore the wound, searching for depressions, fragments, or fissures. Next the edges of the wound are held apart, so that the tissues may

be seen. The fractured edge of bone has a dark-red color. A fissure may in some cases be detected by its holding in its grasp one or more hairs. A very old and infallible sign of fracture is the nature of the clot which is found in the wound: if there is no fracture, this clot can be wiped away; in the case of fracture no amount of washing or wiping can dispose of the clot.

Simple fracture must be determined by the depression which is felt through the scalp. Care must be taken to distinguish this depression from the effusion of blood which takes place after a bruise of the scalp, the diagnostic importance of which has already been dwelt upon. Another symptom which can sometimes be elicited is the "cracked-pot" sound heard on auscultatory percussion. In some cases it is so distinct as to be heard without the aid of a stethoscope, and even by

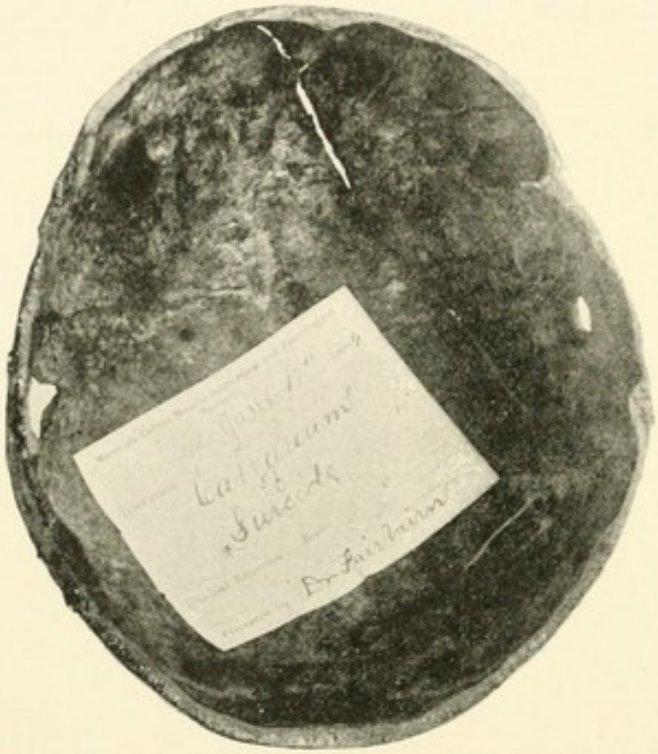


FIG. 202.—Fracture of the vault (from a photograph in the collection of Dr. C. H. Hunter).

the bystanders. Rarely, it happens that the dura mater is wounded, and cerebro-spinal fluid escapes through the fractured skull and forms a translucent tumor beneath the skin. This tumor is recognized by its becoming tense with such movements as sneezing or coughing, and is positive proof of fracture.

The outer table of bone may alone be broken. In such a case the depression is but slight and the cerebral symptoms are not marked. The inner table may also be broken alone. The symptoms are not sufficient for a positive diagnosis, and the fracture can only be suspected when, after a force applied to the head, evidence of cerebral inflammation and pressure supervene.

Treatment.—The question of treatment must be influenced by the amount of injury which the brain has suffered. The bone is of minor importance.

In simple fracture, without evidence of compression of the brain, or if compression is passing off, perfect quiet and good nursing constitute all the treatment required. The patient should be kept in a darkened room, the diet should be light, the bowels should be freely moved by a dose of calomel. The head should be shaved, ice-bags applied, and the patient kept in bed for at least three weeks. When there is marked depression it is evident that the brain has been injured, and, although there may be no immediate evidence of compression or other injury to the brain, the proper course is to trephine with the view of preventing these complications. A depression of the skull is a perpetual source of danger, for if there be no immediate effects there may be developed at even a remote period insanity or epilepsy.

In compound fracture of the vault the wound requires most careful attention. The whole scalp should be shaved, instead of a small portion around the wound, as is too generally the custom. After washing and disinfecting with corrosive-sublimate solution (1 : 2000), and having arrested all hemorrhage and dried the parts, the surgeon next directs his attention to the condition of the bone. If the fracture is a simple fissure without depression, and no hairs or other foreign substances are caught in the fissure, the wound may be closed with catgut sutures and a copious dressing applied. If the fissure holds in its grasp dirt, hairs, or any other foreign material, the edges of the fissure should be chiselled away, removing the outer table of bone and leaving a V-shaped groove. Rubber drainage-tubes or strands of catgut should be placed in position and the wound closed and dressed. When there is depression the bone must be elevated to its proper level and loose pieces removed. It is true that the brain can endure a considerable degree of pressure, and that many patients recover in whose brains foreign bodies have existed for years, but the danger is always great. In skilful hands the operation of trephining is not of itself dangerous, but it should be resorted to as a preventive measure, and not as a last resort when the patient is dying of brain-disease. It may be sufficient to raise the bone by using an elevator, care being taken to bring the displaced portion up to its former level. When the bones are locked together, as is frequently the case, it is necessary to remove a portion of bone with the trephine. The pericranium, if healthy and uninjured, should be carefully preserved, and under favorable circumstances the button of bone removed by the trephine may be replaced. After dealing with the fracture the wound is closed and dressed in the ordinary manner.

Punctured wounds of the brain always demand the use of the trephine.

Fractures of the Base of the Skull.—Fractures of the base may occur in one of the following ways: (*a*) A fissure of the vault may run downward and involve the base. It is convenient to divide fractures of the base according as they involve the anterior, the middle, or the posterior fossa. Fractures extending from the vault are apt to run into the middle fossa and through the petrous portion of the temporal bone. (*b*) The fracture may be caused by indirect violence, as when a person falls from a height, landing in a sitting posture, and communicating the force through the spinal column to the base of the skull. (*c*) The

lower jaw may be driven backward with such force as to fracture the base. (*d*) Punctured fractures can occur through the cavities of the orbit, the mouth, and the nose.

Symptoms.—There is one leading symptom which is proof of fracture of the base, and that is escape of blood and cerebro-spinal fluid from the ear. This sign, however, only exists when the fracture is in the middle fossa and involves the petrous portion of the temporal bone. And not even then must it follow that blood and fluid escape, for the membrana tympani must first be ruptured. Care must also be taken to distinguish between this kind of hemorrhage and bleeding from an ordinary wound in the ear. If it be a simple wound, the hemorrhage will soon cease; if serum escapes, it is only the serous oozing which is common in every wound.

When there is fracture the bleeding and escape of cerebro-spinal fluid are very characteristic. The hemorrhage continues for a long time, and it may be both mixed with, and followed by, the watery discharge. This watery fluid escapes more profusely when the patient increases the intra-cranial tension by forced expiration, coughing, sneezing, or blowing the nose, and the flow is also influenced by the position of the body. The fluid should be collected and examined chemically. It contains chlorids in large amount, a trace of albumin, and sometimes sugar.

There are other positions in which hemorrhage can be taken as an indication of fracture of the base—viz. the nose, the pharynx, beneath the deep muscles of the occiput, and the tip of the mastoid process. In any of these positions the bleeding is characterized by its long continuance, lasting from twenty-four to forty-eight hours. When there is fracture of the orbital plate of the frontal bone, blood will appear at the end of one or two days as an ecchymotic swelling beneath the conjunctiva of the eyeball and, later, in the lids. An ordinary "black eye" produces ecchymosis of the eyelid first. Hemorrhage at the tip of the mastoid process, spreading upward and backward with a crescentic margin, is an indication of fracture of the posterior fossa—a dangerous fracture. Escape of brain-matter is always proof of fracture. It is usually found in the nose or pharynx.

Paralysis of the cranial nerves is an evidence of fracture of the base. Deafness and facial paralysis frequently go together, and afford evidence of fracture of the petrous portion of the temporal bone. Optic neuritis is evidence of fracture of the posterior fossa (Battle).

In many cases the diagnosis of fracture of the base can only be suspected. If a fracture of the vault is extensive and takes a direction downward, we may infer that it reaches the base. A piece of wood entering the orbit must fracture the skull if it pierces the tissues to a greater depth than the orbital cavity extends, and an umbrella rib entering the floor of the mouth must perforate the brain unless the wound is very shallow.

The term compound fracture has a wider significance here than in other parts of the body. A fracture of the base may communicate with the external air through the ear or the nose or the mastoid cells, and is on that account compound, although deep within the cranium. It is important to keep this in mind in considering treatment.

Treatment.—It is seldom that retentive apparatus is required to steady the fractured bones. When the traumatism is so great as to render this necessary, the head should be shaved, covered with a thin layer of absorbent cotton, and enclosed in a plaster-of-Paris cast.

In the majority of cases treatment will consist in keeping the patient perfectly quiet and preventing sepsis in the injured part. The portals of entrance for septic germs are the ear, the nose, the eye, and the mouth. The ear must be thoroughly cleansed from blood, dirt, and wax, irrigated with warm corrosive-sublimate solution, packed with iodoform gauze, and covered with sublimate dressing. The mouth is kept as nearly disinfected as may be by the frequent use of antiseptic washes, such as boracic acid or a solution of Seiler's antiseptic tablets. The nose is thoroughly cleansed by peroxid of hydrogen and douches of boracic acid, and packed with sublimate gauze or borated cotton. The orbit requires particular attention when the fracture has occurred by that route. Drainage is the first consideration, and, if this cannot be otherwise secured, the roof of the orbit should be sufficiently cut away by gouge or chisel to give free exit to pus and other products; a drainage-tube can be placed in the wound, and after thorough disinfection an antiseptic dressing can be applied. The middle fossa is best drained by a trephine opening above and behind the auditory meatus. The anterior fossa is reached through the nose by breaking through the cribriform plate of the ethmoid bone and inserting a drainage-tube.

IV. INJURIES OF THE BRAIN AND ITS MEMBRANES.

Concussion.—In the writings of the older authors the term concussion was used to imply a suspension or sudden arrest of the functions of the brain, the result of a force transmitted through the cerebro-spinal fluid to more or less distant portions of the brain, mainly the fourth ventricle. Authorities of to-day are pretty well agreed that the condition known as concussion is the result of actual injury to the brain, a laceration of its substance, the result of force applied directly or indirectly. Concussion and laceration may be used almost as synonymous terms. In this connection the experiments of Felizet are interesting. He filled a skull with paraffin and let it fall from a height which was not sufficient to fracture the skull. On examination it was found that the bone was unbroken, but at the point of contact the paraffin was flattened, proving that when the force was applied the bone was driven in, and then by its resiliency bounded back to its place. No doubt the same resiliency exists in the living skull; the bone rebounds, but the brain is bruised or lacerated and a small amount of hemorrhage takes place. In post-mortem examination of cases of concussion it is common to find extravasation of blood into the meshes of the pia mater and beneath the arachnoid. According to Duret, these are due to the waves communicated to the subarachnoid fluid, the force of which may have its greatest intensity opposite the point at which the blow is received.

Symptoms.—In mild cases the injured person turns pale, becomes giddy, loses his balance, and falls. He may lie unconscious or semiconscious, and after a time get up of his own accord or with slight

assistance. His mind is confused and he suffers from nausea, and perhaps vomits. In severe cases the symptoms are much more serious. The person falls suddenly, and lies perfectly still, totally unconscious or capable of being only partially roused. The heart is weak and the pulse fluttering. The pupils generally respond to light, but they may be unevenly contracted. Vomiting is the first indication of returning consciousness. After the patient has regained consciousness he suffers from headache, vertigo, and lassitude, and this may continue for several weeks. In the worst cases the injury to the brain is so great that the unconsciousness deepens into coma, or the symptoms of meningitis, cerebritis, or abscess are developed. Remote consequences of such injuries are epilepsy and insanity.

Treatment.—The treatment is the same as for contusions of the skull—perfect quiet and the closest watchfulness for brain-complications. Among the laity it is a common practice to give alcoholic stimulants; this is to be condemned, as their effects upon the brain may prove serious. Aromatic spirit of ammonia is free from this objection, and should headache prove troublesome a dose of bromid of potassium is proper. Every case of concussion should be looked upon as a serious injury, and no amount of remonstrance on the part of the patient should influence you in relaxing the rigidity of your management.

Compression of the Brain.—An organ so delicate as the brain is intolerant of pressure, and refuses to perform its functions when encroached upon by foreign bodies. The causes of compression are—hemorrhage above or below the dura mater or in the center of the brain, collections of pus, hyperemia, depressed fractures, and tumors. The time at which evidences of compression appear varies with the nature of the compression. Rapid extravasation of blood produces immediate compression; inflammation does not produce it until the hyperemia or the inflammatory products have had time to develop; tumors do not cause compression until an advanced stage of their growth, except when they are attended with hemorrhage; in meningitis or osteo-myelitis of the skull this symptom does not appear until the second week, while an abscess in the cerebral substance may not reveal its presence until weeks or months after the accident which caused it.

Symptoms.—The symptoms of compression are in many respects entirely different from those of concussion, and yet there are cases in which the diagnosis is difficult, as one condition runs into the other. There are degrees of compression too, for in one case the whole brain may suffer, in another the pressure may be local. Sudden compression may begin with convulsions.

Total Compression.—The patient is completely unconscious and lies in a state of coma. One leading symptom is very pronounced, and can be heard the moment you enter the patient's room—*stertorous breathing*. If you watch the cheeks, you will see that they expand, and the lips are passively blown outward at each expiration. This is because they are paralyzed. In concussion we saw that the patient could be roused to semi-consciousness: not so in compression, for voluntary and reflex movements are in abeyance. The skin is cold, and usually

it is covered with perspiration. The pulse is slow and strong. The pupils are fixed, generally dilated, and do not respond to light. The bladder has lost its power to contract, and becomes over-distended; the feces are passed involuntarily.

When the cause of compression acts slowly the following sequence of symptoms may be observed: The patient becomes restless and irritable, and complains of nausea and other digestive disturbances; there is severe headache; the pupils are contracted; the face is flushed; the pulse is full and rapid, and the beating of the carotids is apparent to the eye. Impairment of speech, vomiting, and sometimes convulsions precede the period of stupor, which lasts as long as compression exists. A rise in temperature is a symptom of great importance, and has a prognostic as well as a diagnostic value. It comes on early and is persistent. A subnormal followed by a high temperature demands a bad prognosis.

Local Compression.—The patient does not lose consciousness, and the symptoms will depend upon the part of the brain which suffers compression. The anterior lobes show the least response, and it is not uncommon to find a considerable area of cerebral tissue destroyed without having shown symptoms during life. When the anterior portion of the brain is compressed no paralysis is produced, unless the posterior part of the inferior left frontal convolution becomes involved, in which case there is motor aphasia. Pressure in the motor area will be recognized by paralysis of the limbs or impairment of the movements over which the several districts preside, as follows:

Paralysis of the lower limb indicates the upper third of the fissure of Rolando on the opposite side and the corresponding parts of the ascending frontal and ascending parietal convolutions (Fig. 197).

Paralysis of the upper extremity indicates pressure upon the middle third of the Rolandic fissure and the corresponding parts of the convolutions.

Motor aphasia indicates pressure upon Broca's area in front of the lower third of the fissure of Rolando. Mind-blindness may be caused by pressure of the angular gyrus, as shown by a case of Macewen's in which a spiculum of bone from the inner table was driven in upon the anterior portion of the convolution. Word-blindness (apraxia) would point to the temporo-sphenoidal lobe; hemianopsia, to the cuneus and its neighborhood. Pressure upon the pons Varolii or the medulla oblongata speedily endangers life by destroying the nerve-centers themselves or arresting the nerve-currents as they pass from the skull.

In the diagnosis of compression of the brain the following must be excluded: alcoholic intoxication, opium-poisoning, apoplexy, and uremia. A drunken person, unless carrying a very heavy "jag," is not unconscious; he probably has the appearance of habitual indulgence and the smell of alcohol taints his breath. Doubt may arise, however, from various sources: the drunken man may have fallen and caused an injury to his head, which injury may divert the attention of the examiner from the real condition. On the other hand, an injured person is almost sure to have stimulants poured down his throat by those who come to his rescue. The pupils of a drunken man are usually contracted, but they dilate when he is aroused. The temperature is subnormal. The

effects of alcohol pass off in a few hours, when all doubt is removed if not before.

Opium-poisoning is attended with the drowsiness and the deep sleep which characterize the effects of opiates; the pupil is contracted to a pin-point and remains so, and there are no evidences of an injury to the head.

Apopelxy is due in nearly all cases to hemorrhage of the lenticulo-striate artery, which Charcot has designated "the artery of cerebral hemorrhage." In this lesion unconsciousness comes on immediately or after a very short interval; the breathing is stertorous, unconsciousness is complete, and there is either hemiplegia or total paralysis.

Uremia is recognized by a history of albuminuria, edema of the legs, and the absence of paralysis and stertorous breathing.

Treatment.—Compression is only a symptom, and its treatment must depend upon the lesion which is acting as the cause.

Intra-cranial Hemorrhage.—Hemorrhage within the skull, as a rule, arises from one of three arteries: 1. The lenticulo-striate causes the hemorrhage of apoplexy, and comes under the consideration of the physician. 2. The middle meningeal produces those cases in which the bleeding is outside the dura mater. 3. The middle cerebral gives rise to hemorrhage beneath the dura mater—subdural hemorrhage. Other sources of intra-cranial hemorrhage are the sinuses, the small vessels of the membranes, and, in exceptional cases, the internal carotid artery.

The cases of cerebral hemorrhage which fall under the care of the surgeon are nearly all of traumatic origin. They may be classed under three heads: (*a*) extradural hemorrhages, or those which occur between the dura mater and the skull; (*b*) subdural, or those which take place between the dura and the brain; and (*c*) cerebral, or those which take place into the tissue of the brain itself.

Extradural Hemorrhage.—The source of this form of hemorrhage is nearly always the middle meningeal artery, and the exciting cause is a blow or a depressed fracture. The artery is a branch of the internal maxillary and enters the skull through the foramen spinosum; it then divides into an anterior and a posterior branch. The anterior follows the groove in the great wing of the sphenoid, and, reaching the anterior inferior angle of the parietal bone, turns upward toward the middle line of the head. The posterior branch passes over the squamous portion of the temporal bone, and thence to the posterior margin of the parietal bone. One or other of these branches is usually the seat of extradural hemorrhage—the anterior more frequently than the posterior.

Symptoms.—There is one symptom of intra-cranial hemorrhage which is worth all the rest combined. *It is a period of consciousness after the first shock of the injury, followed by paralysis or unconsciousness.* Thus, a person receives a blow upon the head, and, falling to the ground, remains for a time unconscious, owing to concussion of the brain. From this he soon recovers, but at the end of several hours, or it may be one or two days, symptoms of compression appear, manifested by paralysis of a limb or gradually increasing stupor. At the time he received the blow a branch of the artery was ruptured, and the blood began to collect and form a clot upon the surface of the

brain. At first the brain could tolerate the moderate pressure thus produced, but when the clot became larger the symptoms of compression began to be apparent. When paralysis appears it is upon the side of the body opposite to the brain-lesion, and may involve a single movement or limb or take the form of hemiplegia. In some cases we can trace the course of the growing clot by the paralytic symptoms. Palsy of the muscles of the face, motor aphasia, paralysis of the arm, and later of the leg, would indicate that the clot began to form low down near the base and gradually ascended to the middle line. The patient becomes drowsy, and the drowsiness may deepen into coma. The pulse is frequent, and in contrast to it the respiration is slow and stertorous. If the clot tends to increase toward the base of the brain instead of upward, the pupil on the same side will at first be contracted, and afterward dilated and insensible to light. It occasionally happens that the hemorrhage takes place on the side opposite to the injury. In that case the injury and the paralysis will be upon the same side.

Subdural hemorrhage cannot always be distinguished from the preceding variety. The pressure is not so great as in the extradural form; hence the pressure-symptoms are not so clearly marked. The blood comes from the middle cerebral artery, from the vessels of the pia mater or cortex, or from the veins of the surface of the brain. When the motor area is the seat of subdural hemorrhage the paralytic symptoms are the same as those observed in extradural bleeding, but less marked and indefinite. When the frontal lobes are involved the mental condition of the patient becomes changed, as shown by irritability of temper, loss of self-control, and sometimes insanity.

Subarachnoid hemorrhage is not recognized by any symptoms which distinguish it from other forms of intra-cranial hemorrhage. The blood usually comes from the cortex itself, and, if it does not burst through the arachnoid, it spreads over the surface, filling the sulci and gravitating toward the subarachnoid space at the base of the brain. This form may be suspected if after a severe contusion the symptoms are local at first and rapidly become general, attended with convulsions and paralysis.

Cerebral hemorrhage, or hemorrhage into the substance of the brain, probably occurs, in a slight degree, in most cases of concussion, but produces no definite symptoms. When a vessel of considerable size is ruptured, the blood is poured out into the ventricles and the case is one of apoplexy.

Treatment of Intra-cranial Hemorrhage.—When signs of compression appear within a few hours after an injury hemorrhage may be almost positively diagnosticated. The treatment must be determined by the question of localization. If the compression is general and no exact point can be fixed upon as the situation of a clot, we must be content with helping the flow of venous blood from the brain by keeping the head and shoulders slightly raised and by lessening the amount of cerebro-spinal fluid through the influence of purgatives. Formerly, venesection was resorted to, but its value is now considered doubtful.

When the position of the clot can be accurately determined by local symptoms, it is an imperative duty to trephine the skull, remove the

clot, and ligate, if possible, the bleeding vessel. When the middle meningeal artery is the bleeding vessel, which is the case in the majority of injuries, the prognosis is not necessarily bad, and especially if it is the anterior branch of the vessel which is injured. If there is a fissure of the skull along the line of this artery, it is more than likely that the bleeding point is just beneath the fissure, and the trephine should be applied accordingly. It must never be forgotten that the blow may be on one side of the head and the hemorrhage on the opposite side; the paralytic symptoms in that case would be on the same side as the accident. In operating, therefore, the point for trephining must be chosen not from the position of the original injury, but by the localizing symptoms. Thanks to the observations of Krönlein, there is one point at which we are almost sure to find the clot, and that is one and a quarter inches behind the external angular process and on a level with the upper margin of the orbit (Fig. 203).

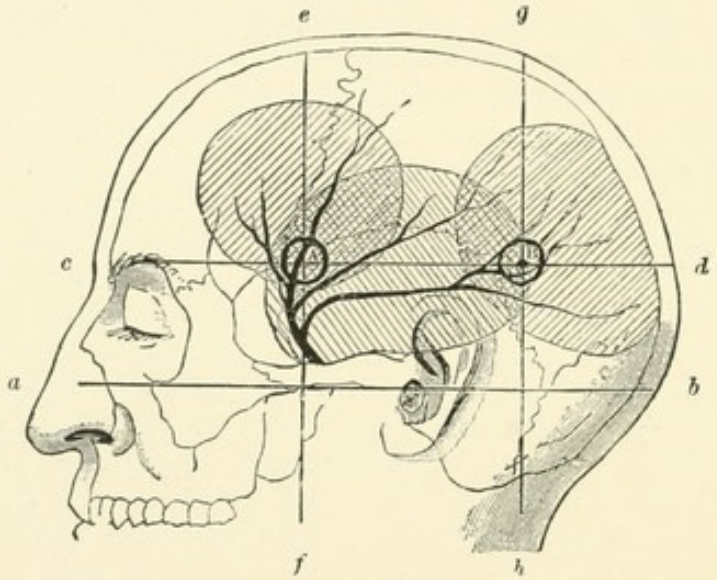


FIG. 203.—Site of trephine opening to reach clot in hemorrhage from middle meningeal artery (Krönlein): *a*, *b*, horizontal line through the meatus; *c*, *d*, on a line with the eyebrows; *e*, *f*, vertical line 3 to 4 cm. behind the ext. ang. process; *g*, *h*, at the posterior border of the mastoid process. A, the point to reach the anterior, and B, the posterior branch.

This reaches the anterior branch of the middle meningeal. If there are dilatation of the pupil and other evidences that the clot is increasing downward, this opening must be made half an inch lower. Should we be disappointed by this exploration, we must immediately look for the clot at the position of the posterior branch of the artery. This is reached by trephining farther back—viz. on the same level as the former opening and just below the parietal eminence.

When the clot is reached it presents the appearance of a dense, almost black coagulum bulging into the opening. This must be carefully scooped out, and if the trephine opening does not give sufficient room, the bone must be further removed by Keen's or Hoffman's cutting forceps. Having got rid of the clot, the next and most difficult task is to find the bleeding point. If the blood keep welling up as fast as it can be sponged away, the carotid artery should be compressed, and sterilized water at a temperature of 110° should be applied to the

wound. When the bleeding point is found, a catgut ligature should be passed around the vessel by means of a full-curved Hagedorn needle, the point of the needle being made to enter the dura mater at one side of the artery, and, passing under the vessel, emerge at the other side. The ligature is then tied so gently as not to rupture the vessel. Another difficulty in stopping the bleeding point is that the part of the brain occupied by the clot does not rise to the opening when the clot is removed, but remains depressed. This may require a further enlargement of the trephine opening. Having found and secured the bleeding vessel, the wound is well cleansed and ample drainage provided for.

The Operation of Trephining.—As this operation is a preliminary to nearly all the operations which can be performed on the brain and involves the technique of all cerebral operations, let us consider it in detail. It is indicated for the removal of a depressed bone in fracture of the skull, for intra-cranial hemorrhage, for the evacuation of cerebral abscess, for the relief of epilepsy or insanity, and for the removal of tumors.

Preparation of the Patient.—The patient's head should be shaved as the very first proceeding, since his examination cannot be conducted satisfactorily without it. It is remarkable how scars, prominences, and depressions are revealed after removal of the hair. The nature of the lesion having been arrived at, not by a "snap" diagnosis, but after careful study of every feature of the case, the fissures or other landmarks are marked by an anilin pencil or by a stick of nitrate of silver. The head is protected by a suitable cap or silk handkerchief. The day before the operation the scalp should be again shaven, thoroughly disinfected, and wrapped in sublimate gauze. When the patient is taken to the operating-room a final washing and sterilizing is carried out.

Anesthesia.—The semi-recumbent posture is believed to lessen the amount of hemorrhage during the operation. Chloroform is undoubtedly the best anesthetic.

Raising the Flap.—Having mapped out the location of the fissures upon the scalp, it is very important that corresponding points should be marked upon the bone. The sharp point of a trocar or the center pin of a spare trephine is pushed through the scalp, and by rotary movement or a sharp stroke of a hammer is made to mark the bone. In any case the point to which the trephine is to be applied should be marked, and if the operation is to be over the fissure of Rolando, the upper and lower end of the fissure should also be marked.

If there is already a wound in the scalp, this can be utilized and enlarged as required. In the uninjured scalp a suitable flap must be raised and the bone exposed. Formerly this was done by a crucial incision, but it had several disadvantages: four triangular flaps were constantly in the way and had to be held aside; the application of sutures to close the wound was troublesome, and a weak point was left which was sure to come over the center of the opening, where the greatest support was required.

A horseshoe flap is the shape which best fills all requirements. It should have its base below when practicable, as this secures better blood-supply. The incision goes through the pericranium, and the flap is raised by separating the pericranium from the bone. The scalp is

likely to bleed freely, but this is readily controlled by grasping its edges in hemostatic forceps. The operation can be made almost bloodless by applying a stout rubber band around the scalp, just above the eyebrows and ears, but the advantage thus gained is more than lost by the copious hemorrhage that follows removal of the tourniquet. For holding the flap out of the way a stout silk thread can be passed through its margin and tied to form a loop.

Trephining the Bone.—The skull is now exposed to view and is examined. If there is fracture with depression, it may be possible to introduce an elevator beneath the depressed portion and restore it to its proper place. If the bones are so interlocked as to make this impossible, the trephine must be used to get rid of the necessary extent of bone.

When the object of the operation is to deal with an intra-cranial lesion a good-sized trephine is applied over the spot indicated by the mark which has previously been made on the bone. The point of the center pin having become well engaged, the trephine begins to cut through the bone by light rapid movements from right to left and from left to right. Care must be taken to keep the instrument at right angles to the bone, in order that it may cut through evenly, and as soon as the center pin has ceased to be necessary it is retracted and fixed with its thumb-screw. The bone-dust is at first dry, but becomes moist and blood-stained as soon as the outer table is cut through. The channel made by the saw must be kept clear by occasionally using a sterilized toothpick or needle, and the instrument itself freed from débris by washing it in carbolic-acid solution. When the diminishing resistance gives warning that the bone has been cut through, the trephine is laid aside and the button of bone removed by gently elevating it. An improvement on the time-honored trephine has been devised by Leonard (Fig. 204). It has a fixed handle in which a shaft revolves,

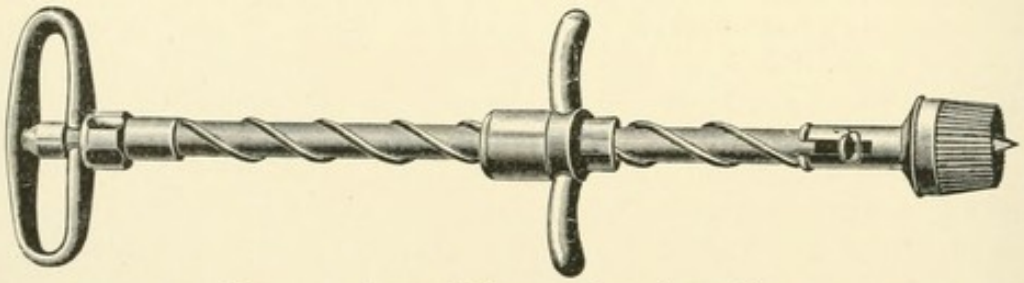


FIG. 204.—Leonard's improved aseptic trephine.

and to which the force is applied through a double raised spiral by means of a sliding handle. By each upward movement of the sliding handle the shaft and trephine are caused to make three complete revolutions. The friction is less and the cutting more easy than in the ordinary treatment.

A trephine opening to be of any utility should be not less than an inch and a half in diameter. Should this be found insufficient, the opening can be enlarged by rongeur forceps (Fig. 205). Before enlarging, however, the dura mater is to be separated from the bone, for which purpose Poirier's (Fig. 206) or Horsley's dural separator (Fig. 207) can be employed, or a stout probe bent to a proper angle.

Examination of the Brain.—The dura mater is now exposed, and the rule is to open it, for without this step a satisfactory examination of the brain cannot be made; but it must be borne in mind that unless

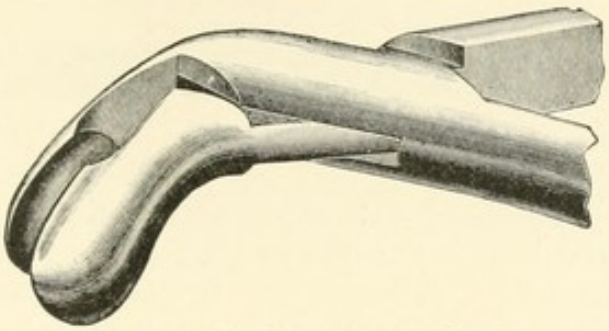


FIG. 205.—Hopkins's rongeur forceps.

the most thorough asepsis is carried out the risk is greatly increased. The cicatrix which follows an incision of the dura may prove troublesome, and should be taken into account. The membrane is divided



FIG. 206.—Poirier's dural separator.

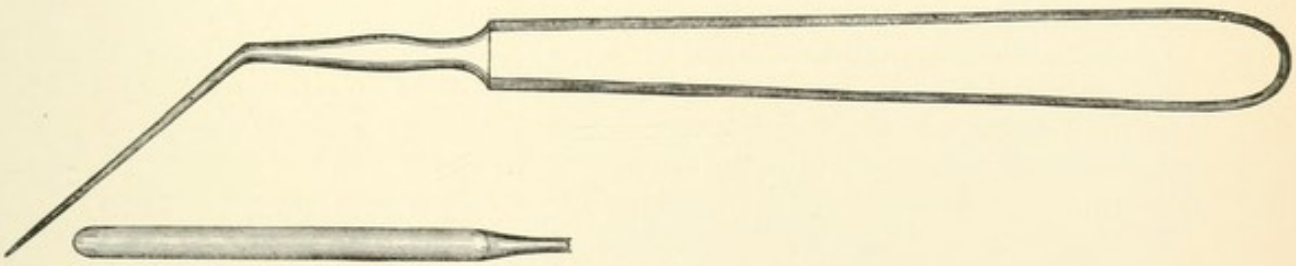


FIG. 207.—Horsley's dural separator.

with curved scissors a quarter of an inch from the edge of the bone, so as to form a flap, which at the end of the operation is replaced and stitched to the quarter-inch margin. The brain now lies in full view, and we must observe the following points:

(*a*) *The Degree of Tension.*—Does the brain bulge into the trephine opening? If so, there is an increase of intra-cranial pressure due to a tumor, an abscess, or excess of fluid in the ventricles.

(*b*) *The Color of the Brain.*—Lividity or a yellowish tinge indicates a probable tumor beneath the cortex. An old laceration has a dirty yellowish-brown appearance. A dark purple substance, seen before opening the dura, forced up into the trephine opening and without pulsation, would indicate subdural hemorrhage.

(*c*) *Pulsation.*—With a moderate degree of compression strong pulsation can be felt and the resistance is increased; when the pressure is due to a large underlying tumor or abscess, pulsation is absent.

(*d*) *Faradization.*—It is not advisable to spend much time in testing the motor-centers by faradization, but should it be deemed necessary

to follow this line of investigation, an ordinary faradic battery with a weak current is sufficient. A very convenient electrode is that devised by Keen (Fig. 208).

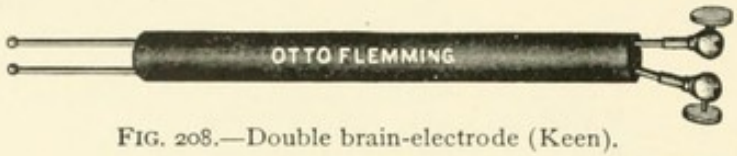


FIG. 208.—Double brain-electrode (Keen).

Operations on the Brain.—If the aim of the operation is the arrest of hemorrhage, the bleeding vessel can be secured by passing a full-curved Hagedorn needle through the brain-tissue and beneath the vessel, and tying the ligature with only sufficient tension to stop the bleeding. A ligature drawn too tightly is sure to tear through the delicate tissues. If it is necessary to remove a diseased portion of the brain-substance, the lines of incision should be made antero-posteriorly, as in that direction they do not cut across motor areas, and are therefore less likely to produce paralysis. If a tumor is to be removed, the necessary incision through the cortex should be made at right angles to the surface of the brain.

Closing the Wound.—When the removed portion of bone is in a healthy condition, it is proper to replace it. With this object in view the greatest care is necessary that the bone should be properly looked after. One assistant should have this matter as his sole charge. As soon as the bone is removed he should place it in a bowl containing a 1 : 2000 sublimate solution, and keep the bowl floating in water at a temperature of 100° to 105° F. All bleeding having been arrested and the wound carefully dried, the flap of dura mater is replaced and stitched with a fine catgut continuous suture. The bone, if healthy, is cut into several pieces with rongeur forceps and laid upon the dura. The skin-flap is laid in position and stitched with catgut or silkworm gut. If the case is one of abscess, hemorrhage, or gunshot wound, a rubber drainage-tube should be placed in the position which will be most dependent when the patient lies in bed. The outer dressing is the same as for any other wound.

Wounds of the Brain.—The brain, although admirably protected from ordinary violence, may yet be wounded by instruments or foreign bodies penetrating the orbit, roof of the mouth, or the cribriform plate of the ethmoid by way of the nose. Instruments, as sabers, bullets, knives, or bayonets, applied with great force, may even penetrate the skull and wound the brain. The wound of the brain in all these instances is a complication of the attending compound fracture of the skull. The symptoms are usually overshadowed by the fracture or they may be remarkably slight or slow in making their appearance. Such wounds are nearly always septic; consequently there is evidence sooner or later of inflammation; the patient complains of headache, and this is followed by the group of symptoms which attends cerebritis and ends in death. The cortex is, as a rule, the part that suffers, except when the wound is received by the mouth, and then it is the base of the brain. In many cases the penetrating body, as a knife-blade or a piece of wood, is broken off and left within the cranium. Such a case came

under my observation in which a splinter of wood about half an inch square and six inches in length was driven into the orbit; the wood was immediately withdrawn, but a portion three inches in length remained in the brain, and was not discovered till three weeks afterward, when evidences of an abscess led the surgeon to operate. Sometimes the localizing symptoms, as paralysis of the face, the arm, or the leg, hemianopsia, aphasia, etc., may lead to a diagnosis of the position of the foreign body.

Treatment.—The wound is to be thoroughly cleansed (the head having been shaved), all pieces of bone and foreign bodies removed, and every effort made to secure asepsis; the dura mater, if practicable, should be united by sutures, a drainage-tube placed at the most dependent part of the wound, the scalp closed by sutures, and a full antiseptic dressing applied. Suppuration may follow in spite of all these precautions; abscesses should be watched for and promptly drained.

V. INJURIES OF CRANIAL NERVES.

The symptoms that indicate injury of the cranial nerves are due either to a lesion of the part of the brain which gives origin to the nerves or to injury along the course of the nerves themselves.

The Olfactory Nerve.—The olfactory nerve begins at the tuber olfactorium in front of the anterior perforating space (Fig. 209). From

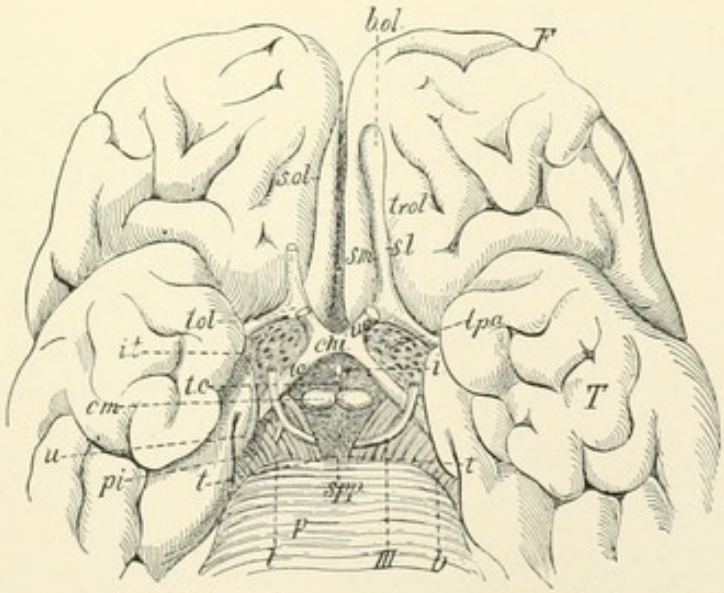


FIG. 209.—Anterior and middle portions of the base of the brain (after Hirt): *F*, frontal lobe; *T*, temporal lobe; *b. ol.*, olfactory bulb; *tr. ol.*, olfactory tract; *t. ol.*, tuber (trigonum) olfactorium; *s. m.*, middle; *s. l.*, lateral root; *i.*, infundibulum (cut off); *c. m.*, corpora albicantia; *l. p. a.*, anterior perforated space; *s. p. p.*, posterior perforated space.

this point the nerve runs forward and slightly toward the middle line, ending in the olfactory bulb (*b. ol.*). The bulb lies upon the cribriform plate of the ethmoid bone, and through the minute openings of this bone two sets of fibers pass to be distributed over the mucous membrane of the nose. The deep origin of the nerve is not positively known, but authorities are generally agreed that there are three roots. The brain-center of the sense of smell is also a disputed point. It has

been placed in the gyrus hippocampi, the gyrus uncinatus, and the cornu ammonis. Loss of smell (anosmia) is not a symptom upon which much reliance can be placed. The sense of smell may be impaired or even temporarily lost by plugging of the nostrils with blood-clots, by acute or chronic catarrh, by unnatural dryness of the membrane, or by constant irritation. Certain occupations produce anosmia; soap-boilers, workers in glue-factories, butchers, and tanners suffer in this way. When anosmia follows a traumatism, we may consider it as evidence of fracture of the anterior fossa of the base of the skull, or possibly a momentary separation of the bulbs, tearing the nerves across at their origin (Moullin). Complete loss of smell, according to Carbonieri, strongly suggests diseases of the olfactory tract or bulb.

The Optic Nerve.—The fibers which enter into the formation of the optic nerves are derived from the optic thalami, the outer and inner geniculate bodies, the anterior corpus quadrigeminum, and the cerebellum. In the first part of their course the combined fibers, under the name of the optic tracts, converge and form the chiasm, and then, diverging and passing forward as the optic nerves, enter the orbit through the optic foramina. In this cavity they pass through the orbital fat, the sclerotic and choroid, and spread over the fibrous layer of the retina.

The cortical center of vision has not yet been accurately determined. It is generally admitted that it is in the mesial surface of the occipital lobe, and probably in the angular gyrus.

Complete blindness would indicate that the nerve was torn across at the foramen or that it had been crushed by a fragment of bone and afterward became atrophied. Lateral hemianopsia, or loss of sight in the corresponding half of the field of vision in both eyes, points to a lesion of the tract or of the chiasm. It is also associated with disease in the occipital lobe, one of the centers of the optic nerve. It is possible in some cases to diagnosticate the location of the injury or disease from the manner in which the symptom appears. If it occurs suddenly and is the only symptom, the disease is in the cortex; if other symptoms accompany it, such as aphasia or hemiplegia, the lesion is not in the cortex.

A ready method, and sufficiently accurate, of examining a case of hemianopsia is the following: Place the patient at a distance of two feet from the examiner. To examine the right eye the patient covers the left eye with his hand and the examiner covers his own right eye. The patient then fixes his right eye on the left eye of the examiner. The examiner then holds up his finger between the patient and himself, and moves it in different directions as far as the border of his own field of vision, the patient at the same time being asked how far out he is able to see the finger. The examiner is thus enabled to notice every motion of the patient's eye toward the object, and, judging from his answers, can compare the patient's field of vision with his own (Hirt).

Loss of sight in the inner or outer side of both retinæ indicate that the chiasm is the seat of injury. Choked disk or papillitis is frequently, but not constantly, found in connection with intra-cranial tumors, but the theories as to its causation are up to the present time conflicting.

The existence of this symptom affords no evidence of the position of the tumor or of its pathological character.

The third nerve leaves the brain at the inner margin of the crus and immediately in front of the anterior border of the pons. It runs forward and outward, and after entering the cavernous sinus divides into two branches. Both of these pass through the sphenoidal fissure into the orbit. The superior branch supplies the levator palpebræ superioris and the superior rectus. Paralysis of this branch will therefore produce *ptosis*. The other portion of the nerve divides into three branches—one to the inferior oblique, one to the inferior rectus, and one to the internal rectus.

The symptoms, therefore, which point to paralysis of the third nerve are *ptosis, external strabismus, dilatation of the pupil*, and *loss of power of accommodation.*

The fourth nerve (trochlear or pathetic) leaves the brain just behind the corpora quadrigemina at the upper surface of the valve of Vieussens. Passing outward and downward, it winds around the outer side of the crus and appears at the base of the brain. It now turns forward to the cavernous sinus, and, running close to the third nerve, passes through the sphenoidal fissure and enters the superior oblique muscle. Paralysis of the nerve affects only the superior oblique muscle, causing diplopia. A very early symptom is giddiness when going down stairs.

The sixth nerve, or abducens, leaves the brain just behind the pons, between it and the anterior pyramid. Running forward, it enters the cavernous sinus, accompanies the internal carotid artery, and, passing through the sphenoid fissure to the orbit, is distributed to the external rectus. This nerve is frequently injured in traumatisms of the head, and such injury is manifested by convergent squint.

The fifth nerve, or trifacial, is seldom injured alone. It frequently suffers in gunshot wounds through the mouth, as in suicides. When the injury is at the origin of the nerve, there is complete anesthesia of the corresponding side of the face. Severe neuralgic symptoms may be taken as an indication that the sensory portion of the nerve is affected. A more severe lesion would result in anesthesia, with a cold and purple condition of that side of the face. The cutting off of the nerve-supply to the conjunctiva causes congestion and engorgement of that membrane, the tears cease to flow, and the saliva ceases to be secreted. The consequent dryness of the nasal cavity causes anosmia, and of the mouth loss of taste. If improvement or recovery takes place, it is fair to assume that the paralysis was due to hemorrhage or inflammatory deposit.

The Seventh Nerve.—The first division of this nerve—the *portia dura*, or *facial nerve*—is especially liable to injury, as it traverses the long bony canal in the petrous portion of the temporal bone. Fractures of the middle fossa, involving this portion of bone, are recognized in a great degree by paralysis of the facial nerve. When the paralysis does not come on immediately, it is due to hemorrhage or inflammation; when the symptoms are immediate, the nerve is injured by compression of a fragment of bone (Fig. 210).

The nerve may be injured as follows:

Situation of Injury.	Symptoms.
At origin of nerve . . .	Paralysis of same side of face, and hemiplegia of opposite side of the body. The sixth is generally paralyzed also.
In the meatus	Facial paralysis of same side. The auditory is injured, as well as causing deafness of same side.
In the aqueduct	Paralysis is confined to muscles of expression.
The petrosal nerve . . .	Paralysis of the soft palate.
The chorda tympani . . .	Loss of sense of taste.

The eighth and ninth cranial nerves are rarely injured, except in traumatisms of extreme gravity. The glosso-pharyngeal, pneumogastric, and spinal accessory, all emerging from the jugular foramen, are all injured alike if injured at all. In a case recorded by Hilton there was great difficulty of deglutition, the tongue was thrust to the opposite side, articulation was slow, and enunciation imperfect. Pain was felt in the neck and down to the clavicle on the affected side.

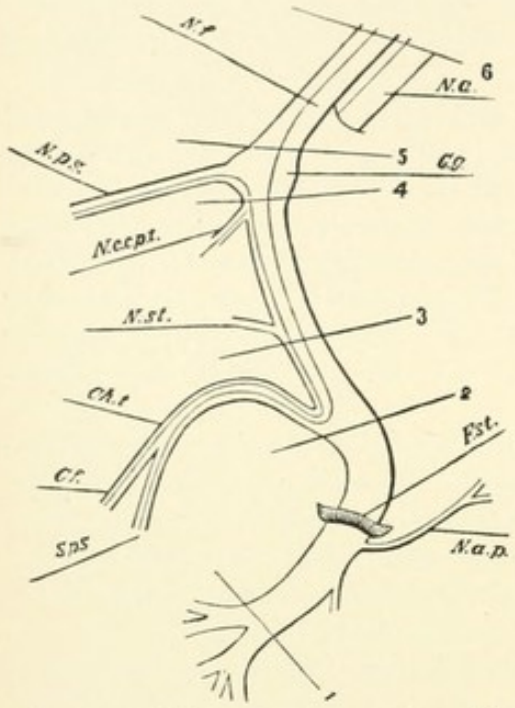


FIG. 210.—Schematic representation of the trunk of the facial from the base of the skull to the pes anserinus; different localizations of the lesion in paralysis (Strümpell): *N. f*, facial nerve; *N. p. s*, great superficial petrosal; *N. c. c. p. t*, nerve communicating with the tympanic plexus; *N. st*, stapedius; *Ch. t*, chorda tympani; *G. f*, fibers of the taste; *S. p. s*, nerve governing the secretion of saliva; *N. a*, acoustic nerve; *G. g*, geniculate ganglion; *F. st*, stylo-mastoid foramen; *N. a. p*, posterior auricular nerve.

VI. GUNSHOT WOUNDS OF THE HEAD.

In the examination of gunshot injuries of the head the following points must receive attention: 1. The wound of entrance; 2. The wound of exit; 3. The position of the bullet; 4. The extent of brain-injury.

The injury produced by a bullet is often more serious than at first sight appears. The examiner should therefore be on his guard against saying that the bullet glanced from the skull, causing only a wound of the scalp. In such cases it is often found that the outer table of the skull is fissured or the inner table is fractured or depressed, or that there is injury to the bone sufficient to produce osteitis and necrosis.

Wounds of the skull are spoken of as non-penetrating, penetrating, and perforating. If the bullet enters the brain and remains there, it is called a penetrating wound; if it passes completely through the skull, it is called perforating. The wound of entrance is small; the opening in the outer table is often the same size as the bullet or it may be a slit-like hole. The inner table is driven in, and may be extensively fractured. At the wound of exit the opening in the inner table is small, while the outer table may display an opening of considerable extent.

In penetrating wounds the question of the position of the bullet

must claim attention. Formerly it was the custom to let the bullet alone, except when it was near the surface and easily found. It is true that many cases recovered, and the patients carried their bullets, with no great inconvenience, through a natural lifetime. But the risk was nevertheless great; remote effects were ever liable to occur, and sudden death from the presence of a bullet has been known to happen as late as thirteen years after the injury. Many of the cases die of cerebral abscess; in others there are inflammation and softening of the brain. Some die of apoplexy, and others drop off suddenly after years of apparent health. The experiments of Flourens throw light upon the latter class. He introduced bullets into the upper part of the hemispheres of the brains of dogs and rabbits. The balls by their own weight gradually sank deeper and deeper into the brain-substance, and finally reached the base of the skull, the tracks of the bullets healing after them. The same thing probably occurs when bullets are lodged in the human brain.

Since the advent of antiseptic surgery the bullet can be sought and removed with less risk than formerly, and, as a rule, the brain suffers less from exploration than from the continued presence of a foreign body.

Finding the Bullet.—Fluhrer has simplified the search for foreign bodies in the brain by his invention of the aluminum probe which bears his name. It is an olive-pointed probe twelve inches in length, and composed of aluminum, which gives it the quality of lightness. The patient's head is so placed that the wound of entrance occupies the highest point, and the supposed track of the bullet is in a perpendicular position. The probe is then gently inserted, and allowed to follow the bullet track by simple gravitation. If it touches the ball, the protruding portion of the probe is measured and an estimate formed of the distance at which the missile lies from the wound of entrance. If near this wound, it may be extracted by enlarging the opening. Sometimes, however, it is imbedded so deeply that it is nearer the opposite side of the skull, and can best be reached by a counter-opening. Having measured the distance of the ball from the wound of entrance, the probe is pushed on till it reaches the counter-opening, and thus the distance from the latter to the bullet can be estimated. Two strands of sterilized silk are attached to the end of the probe and carried through the wound as the probe is withdrawn. One of the threads is made use of to draw a gum-elastic catheter through the wound to serve as a guide. The catheter should be about No. 9 French; it should be thoroughly aseptic and made firm by a stylet. Now pass a loop of silk around the catheter and one of the arms of a pair of forceps, and, thus guided, pass the forceps along the catheter in search of the bullet. The greatest gentleness should be employed, and, failing in one attempt, the forceps should be withdrawn and entered at another point, rather than by sweeping it around the catheter. When the bullet is withdrawn a rubber drainage-tube is attached to the second thread and drawn through the wound.

The "telephone probe" of Dr. Girdner is very ingenious, and has proved a valuable aid in some cases. An ordinary telephone receiver is attached to the probe; the other cord of the receiver is connected

with a metal handle, which is moistened and placed in the patient's hand or against his naked skin. The examiner then places the receiver to his ear, and allows the probe to gravitate along the bullet track as before. Should it come in contact with the bullet, the receiver intensifies the sound, so that it is heard with great distinctness.

Lilienthal has devised a bullet-probe and forceps (Fig. 211) which he thus describes: "The instrument is founded upon the familiar fact that when two dissimilar metals—as, for example, a silver and a copper coin—are held simultaneously in the mouth, the one upon the tongue and the other beneath it, a distinct and unmistakable electrical sensation, together with a strong metallic taste, is perceived as soon as the metals are brought in contact, but not before. The sensation is a

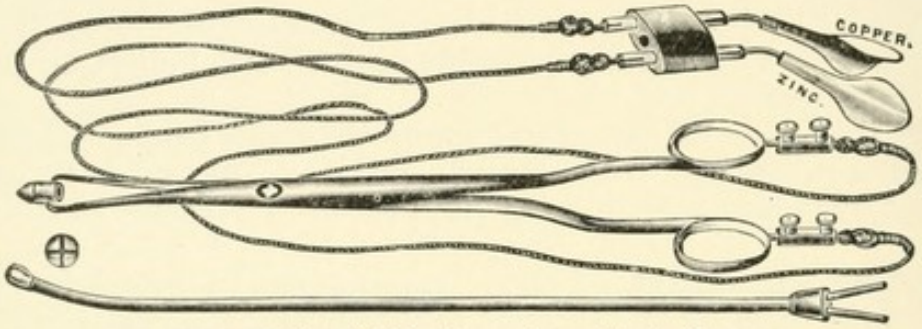


FIG. 211.—Lilienthal's bullet-probe and bullet-forceps.

continuous one as long as the metals touch each other. Sensitive individuals may even see a slight flash of light.

"My apparatus consists of a mouth-piece made of two metal plates which fit *at the sides* of the tongue, one of copper, the other of zinc, stiffly and completely isolated from such other by being set in a hard-rubber frame. Two insulated wires are connected, one with the zinc plate, the other with the copper. The probe itself is a metal containing the continuations of the wires just mentioned. The tip of the probe is isolated from the shank by a hard-rubber washer. The tip consists of two or four (or other even numbers) bright metallic pieces separated from each other by thin hard-rubber or similar material, and connected with the insulated wires in the probe. These hidden wires lie loosely in the probe-shank, so that it may be bent in any way without putting them on the stretch. They are firmly fixed to a plug in the near end of the shank, so that they cannot be drawn tight. From this plug emerge two connecting pins to which the wires from the mouth-piece are to be attached.

"When the operator holds the mouth-piece in position by closing the teeth upon it, nothing is perceived until the electrodes in the probe end touch metal, when an immediate, *continuous*, and unmistakable sensation, together with metallic taste, is experienced. No contact except a metallic one will produce this phenomenon, the current engendered by the mouth-battery being too weak to be appreciated until this battery is short-circuited.

"The probe-end may be made of various shapes, giving more or less opportunity for double contact. It is found, however, that for a small button two electrodes are sufficient, while for a large button four or

more may be of advantage. A slight rotation of the shank, whether it be straight or curved, will usually suffice to establish double contact. The shank is made of thick-walled, flexible-metal tubing, but it should not be bent too near the end, for fear of breaking the button. The probe-shank may also be made wholly or in part of flexible material; for example, jointed metal, or, still better, woven catheter material (silk or linen).

"The probe may be improvised as follows: Cut both ends off a soft catheter. Take two pieces of wire and insulate them to within an inch of their ends by wrapping round each wire a layer of gutta-percha tissue and then warming, or even by winding the wire with adhesive plaster. Run the wires through the catheter, allowing the two ends to project at the proximal end. Two short ones, each bent on itself so that a smooth loop of wire may present, instead of a rough cut end, should project at the distal end. A drop of hot sealing-wax at each end fixes the wires to the catheter and isolates them firmly from each other. The long ends of the wire are now wound tightly around two coins, the one around the copper, the other around the silver piece, previously, of course, removing as much as necessary of the gutta-percha insulation. Entirely cover these connections with sealing-wax. This probe will now work well enough for an emergency, but the danger of short-circuiting in an improvised probe must be borne in mind. Short-circuiting in the probe made by the instrument-maker is hardly a possibility.

"With this instrument I performed the following experiment: Five shots were fired into a piece of raw beef, the bullets passing through a tough fascia, through two layers of muscle, and to or into bone beyond. Four of the bullets (22 caliber) were easily found. The fifth eluded my search, but section showed that the ball had bounded back from the bone, making a channel almost parallel with the one of entrance. The probe, therefore, never came in contact with the projectile."

A most painstaking search sometimes fails to find the bullet. In that case a drainage-tube should be passed into the wound for its entire length, and thorough asepsis maintained during the process of healing.

Besides bullets, other foreign bodies occasionally driven into the brain are portions of clothing, pieces of bone, bits of wood, hair, etc. These are almost certain to carry septic germs with them, and on that account should be removed at the earliest possible moment.

VII. SEPTIC INFLAMMATION WITHIN THE CRANIUM.

Septic germs may gain access to the brain and its membranes by any of the following routes:

1. Through the orbital cavity, because of the extensions of the subdural and arachnoid spaces along the optic nerve. Every suppuration in the orbital cavity or within the eyeball has a tendency to spread to the brain.

2. Through the nose. Septic infection in the nose may spread to the frontal and ethmoid sinuses, and through the naso-pharynx it may infect the ear.

3. By the ear. Suppuration in the middle ear, especially when the tympanum is destroyed, finds its way readily into the brain, and produces more brain-abscesses than all other causes combined. Fracture of the base of the skull involving the petrous portion of the temporal bone is for this reason a compound fracture, and must be treated as such.

4. Along the vessels which pass through the skull and form communications with the scalp and other soft parts without, and the brain and its membranes within, the cranium. Hence it is that a simple scalp wound (if dressed without aseptic care) or an attack of erysipelas of the scalp may be followed by meningitis or cerebral abscess.

Inflammation of the Brain and its Membranes.—It is impossible to diagnosticate with certainty inflammation of the membranes from inflammation of the brain itself. The following diseases may be recognized on the post-mortem table, but not clinically: Inflammation of the dura mater—*pachymeningitis;* inflammation of the pia and arachnoid—*leptomeningitis;* inflammation of the cerebrum—*cerebritis;* inflammation of the cerebellum—*cerebellitis.*

In every case of fracture of the skull or other severe traumatism of the head, and in all cases of suppuration in the orbit, the nose, or the middle ear, the onset of symptoms which indicate inflammation of the brain or its membranes should be carefully watched for.

Symptoms.—After an injury which causes primary meningitis, such as compound fracture of the skull, the first symptom may set in as early as the end of twenty-four or thirty-six hours. In other cases the evidence of encephalitis will appear when the septic infection reaches the membranes. The first warning symptom is generally a chill, followed by a rapidly rising temperature.

(*a*) *Nervous Symptoms.*—There is from the first malaise, then restlessness, increasing to such an extent that the patient becomes uncontrollable. Headache is present, and often intense, and there is intolerance of light and sound. Delirium follows, which after a variable length of time is succeeded by quiet and consciousness.

(*b*) *Febrile Symptoms.*—The temperature rises rapidly and reaches 103° or 104° F. The pulse at first is full and bounding, but afterward becomes small and weak. The eyes are red and congested. Constipation is an early and constant symptom.

(*c*) *Pressure-symptoms.*—Ptosis may be taken as an indication that the third nerve is suffering pressure at its origin or along its course; dilatation of the pupils, external strabismus, and loss of power of accommodation would be further evidence of an affection of this nerve. Incontinence of urine is common in the early stages, and retention at a late period. Paralysis of the tongue, loss of hearing, diplopia, etc. are indications of extension of the disease along the base of the brain.

Differential Diagnosis.—Pyemia may closely simulate encephalitis. Pyemia, however, does not set in before the end of the first week, while primary encephalitis usually occurs about the second or third day. Pyemia is also attended with more frequent and pronounced chills than encephalitis.

Uremic coma is distinguished from encephalitis by the presence of

albumin and tube-casts in the urine and by albuminuric retinitis. There is also edema of the feet and ankles; chills are usually wanting.

Treatment.—The patient should be kept in a darkened room and as quiet as possible. The bowels should be freely moved, but not to the extent of causing severe purgation. The head should be shaved and cold applied in the form of ice-bags or cold-water coil. During the stage of delirium the bladder should be emptied by the catheter at regular intervals. For the nervous excitement hydrobromate of hyoscin, gr. $\frac{1}{100}$, is one of the best remedies, care being taken not to push it so far as to obtain its toxic effects. Bromid of potassium is also an excellent sedative, and can be given in doses of thirty grains three times a day if necessary. Blisters to the nape of the neck and iodid of potassium internally are indicated when pressure-symptoms supervene. During convalescence, should such be the fortunate termination of the case, mental exertion should be avoided for many weeks.

The question of trephining for the relief of suppurative inflammation of the brain or its membranes is one involving considerable difficulty. On the broad surgical principle that pus should be evacuated and the cavity drained it would be clearly our duty to trephine, incise the dura, and drain in every case of suppuration of the encephalon. This, however, has not become an established usage. If the location of the diseased area can be made out by the existence of focal symptoms as definite as we find them in cerebral hemorrhage, for instance, there cannot be a doubt that the duty of the surgeon is to trephine over the area indicated and drain the suppurating part. The results are much more promising when the convexity of the brain is involved than when the base is the seat of the lesion.

VIII. ABSCESS OF THE BRAIN.

We should go far astray if we attempted to diagnosticate abscess of the brain by the symptoms which mark the course of abscesses in other parts of the body. For instance, a brain-abscess may not present any symptoms until weeks, months, or even years after the injury which was its direct cause. The body-temperature is high in ordinary abscess, but in cerebral collections of pus the temperature is normal or subnormal. The pulse, instead of rising to 100 or 120, falls to 60, 40, or even 30 beats per minute. The disease, however, is marked by very pronounced symptoms, and can in most cases be differentiated from other intra-cranial lesions.

The situations of abscess are practically the same as those of intra-cranial hemorrhage—viz. extradural, subdural, cerebral, and cerebellar.

Causes.—1. Suppuration in the middle ear. This is the cause of about 50 per cent. of all cases. It has always been supposed that acute inflammation of the ear seldom leads to brain-disease, but recent epidemics of influenza have shown that such is not uncommon. Chronic suppuration is always attended with danger. Between the tympanum and the middle fossa of the base of the skull is only a thin bony partition. When the mucous membrane is destroyed and the bone laid bare, disease can readily break through this thin plate and

produce inflammation of the membranes, abscess of the temporo-sphenoidal lobe or cerebellum, or thrombosis of the petrosal or lateral sinus.

2. Punctured wounds of the scalp extending to the bone, exposing and bruising the skull over a small area. The instruments causing such wounds usually carry infective matter with them. The bone once infected, thrombosis of the veins of the diploë follows, whence the infection is carried along the perivascular sheaths to the brain. It is this danger which renders the treatment of small scalp wounds so important. The wound may heal externally by first intention, and the patient may forget about his accident and follow his daily occupation, until, weeks or months afterward, cerebral symptoms begin to appear.

3. Punctured fractures are still more dangerous, as the infective material may be carried through the skull into the brain itself.

4. Compound fracture of the skull, provided the wound is large and drainage free, is not likely to be followed by cerebral abscess. Fissures of the skull are dangerous from the fact that there may be infection between the edges of the fractured bone. Such a wound cannot be cleaned by sponging or irrigation. The chisel alone is sufficient, and the best course is to remove a V-shaped portion along the line of the fissure.

5. Contusion of the skull without fracture is occasionally, a cause of cerebral abscess, but there is always an infection of the bone which finds its way to the membranes and brain by the vascular connections.

6. Necrosis of the skull not infrequently leads to the formation of an extradural abscess, which, if not relieved, is apt to extend to the cerebral tissue.

7. Erysipelas and other infective conditions of the face and scalp are, especially in aged people, causes of cerebral abscess. Here, again, the method of infection is thrombosis of the veins and conveyance of the streptococci to the intra-cranial tissues.

Symptoms.—As quite 50 per cent. of cases are due to suppuration of the middle ear, the symptoms as they occur in this class of cases will first occupy our attention. For a more exhaustive study of the subject I would refer the reader to the excellent work of Macewen, to which I am indebted for much that follows. It is convenient to divide the disease into three stages: (1) the initiatory, (2) the fully-formed abscess, (3) the terminations when uninterrupted by treatment.

The Initiatory Stage.—There is a history of chronic suppurative disease of the middle ear, or one of the traumatisms already described, or suppurative disease of the nose, mouth, or orbit. The otitis may have lasted many weeks or months, and may have caused little pain or inconvenience, when suddenly, after exposure to cold or after a blow or fall upon the head, or even without apparent cause, the patient becomes ill and the symptoms point to the brain.

Pain is first felt in the ear, and is described as burning or shooting in character. From the ear it soon spreads to the temporal region, and after twenty-four hours to the frontal and occipital areas. This diffusion of the pain must not be permitted to mislead the surgeon. for even when abscess is in the cerebellum the pain is often felt in the forehead (Macewen). In fact, in all head-affections the location of pain

is of very little diagnostic value. Sometimes the pain darts through the head from ear to ear. The pain often resembles severe neuralgic attacks, with intervals in which it is dull and aching. Rigors are often described by the patient's friends as convulsions, and care must be taken to differentiate between the two. Most cases begin with a rigor, just as we find in abscesses in other situations. The intensity of the chill varies greatly. In one case there may be a slight sensation of cold, in another a violent and prolonged shaking.

Vomiting is a common symptom and may be free from nausea.

The temperature in this early stage is slightly elevated and the pulse is increased in frequency.

The discharge of pus from the ear usually stops, and leads the laity into the belief that this stoppage is the cause of the whole trouble.

Second Stage.—The first or initiatory stage was attended with intense pain, increased temperature, rapid pulse. The second stage shows the reverse. Pain over the ear may still be complained of, but the violent diffused pain is no longer present. The patient's sensibility

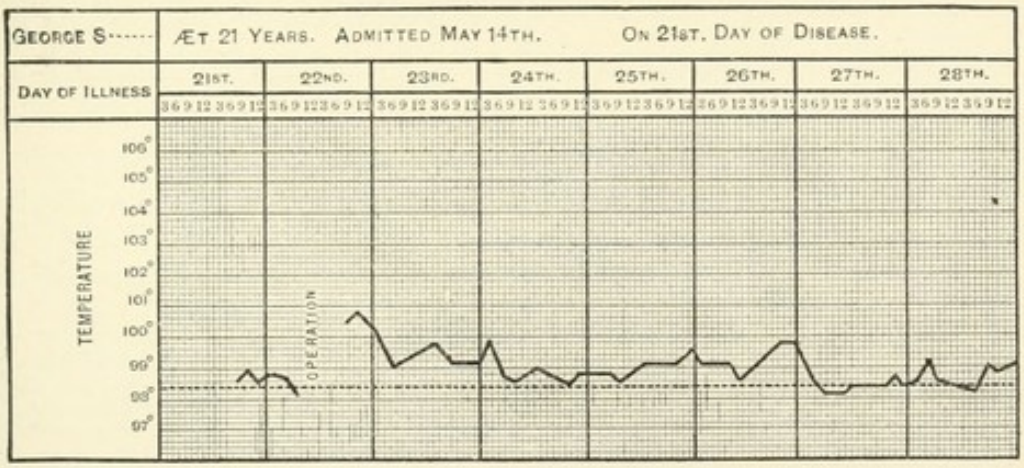


FIG. 212.—Abscess of the brain: temperature-chart of a typical uncomplicated case (Macewen).

is blunted because there is encephalitis, and the pain is really less on account of increased pressure and reduction of mental perception. Two very characteristic symptoms mark this stage: one is pain on pressure over the mastoid process and the squamous portion of the temporal bone on the affected side. The other symptom is delayed cerebration. When asked a question the patient stares vacantly and makes no immediate reply. The answer comes, however, after a brief interval, and is given in a slow, concise, dignified manner, and generally correct. Following this, or coincident with it, is a condition very similar to that which is produced by opium in large doses. The patient is unable to sustain his attention. In giving an answer which requires a number of sentences he gets lost in the middle, and is either asleep or has forgotten what he was talking about before his answer is finished. If he asks for something, he forgets all about it before his request is granted. Another characteristic of the mental condition is *inability to apply the strength.* He may be quite able to perform an act, but the will-power is wanting—a condition very familiar to those who have frequently taken opiates.

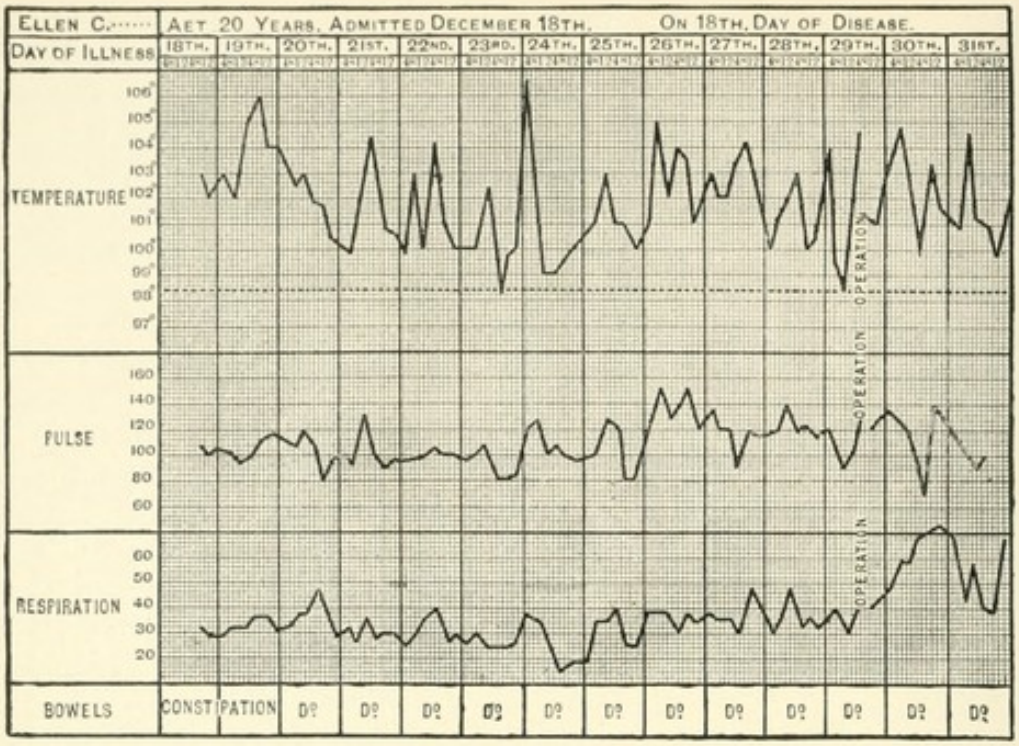


FIG. 213.—Chart of infective thrombosis of cavernous sinus, for comparison with that of cerebral abscess (Macewen).

The temperature in the second stage is normal or subnormal; its average range may be set down at 97° to 99° F.

Figs. 212, 213, 214 illustrate the difference in temperature between

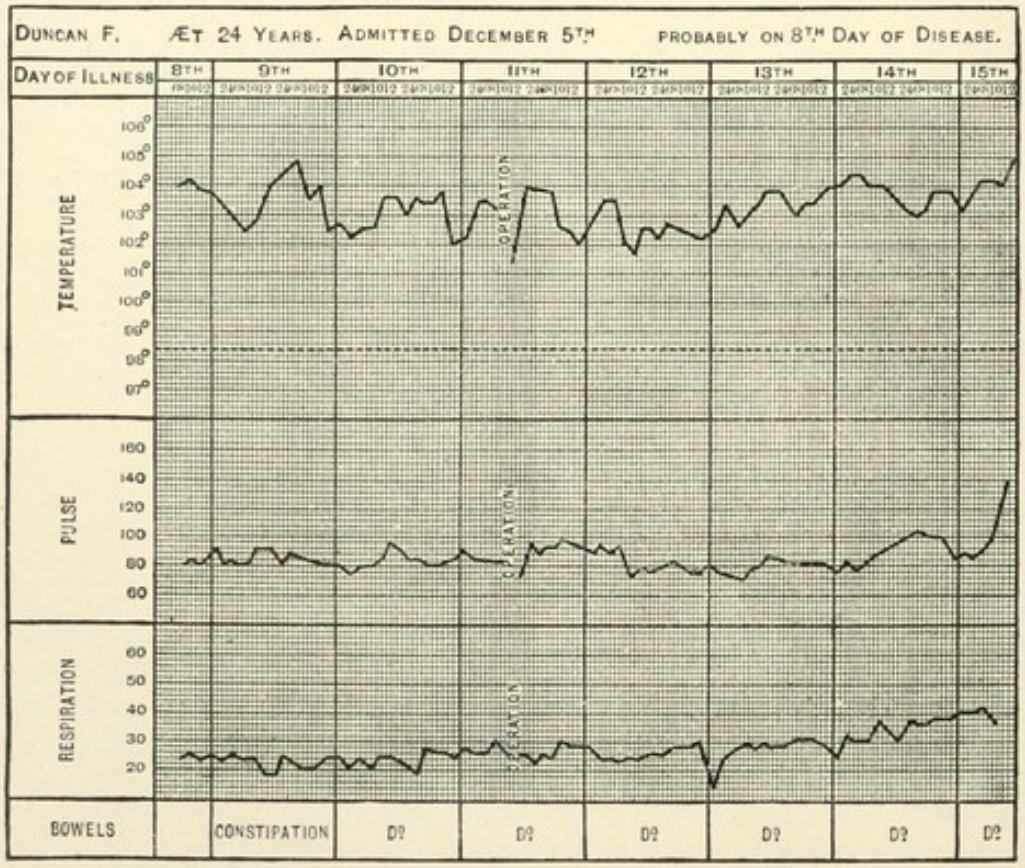


FIG. 214.—Chart of infective purulent cerebro-spinal leptomeningitis (Macewen).

cerebral abscess, infective thrombosis, and cerebro-spinal leptomeningitis.

The pulse also falls below normal, and may beat sixty, forty, or even thirty times in the minute. A slow pulse with a high temperature indicates intra-cranial disease; when pulse and temperature are both high, it points to systemic disease. A slow pulse is produced by pressure on the brain. It is found in abscess, in extradural blood-clots and intra-cranial tumors. The respirations are diminished in frequency, and may assume the Cheyne-Stokes character. This is especially the case when the abscess is in the cerebellum. Other symptoms more or less constant in this stage of cerebral abscess are constipation, vomiting, convulsions, rigors, and optic neuritis.

Third Stage.—If allowed to take its course, cerebral abscess usually ends in death. The patient may pass into a stage of profound stupor and die of coma. The abscess may rupture either upon the surface of the brain, and its contents spread over the convexity of the cerebrum, or it may burst into the ventricles, in either of which events a train of symptoms is produced whose universal termination is death. Spreading over the brain-surface, acute leptomeningitis is produced, and we recognize this new departure by the onset of rapid pulse and high temperature, vomiting, restlessness, squinting, flushing of the face, and spasmodic contractions of the muscles. When the abscess ruptures into the ventricles, a sudden and alarming change takes place in the patient's condition. The pupils dilate widely, the face becomes livid, and the breathing hurried, shallow, or stertorous. The temperature rises rapidly to 103°, 104°, or 105°, and the pulse comes up with a bound from 40 or 50 to 120. Convulsions are common, and the end may be expected in six to twelve hours from the time of rupture.

Besides the general symptoms just described, the situation of a cerebral abscess may be definitely determined by localizing symptoms. Arising from suppurative ear-disease, the abscess is usually in the temporo-sphenoidal lobe or the cerebellum, which are both remote from the motor area, but even then large abscesses may exert pressure upon the motor centers. When the abscess is in the frontal or temporo-sphenoidal lobe, the pupil on the same side may show any of the following conditions: 1. Contracted and stable: this indicates a slight degree of compression and a small abscess; 2. Dilated and stable: indicating a greater degree of pressure and a large abscess.

When there is sufficient pressure upon the third nerve to cause paralysis there are ptosis, external strabismus, and a fixed, dilated pupil of the same side.

Hemiplegia of the opposite side is observed in large abscesses. Aphasia is sometimes produced. Motor aphasia suggests pressure on Broca's convolution; sensory aphasia or word-deafness, the posterior half of the first temporal convolution.

Abscess of the occipital lobes is a rare affection and is generally pyemic.

Abscess of the cerebellum is attended with great prostration, feeble pulse and respiration, and low temperature. Certain muscular phenomena are sometimes observed; these are retraction of the head and neck and rigidity of the masseters, causing firm closure of the

mouth. Yawning is common, and speech when attempted is slow and jerky.

Differential Diagnosis.—In the early stage it is impossible to differentiate cerebral abscess from meningitis or acute encephalitis. In fact, at this stage the diseases are coincident, the abscess being surrounded by an inflamed zone of brain-tissue. Rigors occurring in the course of encephalitis should cause suspicion of abscess. Time is an important factor in diagnosis. Meningitis develops within three or four days, while abscess seldom appears before the end of a week. The onset of meningitis is also more abrupt, and is attended with delirium, high temperature, photophobia, and contractions of both pupils simultaneously; in abscess only one pupil is affected, and that on the side in which the abscess is situated.

Thrombosis of the Lateral Sinus.—In this condition the temperature is high, and the jugular vein is felt to be hard and knotted, for the thrombus which occludes the lateral sinus also extends into the internal jugular. Respirations are quickened and vomiting occurs when the patient is in the upright position. Pyemic symptoms develop at a later period, and when abscesses appear in the lungs and joints there can be no room for doubt.

Tumor of the brain is distinguished from abscess by the slow development of the symptoms. Febrile symptoms are wanting, nor is there a history of an injury or a suppuration which could be the source of infection. The localizing symptoms in the case of tumors are more definite than in abscess, and optic neuritis is more constant and pronounced.

An error to be carefully guarded against is the mistaking of a cerebral abscess, spreading from the middle ear through the tegmen, for disease in the mastoid cells. It has repeatedly happened that the surgeon has opened the mastoid cells without benefit, the disease going on to a fatal termination, and a post-mortem examination showing that the suppuration had spread through the tegmen, causing meningitis or abscess (Crafts).

Treatment.—*Prophylactic.*—There are few diseases in which so much can be done in the way of prevention as in abscess of the brain. A wound of the scalp, be it ever so small, should be treated with the utmost aseptic care. Too often such cases are rushed to the nearest drug-store, the blood washed off with an unclean sea-sponge and germ-laden water, a few locks of hair cut away with scissors, and an artistic stellate patch of sticking-plaster applied to the wound. Suppuration is inevitable, and the risk of septic infection ever present. In scalp-wounds and, *a fortiori*, in compound fractures, the scalp should be shaved for a considerable distance around the seat of injury; dirt should be washed off with soap and water, and, if a flap of the scalp is so impregnated that the dirt cannot be washed away, it should be removed with a sharp knife, so as to leave a freshened surface. Ether, alcohol, or turpentine should next be used, and afterward a solution of corrosive sublimate, 1 : 2000. If a fissured fracture of the vault holds in its grasp hair or other sources of infection, a V-shaped channel should be chiselled out, removing the lips of the outer and leaving the inner table of the skull. If the surface of the bone, without being fractured, has dirt

ground into it which cannot be washed out, the surface should be chiselled off.

When the dura mater or the brain has been infected in compound fractures, the dura should be freely incised and carefully disinfected. Fractures of the base or punctured fractures made by way of the orbit, the nose, or the mouth should be kept from infection by constant disinfection of the cavities, as also the cavity of the ear. Chronic suppuration of the middle ear should be looked upon as a constant source of danger and treated accordingly.

Abscess of the brain is almost invariably fatal unless means be taken to evacuate the pus and drain the abscess-cavity. The recent advances in brain-surgery have placed the operation of trephining for abscess on a sound basis, and many successful cases have been reported. The localizing symptoms must be mainly relied upon to determine the position for the opening in the skull. If a scar is present and the local symptoms indicate that the abscess is beneath the scar, the trephine should be applied there. If, on the other hand, the localizing symptoms point to some other part of the brain as the seat of abscess, the position of the scar should be disregarded.

The preparation of the patient and the mode of opening the skull have already been described. Macewen suggests that the exposed osseous surface made by the trephine be rubbed over with iodoform and boracic-acid powder to protect the bone from contamination by the pus about to be withdrawn.

On opening the dura mater the brain-substance will bulge up into the wound, and if the pressure be great the normal pulsations will be wanting. The best instrument for exploring the brain is an ordinary grooved director. It is pushed gently into the cerebral substance at right angles to the surface and in the direction in which the collection of pus is supposed to lie. When the cavity is reached, the operator is warned of the fact by a sense of lessened resistance and by the appearance of pus in the groove of the instrument. Should the first attempt fail, the director is to be withdrawn and passed in another direction, nothing being done which will change the puncture to a laceration of the brain-substance. When pus is found a fine straight knife is passed along the director, and an opening made sufficient to admit a pair of hemostatic forceps. The latter instrument is then passed into the abscess, moderately opened and withdrawn, so as to dilate the incision made by the knife. The granulation-tissue lining the cavity is next carefully and gently scraped away with a spoon and the cavity washed out with boric-acid solution. A rubber drainage-tube is passed down to the bottom of the cavity and made to emerge through an opening in the scalp, to which it is attached by a stitch. The bone is not replaced. A moist dressing is applied. At the end of forty-eight hours the tube is shortened from day to day until it is no longer required. It must be borne in mind that suppuration is apt to recur, and this may be months and even years after apparent healing. On this account the drainage-tube should not be removed too early. It must be remembered, too, that drainage-tubes do not act so effectually here as elsewhere; an abscess once evacuated, the walls of the cavity rapidly come into contact with each other as a result of pressure in the neighboring areas.

In this way it is easy for septic germs to be retained instead of coming away with the drainage, and such germs, remaining latent for a time, may result in abscess at a remote period.

Abscess of the cerebellum is best reached by a trephine opening made just below the position of the lateral sinus—that is to say, below a line leading from the external auditory meatus to the external occipital protuberance. The proper point on this line is one midway between the tip of the mastoid process and the inion. Abscess in the *frontal lobes* is reached either from the temporal region or from the front of the brow according to the position of the abscess. If the pus is contained in the posterior part of the lobe, it is best reached from the temple, but at the same time there is a danger that after going through the temporal muscle suppuration may take place beneath it, the part being infected from the abscess. By the frontal route the danger is that the frontal sinus may be opened into. In cases which involve the sinus itself this opening is a necessity. To expose the cribriform plate of the ethmoid a small opening may be made a quarter of an inch above the glabella, "remembering that the frontal lobes dip at this point to the level of the nasion" (Macewen).

When the cerebral abscess is a result of disease in the middle ear the first procedure in an operative way is the opening of the mastoid process and its thorough cleansing. A vertical incision two inches in length is made a quarter of an inch behind the external auditory meatus, beginning at the posterior root of the zygoma and ending a third of an inch from the tip of the mastoid process. The incision is made down to the bone, and the periosteum and soft parts are separated forward so as to expose fully the external auditory meatus. This flap, including the auricle, is held forward by a sharp retractor, and bleeding points, if any, are stopped.

At this stage Macewen recommends attention to the three following points: "First, the position of the suprameatal triangle—a triangle formed by the posterior root of the zygoma above, the upper and posterior segment of the osseous external meatus below, and an imaginary line uniting these two extending from the most posterior portion of the external osseous meatus to the zygomatic root (Figs. 215, 216). Within this triangle and touching its base the opening into the mastoid antrum is made with safety. Second, the degree of obliquity of the posterior osseous wall of the external auditory meatus, as when this wall is directed more obliquely from behind forward, the mastoid antrum is situated slightly more anteriorly than when the osseous wall of the meatus is directed more transversely from without inward. Third, the depth of the inner wall of the tympanic cavity from the level of the skull at the osseous portion of the external auditory meatus, which may be determined by introducing a probe through the external ear till it comes gently in contact with the inner wall of the tympanum, the membrane having been previously perforated by pathological processes, and then marking on it the limit of the outer aspect of the osseous meatus. If the middle ear lie deep, the mastoid antrum, which is more superficial, may be expected to be relatively deeply seated."[1] The opening into the antrum is made slightly forward

[1] *Diseases of Brain and Spinal Cord*, p. 297.

to avoid the sigmoid sinus. At the depth of half an inch lies the facial nerve, and this must be avoided, twitching of the facial muscles

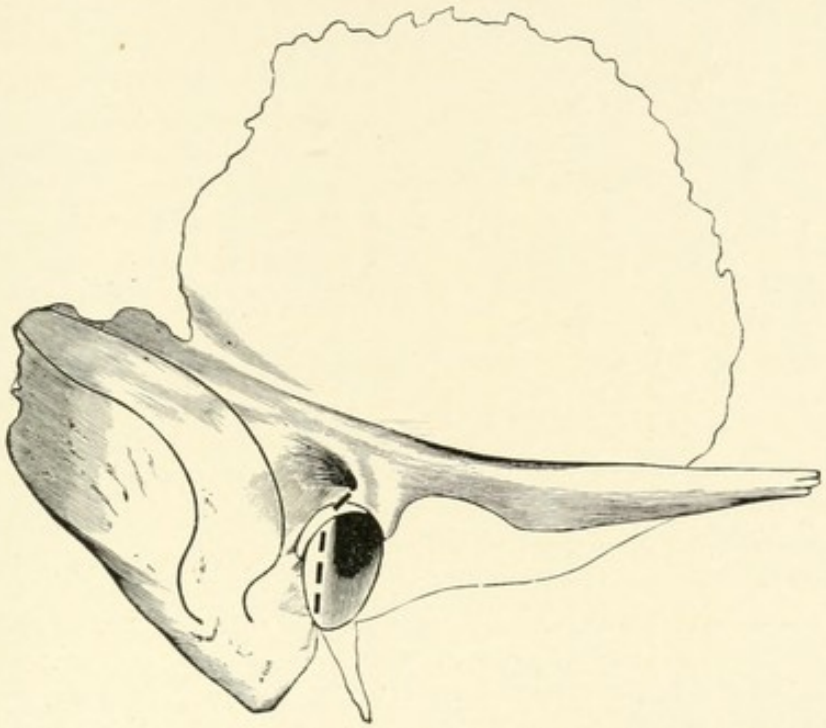


FIG. 215.—Schema of squamo-mastoid portion of the temporal, showing the suprameatal triangle in relation to the sigmoid groove and facial nerve (Macewen).

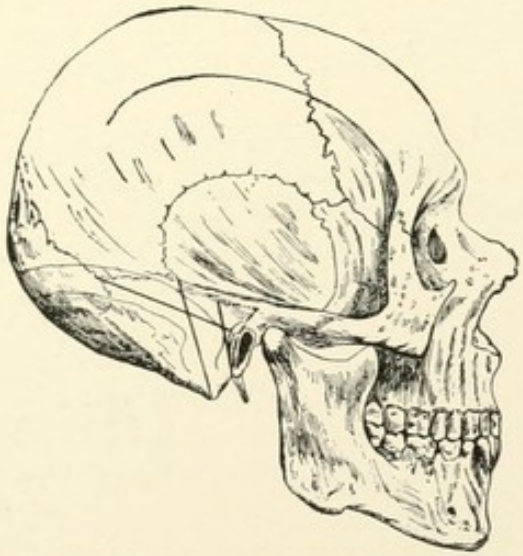


FIG. 216.—Surface guides for the sigmoid sinus and the suprameatal triangle (Macewen), artificial lines drawn upon the skull indicating the following: (1) The short vertical line from the posterior border of the external auditory meatus to the posterior root of the zygoma marks the base of the suprameatal triangle (*a*); the *broken* line indicates the anterior border of the suprameatal triangle, its base being the *dotted* line marking a part of the root of the zygoma. This broken line also indicates the course of the facial nerve. (2) The second vertical line, extending from the parieto-squamo-mastoid junction to the tip of the mastoid; the upper two-thirds of its length indicates the position of the sigmoid sinus. (3) The oblique line passing from the asterion to upper limit of the external auditory meatus indicates the posterior two-thirds of the sigmoid sinus from its commencement to its knee.

giving warning when the nerve is too closely approached. For its avoidance Macewen advises keeping close to the floor of the middle fossa and nearer to the posterior border of the opening, toward the

posterior superior angle of the suprameatal triangle. Should this operation fail to relieve the symptoms, the abscess must be looked for in the temporo-sphenoidal lobe by a new opening. This opening should be made one and a quarter inches behind, and the same distance above, the external auditory meatus. A quarter-inch trephine is large enough to begin with, the opening being afterward enlarged, if necessary, by the rongeur forceps. The dura mater is incised and a grooved director passed into the brain-tissue, as already described. The instrument should be made to take a direction toward the opposite ala of the nose—that is to say, downward, forward, and inward. Failing to find pus in this direction, the director is withdrawn and careful search made in other parts of the lobe.

Thrombosis of the lateral sinus is a sequel of suppurative disease in the middle ear, and is usually associated with pyemia. The symptoms are so similar to those of cerebral abscess that until recent years the two conditions were confounded. Like abscess, thrombosis occurs in the course of chronic otitis media, and is ushered in by vomiting, headache, and pain in the region of the sinus. Rigors and rapid rise of temperature are common, there is edema behind and over the mastoid, and the cervical glands may be enlarged. In many cases there are the general symptoms of pyemia. When pyemic symptoms are wanting the diagnosis must rest upon two points—viz. tenderness along the course of the lateral sinus—that is, from the external auditory meatus to the external occipital protuberance—and tenderness along the course of the internal jugular vein, the vessel feeling hard and knotted to the fingers. Choked disk is usually present, and the temperature, as a rule, runs high, instead of normal or subnormal, as in cerebral abscess.

Treatment.—When allowed to go unrelieved by operation, the disease is always fatal, while about 66 per cent. of cases operated upon have ended in recovery. The mastoid is opened in the manner already described and thoroughly cleansed. The sinus is next exposed, and the thrombus or pus, as the case may be, washed out. Hemorrhage is checked by packing the sinus with strips of iodoform gauze. Finally the internal jugular is exposed down to the farthest limit of the thrombus, and here the vessel is tied to prevent the clot extending toward the heart. Too much stress cannot be laid upon the importance of properly treating otitis media, which is so common a source of abscess and thrombosis.

IX. CEREBRAL TUMORS.

The tumors met with in the brain are the following: Glioma is formed in the cerebrum, seldom in the cerebellum or the spinal cord. Sarcoma occurs most commonly at the base of the brain, and in most cases arises from the dura mater, the periosteum, or the bone itself. It varies in size from a walnut to the human fist, and may be solitary or multiple.

Carcinoma is usually secondary to the disease in the breast, the lung, or the pleura, and occurs as a soft tumor in the ventricles, frequently causing hydrops ventriculorum. Tubercular growths are the most fre-

quent of all cerebral neoplasms. Their most common seats are the pons, the cerebellum, and the cortex. Syphilomata or gummata chiefly occur in the dura mater, and thence spread to the brain-substance. The growths, in appearance, closely resemble tubercles, but are readily distinguished by absence of the tubercle bacilli.

Symptoms.—Tumors of the brain produce no symptoms until they are sufficiently developed to cause irritation by pressure upon or destruction of the neighboring brain-tissue. Apart from pressure, however, it is certain that tumors, especially those of an infective character, are capable of producing irritation of the adjacent parts, which may be manifested by clearly-marked symptoms. The evidences of a cerebral tumor are of two kinds, general and focal.

General Symptoms.—*Headache* is one of the earliest and most constant of all the symptoms. It begins as a dull, indefinable pain which the patient cannot localize. His head aches all over, and as the disease advances the suffering may be so intense as to threaten his reason. The slightest movement or the slightest percussion of the head greatly aggravates the pain. It is difficult to imagine a more pitiable condition than that caused by a cerebral tumor. Tormented by day and by night, the patient has occasional remissions, but never freedom from pain—pain that even continues in sleep, and wears and wastes the sufferer till his nervous system becomes a wreck—no relief from remedies, no hope of ease except through long-delayed death.

Pain, as distinguished from headache, is an almost constant symptom. It is increased by pressure, but more particularly by percussion.

Vomiting is generally present. It has no connection with the ingestion of food, is unattended with nausea, furred tongue, or constipation.

Epileptiform convulsions may be general or confined to one side, and in one or other of these forms they occur in about 50 per cent. of all cases. Consciousness may or may not be lost during the attacks. The value of convulsions as a diagnostic sign is thus summed up by Horsley: "Of all the initial symptoms of cerebral tumor, the epileptic convulsion is the most important, not only because it is a clear indication, but also because tumors causing the most characteristic forms of epilepsy are the most easily removed. The convulsions may be—1. General, and so simulate idiopathic epilepsy; 2. Generalized, but preceded by a localized aura; 3. Though generalized, also commenced by a localized muscular spasm; 4. A typical Jacksonian fit, becoming in some cases more generalized, and in some followed by a certain degree of paralysis; or, 5. It may evince itself by single spasms, not grouped as in a complete fit."

Some idea of the location of the tumor may be formed by studying the characters of the fit. "Lesions of the frontal lobe appear to produce convulsions of the generalized type, and, above all, as Dr. Jackson has often pointed out, convulsions in which movements of a half-purposive character are very prone to be exhibited." The first disturbance during the fit is the turning of the head and eyes to the opposite side, and this is explained by the fact that the cortical center for this movement is situated farthest forward of all the centers, and the progress of the disease is from before backward.

"The parietal lobe may be assumed to be the seat of tumor if the

convulsions are of the pure Jacksonian type, because the parietal lobe contains a large proportion of the most important motor-centers.

"Tumors of the parieto-occipital region will probably be characterized by general convulsions, with ocular deviation and visual auræ.

"Tumors of the occipital lobe most commonly present generalized convulsions, hemianopsia from destruction of the cuneal region, and are not infrequently accompanied by so-called hysteric manifestations. Hemianopsia, it is to be noted, is also a frequent and, in fact usual, accompaniment of tumors in the parieto-occipital region when the lesion burrows deeply and so affects the optic radiations. Finally, in the case of tumors exciting epilepsy from the occipital lobe it is to be remembered that, owing to vertical pressure on the tentorium, they may also give rise to symptoms resembling closely those of cerebellar growth; for example, nystagmus, tottering, etc. Epileptic convulsions from lesions of the temporal lobe have been observed in cases of gross organic disease (published by Dr. Thomas Wilson and others), and are preceded by a sensory aura of the auditory type, also by the occurrence of amnesia; and further, when paresis follows, it is apt to be of a graduated type from the pressure on pyramidal fibers and areas of motor representation in the cortex. Those cases of tumor of the inner surface of the temporal lobe which have been carefully observed are extremely interesting, for they have shown that the epileptic convulsion is characterized by the occurrence of hallucinations of smell and taste, the special-sense area of representation of these functions having originally been demonstrated by Dr. Ferrier to be situated in this region. It should be noted that, whatever be the nature of the fits in the subsequent progress of the case, the initial attack is very often a generalized one. Moreover, in a certain number of instanҫes the attacks are sometimes localized and sometimes generalized in the same case. The largest tumor I ever removed (the case of a lady operated upon six months ago, she being still in good health and recovering from the paresis) was treated for more than nine years as one of idiopathic generalized epilepsy, and that even at a time when the growth was already penetrating the skull. A careful analysis and observation of the fits would have shown that many of them were characteristically unilateral. The larger and more deeply seated the growth, the more generalized are the convulsions. There is frequently present in cerebral tumor a general muscular weakness, which has often been confounded with simple neurasthenia, and has sometimes led to a mistaken diagnosis of hysteria; cases of this kind have from time to time been reported."[1]

Vertigo is more characteristic of cerebellar than of cerebral tumor, and a peculiarity of it is that it continues while the patient occupies the recumbent position.

Impairment of mental faculties constitutes another very important general symptom. This is first noticed by the patient's friends, who are grieved to find that his mind is becoming weakened. His memory begins to fail, he loses himself in places that are most familiar to him; his movements become slow, awkward, and unsteady, and his face

[1] *American Year-Book of Medicine and Surgery*, 1896.

assumes a vacant and listless expression. Although he may be highly educated, the simplest arithmetical problems are beyond him, and he even forgets how to read and write. From this step to complete insensibility is short, and he may become so helpless as to allow his urine and feces to escape unheeded.

Eye-symptoms are often of great value in arriving at a diagnosis. Choked disk is pretty constant, and may be found in both eyes or limited to one. If the latter, it may be fairly assumed that the tumor is in the opposite hemisphere, but no idea can be formed of the size and position of the growth. When choked disk and optic neuritis are found coexisting in both eyes, it may be inferred that the tumor is on the side opposite to the eye which has the most swelling. It must not be forgotten that simple anemia may cause choked disk just as typical as can be found in cases of cerebral tumor. Although neuritis may be long continued, it must be regarded as a transient symptom. The papillitis may have passed away, with the exception of remnants in the form of spots of degeneration in the retina filling in the center of the disk or white tissue along the line of the vessels.

Paralysis of a muscle or group of muscles about the eye is not of special value in the diagnosis of tumor, except as corroborating other symptoms. It is an evidence that the origin of the nerve or the nerve itself is suffering pressure or irritation. Spasm of muscle is more valuable as indicating that the *cerebral center* from which the nerve arises, and not the *trunk* of the nerve, is the seat of pressure.

Hemiplegia has been observed in a number of cases, and, strange to say, the tumor which appears to produce it may at the autopsy be found in an indifferent area. We would naturally expect that a right-sided hemiplegia would be associated with a tumor pressing on the left Rolandic fissure, but in such cases the tumor has been found in the white matter of the frontal lobes (Hirt).

Focal Symptoms.—The first of these to demand attention is *hemianopsia*. If each retina be divided into two hemispheres by a vertical line, and it be found that the right half of each is insensible to vision, it will also be found that objects in the left half of the visual field are not seen. If, on the other hand, the left half of each retina is blind, it follows that objects in the right half of the visual field are not seen. This condition is known as homonymous hemianopsia.

The great value of this symptom is, that it points to the cuneus as the seat of the lesion, and the tumor, if such be the cause of compression, is situated on the same side as the blindness.

Aphasia.—Is the person right- or left-handed? If left-handed, motor aphasia is an indication that the pressure is upon Broca's area on the right side, and if right-handed, it is upon the left side.

Sensory aphasia, or word-deafness, by which is meant the loss of memory of the sound of a word, points to the posterior half of the first left temporal convolution as the seat of the lesion.

Alexia, or word-blindness (the loss of memory of words as they appear when written or printed), indicates that the tumor is situated in the left parietal lobe and at the lower posterior portion, especially the angular and supramarginal gyri.

Agraphia, or loss of memory of the movements necessary to con-

vey our thoughts in writing, points to a lesion either below Broca's area or near the area which controls movements of the hand.

Paralysis.—Facial paralysis would be an indication that the lower third of the opposite Rolandic fissure was suffering compression; paralysis of the arm would point to the middle third; and paralysis of the leg, to the upper third of the fissure on the opposite side. The uncertainty of hemiplegia as a symptom has already been noted. When focal symptoms appear early in the disease it is an indication that the tumor is basal, producing fatty degeneration and gray atrophy of the involved cranial nerves (Hirt).

A tumor in the anterior fossa of the base will affect the olfactory, the optic, the motor oculi, and the first branch of the fifth nerve.

A tumor in the middle fossa will affect the motor oculi, the pathetic, and the chiasm if situated above the dura mater, and the ocular nerves and the fifth if situated below the dura.

A tumor in the posterior fossa will affect the facial, the trigeminus, the auditory, the glosso-pharyngeal, the vagus, the accessorius, and the abducens (Hirt). In many cases it is impossible to differentiate tumors of the posterior fossa from tumors of the cerebellum.

Diagnosis.—Although some cases present a train of symptoms which, if properly interpreted, lead to a positive diagnosis and afford beautiful examples of inductive reasoning, there are others in which the most valuable symptoms are in abeyance throughout the entire course of the disease. Headache is a leading symptom, but there are cases in which it stands alone for months or even years, and without the combination of other general or focal symptoms it is liable to be regarded as obstinate hemicrania or migraine. Headache from causes other than brain-tumor is never constant. It is relieved by ordinary remedies, and there are remissions during which pain entirely ceases. It is not so with cerebral tumors: once in pain, always in pain—no remission that brings complete relief, no restful sleep, and no improvement from the use of drugs.

In another class of cases vomiting and vertigo are the only symptoms. These two symptoms are common to so many morbid conditions of the brain that if unsupported by other evidence they do not give sufficient data for a diagnosis of tumor. They are, however, sufficient to draw our attention to the possibility of a tumor, and an exhaustive examination of the eye and other focal symptoms may bring further evidence to light.

In still another class of cases convulsions may stand as the only witness. The question of epilepsy must then be settled. Convulsions of an epileptic origin generally come at intervals of considerable length, and are more or less relieved by bromid of potassium and other remedies. The convulsions of brain-tumors are persistent, and treatment is of little or no avail. The brain-lesions which come nearest to tumors are abscess, meningitis, and thrombosis of the lateral sinus. The onset of tumor-symptoms is more gradual than in any of these: there is an absence of fever and no change of temperature, except that in the later stages it may be subnormal, and may be taken as an indication that the end is not far off. In abscess there is generally a cause which leads up to infective inflammation and culminates in abscess. The pulse

is increased in frequency, and the temperature is elevated during the inflammatory stage and changed to subnormal conditions during the existence of the abscess. Acute abscess of the brain should give rise to no difficulty in diagnosis, but chronic abscess may in every particular so closely resemble tumor as to make a positive diagnosis impossible. However, as pointed out by Horsley, this is not of so much importance as might at first appear, since the skull must be opened for the relief of either condition.

Meningitis is usually acute in its character throughout. Thrombosis of the lateral sinus has its tenderness along the line from the external auditory meatus to the inion, and there is a knotty, tender condition of the internal jugular vein.

In order to make the examination complete and exhaustive Weir and Seguin recommend that in every suspicious case answers be obtained to the following six questions: 1. Is there a tumor? 2. What is the location of the tumor? 3. At what depth does the tumor lie—that is, is it cortical or subcortical? 4. Is the tumor single or multiple? 5. What is the size of the tumor? 6. What is the nature of the tumor?

In the present state of our knowledge our answers must be based upon the following considerations:

1. *Is there a tumor?* The answer must be "Yes" if we find the following symptoms or a majority of them: (*a*) Headache persistent and not localized, with remissions, but never absence of pain. (*b*) Localized tenderness elicited by pressure with the thumb. (*c*) Convulsions, general or local. (*d*) Cerebral vomiting and vertigo. (*e*) Changes in the mental condition. (*f*) Paresis or paralysis of muscles or groups of muscles. (*g*) Choked disk (not dependent upon anemia), hemianopsia, aphasia, and other impairments of speech. Perhaps the most important of all signs of cerebral tumors is the fact that all its manifestations are *steadily progressive.*

2. *What is the location of the tumor?* The answer must be determined mainly by the focal symptoms and the character of the convulsions.

(*a*) *The Frontal Lobe.*—Focal symptoms may be entirely wanting if the tumor is in the anterior portion of the lobe, as this is a latent zone. In a case reported by Raymond the symptoms were general weakness and helplessness, but no true paralysis, headache, amaurosis, and busy psychical delirium without physical restlessness. Changes in the disposition of the individual, dementia, and mania are symptoms of the greatest value. There are usually also optic neuritis, vomiting, and the characteristic headache. Convulsions can only be of value when the disease has progressed toward the posterior portion of the lobe and presses upon the area which controls movements of the head and eyes, as already described.

(*b*) *The Parietal Lobe.*—Here the focal symptoms are invaluable, as this lobe contains a large area of the principal motor centers. The convulsions are usually of the pure Jacksonian type; the focal symptoms may point to the arm, leg, or face area, and the evidence is still more satisfactory if the history of the case shows that the several areas have been encroached upon in their proper order.

(*c*) *The Occipital Lobe.*—Hemianopsia is here a valuable symptom, as pointing to the cuneus. Frontal headache, optic neuritis, optic spectra, sometimes total blindness and widely dilated pupils, are the leading symptoms. The convulsions are generalized and accompanied by the so-called hysteric manifestations.

(*d*) *The Pituitary Body.*—According to Andriezen, lesions of this body are manifested by the following symptoms: (1) Depression and apathy; (2) general muscular weakness; (3) loss of fine co-ordination equilibration; (4) generalized twitching and spasms of the muscles; (5) subnormal temperature; (6) wasting of the body-tissues; (7) attacks of dyspnea; and (8) rapid progress toward death. Woolcombe reports a case in which all the symptoms except dyspnea and muscular twitchings were present.[1]

(*e*) *The Corpora Quadrigemina.*—Tumors in this region are interesting on account of the resemblance of their symptoms to those of cerebellar tumors. In one case, that of a boy four years of age, double ptosis was the first symptom, after which decided ataxia of locomotion was developed, and of the upper limbs two weeks later. He was drowsy, spoke slowly, presented complete double external ophthalmoplegia, lateral nystagmus, and blindness, but no optic neuritis or choroiditis. He died six months after the first symptoms appeared. The autopsy showed the corpora quadrigemina gray and gelatinous in appearance, the result of glio-sarcomatous infiltration.[2]

3. *At what depth does the tumor lie—that is, is it cortical or subcortical?* This question is more easily asked than answered. In cortical tumor there is usually an absence of anesthesia, the number of centers pressed upon is not so great, and the focal symptoms are more sharply defined. Local pressure by the thumb may possibly elicit tenderness, and there may be a rise of temperature. We must admit that our knowledge on this point is very limited, and when we undertake an operation for the removal of brain-tumor we have to take chances as regards its depth.

4. *Is the tumor single or multiple?* The answer must rest upon the precision of the focal symptoms. If only one area suffers pressure, the tumor is single and probably small. If several areas far apart show symptoms of pressure, there are several tumors or one very large tumor.

5. *What is the size of the tumor?* Here, again, the focal symptoms must be our guide. The size of the tumor is probably in proportion to the number and extent of the areas pressed upon.

6. *What is the nature of the tumor?* Statistics are of some value in answering this question. Before twenty years of age tuberculosis is more frequent than any other disease. If the patient has suffered from cancer of the breast, lung, or pleura, the brain-tumor is also probably cancerous; cases of this kind are of course beyond our help. Syphilitic gumma may be diagnosticated if the patient shows a history of syphilis in other parts of his body. As in syphilis elsewhere, we can always fall back upon therapeutics as an aid to diagnosis, and, putting the patient upon antisyphilitic treatment, watch the result. If, after pushing the iodid for six weeks, and increasing the dose until it reaches

[1] *Ann. of Med. Sciences*, 1895, vol ii. p. 39, A.

[2] *Op. cit.*, p. 40, A.

half an ounce a day, there be no improvement, it will then be proper to attempt the removal of the tumor by operation.

Prognosis.—The life of a person suffering from a tumor of the brain (except those which are gummatous and yield to syphilitic treatment) is practically without hope. The symptoms are steadily progressive, and if left to Nature the only result is death. The duration of the disease varies greatly, and the wiseacre who is in the habit of setting dates for his patients to die is likely to prove a false prophet. Roughly speaking, the disease proves fatal at the end of one or two years, but sudden death may occur at any time, as is peculiarly the case in brain-lesions.

Treatment.—Except for syphilitic gummata, no medicinal treatment affords the slightest hope of cure. Operation for the removal of the neoplasm holds out the only hope in the majority of cases, for, although the percentage of complete recoveries is not large, every case that lives is a life saved. Not more than 10 to 14 per cent. of all cases of brain-tumors are so situated as to warrant surgical interference. In 5 to 7 per cent. the neoplasm can be removed; in an equal number benefit may be obtained by relieving pressure. A great deal of skill and judgment is necessary to decide upon the propriety of operating in any given case, and the decision must not be hastily arrived at. The operation is practically the same as that described for abscess of the brain.

Tumors of the Cerebellum.—The early symptoms of tumors of the cerebellum are almost identical with those attending growths in the cerebrum, except that they come on more rapidly. Headache is severe, and, although it may be confined to the occipital, it is frequently felt in the frontal, temporal, or parietal region. Vertigo, vomiting, convulsions, and optic neuritis develop much more rapidly than in cerebral tumors. Later, there are developed local symptoms which are very characteristic—viz. cerebellar ataxia and the staggering gait. When the staggering gait is observed, it indicates that the middle lobe of the cerebellum is the seat of a lesion or is suffering pressure from surrounding parts. If the symptoms appear early in the disease, we may assume that the tumor began in the middle lobe; if it comes on late in the disease, the assumption is that the tumor had its beginning in one hemisphere, and grew to such an extent as to exert pressure on the middle lobe. In a case reported by Crafts the tumor began in the hemisphere, and remained latent until it encroached upon the middle lobe, when symptoms suddenly supervened, and death followed at the end of three months. In a large number of cases it has been observed that the patient staggers away from the side on which the tumor is situated. In 20 cases in which staggering to one side was a prominent and constant symptom, 16 staggered away from the side of the lesion and 4 toward the side of the lesion (Starr). According to Dr. Risien Russell, the deep reflexes may afford valuable diagnostic data. He has proved that in cerebral tumor the deep reflexes are exaggerated on the *opposite side*, but in cerebellar on the *same side* as the tumor. Other authorities place no value on the reflexes. The cranial nerve-affections, such as strabismus, facial or lingual paresis, etc., should be carefully studied. The symptoms appear on the same side as the tumor. Paralysis of

muscles about the eye is useful as a diagnostic point between tumor of the corpora quadrigemina and tumor of the cerebellum.

If the ocular paralysis precedes the ataxic symptoms, the tumor is in the corpora quadrigemina; if the ataxic symptoms come first, the tumor is in the cerebellum (Bruns).

Treatment.—The cerebellum is not within easy reach, as only one of its three surfaces is in contact with the skull, nor is it possible to tell whether a given tumor is near that surface or in a more remote and inaccessible part. For these reasons operations for the removal of cerebellar tumors are even less encouraging than operations on the cerebrum.

X. EPILEPSY.

It has long been recognized that wounds and injuries of the head are, in a certain proportion of cases, followed by epilepsy. In the Franco-Prussian War, of 8985 individuals wounded on the head, 46 were afterward afflicted with epilepsy, while of 77,461 persons wounded in the body or extremities, only 17 became epileptic.

This liability to epilepsy is one reason why scalp wounds, fractures, and other head-injuries should receive the most careful treatment at the outset. It is much easier to remove a depressed spiculum of bone shortly after the accident than to cure an epilepsy which, as a result of the depression, comes on months and years afterward.

In examining a patient suffering from epilepsy we must keep before our minds the following varieties of the disease:

1. *Idiopathic Epilepsy.*—This is the ordinary disease as met with in medical practice. It has no assignable cause, and its nature has never been discovered. Patients suffering from this form of the disease are suddenly seized with a fit; they can give no warning, except perhaps a faint cry; they lose consciousness immediately, and fall down in convulsions which are general, first of a tonic and then of a clonic character. These movements last for several minutes, and then the patient falls asleep, to awake in a worn and exhausted condition.

2. *Jacksonian Epilepsy.*—Dr. Hughlings Jackson as far back as 1864 recognized a class of epileptics in whom the convulsions began with a conscious sensation in some definite part of the body, either one-half of the face or one of the extremities. The sensation or aura is followed by convulsive movements of the muscles of the part; the patient, as a rule, retains consciousness throughout, except when the convulsion becomes general. Although Jackson's observations were made long before the question of cerebral localization had received much light, he positively affirmed that the parts of the brain affected in epilepsy of this type were the convolutions on either side of the fissure of Rolando. Cerebral localization has proved that he was correct. It is not uncommon to find this convulsion beginning in the face, thence spreading to the arm, and lastly to the leg, indicating that the organic lesion is producing irritation in the lower, middle, and upper thirds of the fissure of Rolando consecutively.

The convulsion in Jacksonian epilepsy begins in four different ways:

(*a*) *The motor form*, just mentioned, begins with disturbance in the motor area, and the aura is felt in the face, the arm, the leg, etc.

(*b*) *The Sensory Form.*—In this variety one of the special senses is the seat of the aura. If a warning of an impending convulsion comes to the patient as a *sound*, the affected area is in the temporal region; if as a perversion of *taste* or *smell*, the temporo-sphenoidal region; and if as an hallucination of *vision*, the occipital region is the part affected.

(*c*) *The Aphasic Form.*—In one class of cases the convulsion begins with spasm in one side of the face, immediately followed by loss of the power of speech. This may be the one symptom noted in the whole attack. In a right-handed person this would point to a lesion in the third frontal convolution in the left hemisphere, and in left-handed persons to a lesion in the corresponding area in the right side.

(*d*) *The Psychical Form.*—In this form there is no convulsion. The patient suffers a temporary aberration of mind. He becomes maniacal or simply bewildered and stupid, and afterward has no recollection of what occurred during the attack. In this class of cases the lesion is in the frontal lobes.

The interesting feature in regard to epilepsy is that a large number of cases result from injuries. A spiculum of bone, a dense cicatrix, a depressed fracture, and a clot of blood resulting in a cyst are causes which are within the surgeon's power to remove, while the ordinary type of general epilepsy is beyond surgical aid.

Epilepsy resulting from traumatism is usually long delayed, the first convulsions coming on weeks, months, or even years after the injury. The fits at first are mild and less frequent than they are at a later stage, when the disease is fully developed.

In examining a patient for epilepsy the history requires the closest attention; the minutest details of the accident, notwithstanding it may have happened years before, must be thoroughly revived. To examine the head for scars and depressions the scalp must be shaved. The character of the convulsions must not be received from the patient's friends, as they are usually unable to describe accurately what took place during a convulsion, their minds having been occupied in the care of the patient. When possible, the surgeon himself should observe one of these fits, or at least have the evidence of a trustworthy nurse. Care should be taken to ascertain the part in which the aura begins, the muscles first affected, and the order in which the several areas are attacked. Thus an aura beginning in the leg, followed by twitching of the extremity, then twitching of the arm of the same side, and finally twitching of the muscles of the face and of speech, would indicate that the irritation began in the upper third of the Rolandic area, and travelled downward to the lower end and in front of the fissure.

Having studied the character of the fits, the muscles involved, and the area of the brain which is the seat of the disturbance, the question of operation is to be considered.

Be it remembered that the number of cases of epilepsy suitable for operation is comparatively small. Starr carefully observed 427 consecutive cases, and came to the conclusion that 26 were "of organic origin and suitable for operation, because it was possible to locate the lesion with approximate certainty." The following rules may serve as a guide in the selection of cases:

1. Cases of ordinary general epilepsy in which the lesion cannot be definitely located are not operable.

2. In traumatic epilepsy, when the focal symptoms point to a definite locality in the brain and the scar or other injury correspond, the trephine opening should be made at the position of the scar.

3. When the focal symptoms do not correspond with the scar, the position of the scar should be disregarded, and the opening made at the point indicated by the focalizing symptoms, unless it be found that the scar itself is very sensitive, and that simple pressure upon it is sufficient to bring on a fit. In this case the scar only should be excised and the result watched.

4. In epilepsy of a general type following depressed fracture, but in which localizing symptoms are absent, the trephine opening should be made at the seat of the fracture.

Treatment.—The operation of trephining for epilepsy is conducted in the manner already described. On reaching the dura mater the membrane should be carefully inspected and incised for the purpose of examining the brain. Should scars be found upon either the dura or the brain, the whole of the scar-tissue must be removed—down to the white matter if necessary. When it is necessary to remove a part of the dura mater, its place should be supplied by a piece of the pericranium of equal size, with the view of preventing hernia cerebri.

CHAPTER IX.

INJURIES, DISEASES, AND DEFORMITIES OF THE SPINE.

Surgical Anatomy.—The spinal column is composed of thirty-three vertebræ, of which seven are cervical, twelve dorsal, five lumbar, and nine are united to form the sacrum and coccyx. From the posterior aspect of each vertebra is given off a bony arch which forms a canal for the spinal cord. The bodies of the vertebræ, resting upon one another, must necessarily be strongly supported in order to give strength and security to the trunk. This support is secured (1) by ligaments as follows: the anterior common ligament, the posterior common ligament, and the ligamenta subflava; (2) by five layers of muscles; (3) by articulations with the ribs in the dorsal region. The normal curves of the spine are produced by variations in thickness of the bodies of the vertebræ. There are three of these curves, all of which are antero-posterior. The cervical curve is convex in front, the dorsal convex behind, and the lumbar convex in front. The spinal cord in its passage through the spinal canal is well protected by its membranes, by cerebro-spinal fluid, and loose connective tissue, which latter contains a plexus of veins. These structures lie in the following order from within outward: The pia mater with its vascular network closely embraces the cord itself. Next comes the arachnoid, between which and the pia mater is the subarachnoid space containing the

cerebro-spinal fluid. The dura mater is the outermost membrane; the subdural space separates it from the arachnoid.

The cord is steadied by the spinal nerves as they pass through the intervertebral foramina by the cerebro-spinal fluid and by the ligamentum denticulatum.

A practical point, which must be borne in mind, is that each nerve after emerging from the spinal cord does not immediately pass out through an intervertebral foramen, but runs down the cord for a variable distance, and makes its exit through a foramen lower down. Thus the eighth cervical nerve arises from the space between the fifth and sixth cervical vertebræ, and passes out through the foramen below the spine of the seventh cervical vertebra.

Examination of the Spine.—The patient should have all clothing removed to the waist, and should stand erect, with the heels together, the arms hanging down by the sides, and the eyes looking forward. Infants should be examined in the sitting position. The following questions can then be answered:

1. *Is there deformity?* The natural curves of the spine may be increased or diminished or the whole spine may be arched backward in one great curve. This is a sign of debility. It is suspicious of rickets, and when in conjunction with it we find swelling of the extremities of the long bones and the fontanelles unclosed, we may call the case rachitic spine. The spine may be sharply curved backward, as in Pott's disease, or the vertebræ may be rotated one upon the others. Rotation is determined by comparing the prominence of the angles of the ribs, the lumbar transverse processes, the height and prominence of the scapula, and the iliac crests. The patient is then viewed from the front, and it is noted whether one breast is more prominent than the other or whether there is flattening of the chest on one side. The patient should now be asked to bend forward while he keeps the knees straight. Standing behind him, you will be able to determine the freedom of movement of the spine and the presence or absence of rigidity at any part. Rigidity of the muscles, or stiffness, is one of the earliest indications of Pott's disease. The tips of the spines are next examined by passing the fingers over them, when any irregularity or abnormal prominence or lateral curvature can be noted. 2. *Is there tenderness at any point?* This can be elicited by passing the finger over the spinal processes. If tenderness is felt at any spot, the skin should then be pressed lightly or pinched up without pressing it against the bone. If pain is still complained of, it is an indication of hysterical spine. Tenderness can also be sought for by pressing downward upon the spine, the hands of the surgeon being placed upon the head or upon the shoulders of the patient according as the cervical or lower parts of the spine are being examined. This method, however, must be used with great caution, the pressure being at first very gentle and cautiously increased. Rough pressure may prove very injurious in cases of caries of the vertebræ, and cannot be too severely condemned. 3. *Is there pain?* Many cases of spinal disease are attended with very little pain. Sometimes it is felt in the spine itself, but much more frequently the pain is felt in front, at the extremities of the nerves, and gives the sense of constriction. Such pains are sometimes spoken of

as "girdle pains." 4. *Is movement restricted?* The patient should be asked to bend forward, backward, and from side to side. He should pick objects from the floor, should walk, run, and jump from a stool or chair. During these exercises it must be noted whether the patient complains of pain or stiffness or tries to save his spine by causing the arms or shoulders to bear his weight.

Injuries of the Spine.

Sprains.—Sprains of the back are very common injuries, and occur with all degrees of severity. Violent exertion, as in lifting heavy bodies, may cause injuries of the muscles alone, resulting in a stiffness of the back and a local tenderness which soon pass off.

In more severe injuries the ligaments of the spine may be overstretched or torn, and in the case of the ligamenta subflava the rupture may be attended with hemorrhage, resulting in paralysis. The bones may be injured, the vertebræ separated from the intervertebral substance, and the cord itself may suffer.

Symptoms.—These will depend upon the extent of the injury. There is usually more or less shock, pain, tenderness, and swelling; ecchymosis is slow in making its appearance on account of the thickness of the skin. In some cases a considerable quantity of blood is poured out, forming a hematoma, which if not absorbed may require incision. In severe cases it may be a difficult point to decide whether the spine is fractured or not. The degree of paralysis will have to settle the question. In severe sprains or contusions, as when a man falls across a beam or iron bar and has his body forcibly doubled up, the lower limbs may be more or less paralyzed, but the paralysis is never so complete as that which results from fracture.

A rigidity of the muscles is usually a prominent symptom, and in medico-legal cases plays an important part, owing to its resemblance to Pott's disease. When the injury is unilateral the rigidity will be confined to the injured side—a condition which cannot be simulated.

Treatment.—Shock, if present, must be relieved by stimulants, morphin, or hot applications, after which absolute rest constitutes the principal treatment. Friction and massage are very valuable in reducing swelling and promoting absorption, and strapping the back with broad bands of adhesive plaster extending around two-thirds of the body will afford great relief.

"Railway Spine."—The peculiar circumstances attending railway accidents, and the frequency with which such injuries are the subject of litigation, give them special interest to the surgeon. A person whose back is injured in a railway accident may sustain any degree of injury from simple strain or contusion of the muscles to laceration of the ligaments or fracture of the spine, but additional elements come into the case by reason of the fright and shock which attend the accident. The passenger may be roughly awakened from sleep by the catastrophe. The screams of his fellow-passengers, the sight of dead and mangled bodies, the horrible sensation of being held down by portions of the wreck, and, to crown all, the outbreak of fire, which he feels will surely reach him before he can be extricated, produce

impressions on his mind which last for weeks and months and add a neurotic element to the traumatism. Long after the injury has had time to heal the patient complains of vague pains or pains that exist only in his imagination. There are tender spots, lameness and weakness of the back, inability to incline the body from one side to the other or to move the shoulders. Numbness and tingling in the lower limbs are frequently complained of, as also is anesthesia or hyperesthesia. The skin is moist, or in some cases bathed in profuse perspiration, while the kidneys act freely, compelling the patient to get up several times in the night. The eyesight is affected, according to the patient's story, although no changes in the retina or other parts of the eye can be found to account for these subjective symptoms.

The mental condition is more or less affected. The patient is nervous and incapable of concentrating his attention upon his business or anything that requires continuous volition. He becomes despondent and gloomy, looking forward without hope and filled with the idea that ruin stares him in the face.

These are the cases that bring out two types of expert witnesses, one side swearing that the man is seriously injured and permanently disabled, the other side testifying that the symptoms are fraudulent and only assumed for the purpose of mulcting the railway company. The examination of such patients must be conducted with great care, and, while it is necessary to be guarded against so-called "litigation symptoms," fairness and justice demand that all real symptoms should carry due weight. The following suggestions may be of value:

1. Do not rely upon a single symptom, but weigh all the symptoms.
2. Study the manner of the patient, and test his truthfulness or studied attempts to exaggerate his complaints.
3. Exclude all pains the existence of which cannot be confirmed by any physical evidence, and which rest wholly upon the unsupported statements of the patient (Dercum).
4. Admit all pains the signs of which are evoked without any previous warning or suggestion (Dercum).
5. Pay especial attention to every symptom which is beyond the control of the patient, as temperature, deformity, persistent rigidity of muscles, vomiting, sweating, bloody urine, etc.

For estimating the value of pain as a symptom Dercum recommends a method of examination which is often of great value. The superficial tender spots are tested by injecting at one of the painful areas either cocain or, as suggested by Keen, simple cold water. If the pain is genuine, the injection relieves that particular spot, while the others remain tender.

Deep-seated pain is most likely to occur at the position of the injury, is more slowly developed, and is not attended with hyperesthesia, while superficial pain is often hyperesthetic and may occur at points remote from the seat of the traumatism. Pressure upon one part of the body while the patient's attention is directed to another is often sufficient to detect fraud, Disease in the vertebræ or intervertebral substances can be detected by pressure upon the head or shoulders transmitted through the spine. Percussion with an ordinary plexiimeter is useful, for through its aid tenderness in bone can be elicited

by blows upon the soft parts which are otherwise painless. When spasm of the muscles is excited by percussion it is a valuable sign, as no amount of practice on the part of the malingerer will enable him to imitate it. Fraudulent persons are sometimes detected by the use of a battery, as shown by Keen, one electrode being applied in the ordinary way, while the cord of the other is concealed in the hand and disconnected. If the patient complains of pain, we may know he is dishonest.

Treatment.—The traumatic lesions require treatment on general principles—viz. rest, support to the spine, etc. The neurotic element is more difficult to manage. From the very first the aim of the surgeon should be to prevent the patient from falling into the condition of hypochondriasis. If financial compensation is expected, it is advisable to have the matter settled as soon as possible, a prompt settlement being better for the patient than living in suspense, even if there is a prospect of obtaining a large amount. The idea of permanent inability to work should be prevented, and the patient urged to resume his employment as soon as possible.

Concussion of the spinal cord is a condition which probably never occurs, owing to the effective manner in which the cord is protected and steadied in the spinal canal. When injuries of the cord arise to which the term "concussion" seems applicable, the accident is probably a capillary hemorrhage, a laceration of the cord, or a vasomotor disturbance with exudation of serum.

The *symptoms* of so-called concussion are those of shock—viz. pallor, nausea and vomiting, syncope, cold perspiration, etc. The symptoms which point to the spine as the cause of the shock are numbness, tingling or even paralysis of the upper or lower limbs, and constriction of the chest. The *treatment* is absolute rest.

Compression of the spinal cord may arise from three different sources:

1. **Dislocation of a vertebra,** or a fracture in which a fragment is driven in upon the cord. In cases of this kind the symptoms come on immediately after the accident.

2. **Hemorrhage.**—The blood may be poured out from the vessels in the substance of the medulla, from the vessels lying between the medulla and its membranes, or from the plexus of veins which lie between the dura mater and the spinal canal. Hence there are three varieties of spinal hemorrhage:

(*a*) *Intra-medullary* (*Hemato-myelia*).—This form is recognized by its sudden onset and by a history of an injury or of disease in which there are marked changes in the blood. There are pain, rigidity, spasms, and paralysis. The pain is referred to the back and encircles the body as the so-called "girdle pain." The reflexes connected with the affected area are diminished or entirely lost. The symptoms are bilateral, are developed rapidly, and usually end fatally. Among the most distressing accompaniments are bed-sores, retention of urine, and incontinence of feces.

(*b*) *Extra-medullary* (*Hemato-rachis*).—In this form of hemorrhage the pain is sudden, severe, and referred to the back. The symptoms are pain, tingling, and hyperesthesia along the course of the nerves

which have their origin near the seat of the extravasation, and paralysis more or less marked, but seldom complete. Convulsions are not uncommon, and there is frequently retention of urine.

Treatment.—The first principle of treatment is absolute rest. In the way of drugs iodid of potassium and mercury have been relied upon. The question of operating upon such cases is receiving attention. If the hemorrhage is low down in the spinal column and extramedullary, an operation should be considered. If also there be rapidly advancing paralysis extending upward to the more vital centers, operation affords the only hope.

3. **Meningitis and Effusion of Lymph causing Compression.**—This is most frequently met with as a complication of Pott's disease. It is a pachymeningitis, and its most distinguishing characteristic is that the symptoms of paralysis appear from one to eight weeks after the first appearance of meningitis.

Wounds of the Back.—While wounds of the back are commonly flesh wounds, it occasionally happens that the penetrating instrument enters the chest, the abdomen, or the spinal cord. Hence wounds in this position should be examined with special care. The injuries to be sought for are the following: (1) If in the cervical region, the vertebral artery may be wounded and may result in a false aneurysm. To distinguish this from a wound of the carotid is often exceedingly difficult, and several cases are on record in which the carotid was tied by mistake. The diagnosis can be settled by exposing the carotid sufficiently to ascertain its relation to the aneurysm or by passing the ligature around it, noticing the effect of constriction before tying. The thyroid or occipital artery may also be wounded. (2) The cavity of the pleura may be penetrated. This accident is recognized by air passing in and out of the wound with each respiratory movement. (3) The wound may penetrate the abdominal cavity, in which case the symptoms will be those of wounds of the special organs involved.

(4) The spinal cord may be involved. The danger of injury to the cord is greatest when the direction of the wound is from below upward, the instrument passing between the spinous processes, the laminæ, or the transverse processes. This occurs most readily in the cervical region, owing to the more horizontal direction of, and the greater space between, the spinous processes. The penetrating instrument may wound the bone, the membrane, or the cord itself. A wound of the bones alone would present no special symptom. A wound of the membranes would be recognized by the escape of cerebro-spinal fluid. A wound of the cord itself would produce paralysis, depending in its extent upon the structures divided. If the entire thickness of the cord is divided, complete paralysis, both of motion and sensation, is the inevitable result. If only one side is divided, crossed paralysis will follow—namely, paralysis of motion on the same side as the injury, and paralysis of sensation on the opposite side. Later symptoms of injury of the cord are paralysis of the bladder leading to retention of urine, paralysis of the bowels resulting in incontinence of feces, and trophic changes producing bed-sores.

Treatment.—Hemorrhage is not usually a marked symptom. When a vessel of any size is wounded, the external opening should be enlarged

and the divided ends of the vessel secured by ligature. Wounds of the aorta and vena cava are of course rapidly fatal. The wound must be treated on general antiseptic principles, and fragments of bone or foreign body pressing upon the cord must be removed; the bladder and bowels should receive close attention. The result will depend upon the extent of the injury to the spinal cord.

Fractures of the Spine.—Injuries of the spinal column, like those of the cranium, receive their importance from the delicate nature of the contents of the strong bony canal. Fractures of the vertebræ are serious injuries, because the risk of compression, laceration, or contusion of the cord is great and the results of such injury are far-reaching. In the clinical picture of fracture of the spine the salient points are paralysis of motion and sensation, loss of control of the bladder and rectum, bed-sores, and a condition of utter helplessness.

Causes.—Falls from scaffoldings, bridges, or buildings, the caving-in of tunnels or embankments, and the general smash-up attending railway accidents are the common causes of fracture of the spine. A large proportion of cases occur when the body falls and in striking the ground assumes the position of forced flexion, the force being sufficient to crush the bodies of the vertebræ. It is seldom that the fracture is uncomplicated. The force which breaks or crushes the bones lacerates the ligaments and muscles, and produces hemorrhage of the spinal cord. The part of the column above the fracture is usually dislocated forward, compressing the spinal cord, or a fragment of bone may be driven into the cord.

Symptoms.—When the fracture is compound the fragments may be felt by the disinfected finger or by a probe. A case of fracture of the vertebræ comes under our notice under circumstances more or less like the following: A man falls from a ladder or is caught by a "cave-in," or is driving under a low arch which catches and doubles him up. He lies still, is in great pain, and cannot bear to be moved; there is more or less paralysis of motion or sensation, or both. The seat of the injury is painful to touch, and there may be evidence of displacement of the bodies of the vertebræ or of their spinous processes. Later there is evidence that the bladder and rectum are paralyzed. These symptoms are, in the main, common to all fractures of the spine. They vary according to the part of the spinal column which is affected, and to arrive at an exact diagnosis we must divide fractures of the spine into those occurring in the following sections:

First Section, the Three Lower Lumbar Vertebræ.—We may set it down as a rule that the higher the point at which the fracture occurs the more marked are the symptoms and the more serious the consequences. Fracture of the three lower lumbar vertebræ is below the end of the cord, which terminates at the level of the second lumbar vertebra. The cauda equina is, however, in the way of being injured, but, as its fibers slip easily over one another, it is possible for them to escape. In this event the fracture may be free from serious symptoms. It is probable that many fractures in this locality have been diagnosed as sprains of the back and treated accordingly, complete restoration of function giving color to the assumption that the diagnosis was correct.

When the nerves are injured there is more or less paralysis of the parts which they supply.

Second Section, between the Second Lumbar and the Tenth Dorsal Vertebræ.—From this portion of the spine proceed the nerves which form the lumbar and sacral plexuses. The leading feature of fracture in this section is, consequently, paralysis of the parts to which these nerves are distributed. The lower limbs are palsied, the bladder loses its power of expulsion, the bowels act involuntarily, and bed-sores are inevitable. The average duration of life under these circumstances is from six months to two years.

Third Section, the Dorsal Vertebræ.—In addition to the symptoms just enumerated, fracture between the tenth and second dorsal vertebræ is attended with paralysis of the abdominal muscles and the lower chest muscles. There are tympanites and great abdominal distention from collections of gas. Respiration is interfered with, and owing to the difficulty of expelling mucus from the bronchi and air-vesicles, hypostatic congestion and pneumonia are common complications and may prove to be causes of death.

Fourth Section, the Cervical and Cervico-dorsal Regions.—When the first or second dorsal vertebra is the seat of injury, only a portion of the brachial plexus is involved; consequently, paralysis of the upper extremity is incomplete. If the fracture is in the lower cervical region, the whole plexus is involved, and paralysis of the arms is necessarily complete, both as regards sensation and motion. The respiration is diaphragmatic; breathing is interfered with, especially expiration, and the voice is weak or wholly lost. In some of these cases the temperature rises to a remarkable degree—108°, 110°, or 112° F.; in one case recorded by Teale it was 122°, and yet the patient recovered.

In the upper cervical region the fifth and sixth vertebræ are the most likely to be fractured. Death may be instantaneous, owing to paralysis of the nerve-center of respiration in the medulla oblongata or injury to the phrenic nerve.

Fifth Section, the Atlas and Axis.—Fracture in this section is almost certainly fatal, yet the patient lives, in a majority of the cases, from a few hours to two weeks. Exceptional cases are on record in which life was prolonged—in one case for fifteen months (Shaw), and in another case for fourteen years (Hilton). The injury being in close relation with the medulla oblongata, and above the origin of the phrenic nerve, respiration is naturally most dangerously interfered with.

There must, of necessity, be great difficulty in distinguishing this accident from dislocation of the bones, and in some instances it is impossible to settle the question except by a post-mortem examination. Crepitus is the only symptom which can be considered of value, and it is not advisable to search too diligently for it. Stiffness and rigidity of the muscles of the neck, pain at the seat of injury, and paralysis of everything below the fracture are the signs usually present and are common to both dislocation and fracture.

Diagnosis of the Exact Position of the Fracture.—When there is sufficient displacement to produce a deformity of the spine, or in the exceptional cases in which crepitus can be detected, or in compound fracture in which the finger or probe can be used to secure accurate

information, there is no difficulty in localizing the seat of fracture. In many cases, however, these evidences are wanting, and we have to arrive at a diagnosis of the level of the fracture by the three following methods:

1. *By Determining the Extent of the Motor Paralysis.*—In working out the data afforded by this method the following table, from Keen's article on "Fractures of the Spine," in Dennis's *System of Surgery*, will be found useful. The table is founded on one devised by M. Allen Starr and elaborated by Mills:

Localization of the Functions of the Segments of the Spinal Cord.

Segment.	Muscles.	Reflex.	Sensation.
Second and third cervical.	Sterno-mastoid. Trapezius. Scaleni and neck. Diaphragm.	*Hypochondrium* (third to fourth cervical). Sudden inspiration produced by sudden pressure beneath the lower border of ribs.	Back of neck and of head to vertex (occipitalis major, occipitalis minor, auricularis magnus, superficialis colli, and supraclavicular).
Fourth cervical.	Diaphragm. Deltoid. Biceps. Coraco-brachialis. Supinator longus. Rhomboid. Supra- and infra-spinatus.	*Papillary* (fourth cervical to second dorsal). Dilatation of the pupil produced by irritation of neck.	Neck. Shoulder, anterior surface. Outer arm (supraclavicular, circumflex, musculo-cutaneous, or external cutaneous).
Fifth cervical.	Deltoid. Biceps. Coraco-brachialis. Brachialis anticus. Supinator longus. Supinator brevis. Deep muscle of shoulder-blade. Rhomboid. Teres minor. Pectoralis (clavicular part). Serratus magnus.	*Scapular* (fifth cervical to first dorsal). Irritation of skin over the scapula produces contraction of scapular muscles. *Supinator longus* (fourth to fifth cervical). Tapping the tendon of the supinator longus produces flexion of forearm.	Back of shoulder and arm. Outer side of arm and forearm to wrist (supraclavicular, circumflex, musculo-cutaneous or external cutaneous, internal cutaneous, radial).
Sixth cervical.	Biceps. Brachialis anticus. Subscapular. Pectoralis (clavicular part). Serratus magnus. Triceps. Extensors of wrist and fingers. Pronators.	*Triceps* (sixth to seventh cervical). Tapping elbow-tendon produces extension of forearm. *Posterior wrist* (sixth to eighth cervical). Tapping tendons causes extension of hand.	Outer side and front of forearm. Back of hand, radial distribution (chiefly musculo-cutaneous or external cutaneous, internal cutaneous).
Seventh cervical.	Triceps (long head). Extensors of wrists and fingers. Pronators of wrist. Flexors of wrist. Subscapular. Pectoralis (costal part). Serratus magnus. Latissimus dorsi. Teres major.	*Anterior wrist* (seventh to eighth cervical). Tapping anterior tendon causes flexion of hand. *Palmar* (seventh cervical to first dorsal). Stroking palm causes closure of fingers.	Radial distribution in the hand. Median distribution in the palm, thumb, index, and one-half middle finger. (Musculo-cutaneous or external cutaneous, internal cutaneous, radial, median.)

Segment.	Muscles.	Reflex.	Sensation.
Eighth cervical.	Triceps (long head). Flexors of wrist and fingers. Intrinsic hand-muscles.	. . . . .	Ulnar area of hand, back, and palm, inner border of forearm. (Internal cutaneous, ulnar.)
First dorsal.	Extensors of thumb. Intrinsic hand-muscles. Thenar and hypothenar muscles.	. . . . .	Chiefly inner side of forearm and arm to near the axilla (chiefly internal cutaneous and nerve of Wrisberg or lesser internal cutaneous).
Second dorsal.	. . . . .	. . . . .	Inner side of arm near and in axilla (intercosto-humeral.)
Second to twelfth dorsal.	Muscles of back and abdomen. Erectores spinæ.	*Epigastric* (fourth to seventh dorsal). Tickling mammary region causes retraction of the epigastrium. *Abdominal* (seventh to eleventh dorsal). Stroking side of abdomen causes retraction of belly.	Skin of chest and abdomen, in bands running around and downward, corresponding to spinal nerves. Upper gluteal region (intercostals and dorsal posterior nerves).
First lumbar.	Ilio-psoas. Rectus. Sartorius.	*Cremasteric* (first to third lumbar). Stroking inner thigh causes retraction of testicle.	Skin over groin and front of scrotum (ilio-hypogastric, ilio-inguinal).
Second lumbar.	Ilio-psoas. Sartorius. Quadriceps femoris.	. . . . .	Outer side of thigh (genito-crural, external cutaneous).
Third lumbar.	Quadriceps femoris. Anterior part of biceps. Inward rotators of thigh. Abductors of thigh.	*Patellar* (third to fourth lumbar). Striking patellar tendon causes extension of leg.	Front of thigh (middle cutaneous, internal cutaneous, long saphenous, obturator).
Fourth lumbar.	Abductors of thigh. Adductors of thigh. Flexors of knee. Tibialis anticus. Peroneus longus.	*Gluteal* (fourth to fifth lumbar). Stroking buttock causes dimpling in fold of buttock.	Inner side of thigh, leg, and foot (internal cutaneous, long saphenous, obturator).
Fifth lumbar.	Outward rotators of thigh. Flexors of knee. Flexors of ankle. Peronei. Extensors of toes.	*Achilles tendon* (fifth to first sacral). Overextension causes rapid flexion of ankle, called ankle-clonus.	Back and outer side of leg; sole; dorsum of foot (external popliteal, external saphenous, musculo-cutaneous, plantar).
First and second sacral.	Flexors of ankles. Extensors of ankles. Long flexor of toes. Intrinsic foot-muscles.	*Plantar* (fifth lumbar to second sacral). Tickling sole of foot causes flexion of toes and retraction of leg.	Back and outer side of leg; sole; dorsum of foot (same as fifth lumbar).
Third, fourth, and fifth sacral.	Gluteus maximus. Perineal. Muscles of bladder, rectum, and external genitals.	Vesical centers. Anal centers.	Back of thigh, anus, perineum, external genitals (small, sciatic, pudic, inferior, hemorrhoidal, inferior, pudendal).
Fifth sacral and coccygeal.	Coccygeus muscles.	. . . . .	Skin about the anus and coccyx (coccygeal).

2. *By Determining the Extent of Cutaneous Anesthesia.*—Chipault, in a paper reported in the proceedings of the "Congrès française de Chirurgie," 1894, classifies these lesions as follows:

(*a*) *Cervical Type.*—Anesthesia spares only the neck and the deltoid regions before and behind. The four limbs and the trunk, including the diaphragm, are paralyzed, while the sterno-mastoid and the superior part of the trapezius are still able to produce inspiration. Death follows by interference with respiration. *In this type the lesion is situated at the upper limit of the third cervical segment* (Fig. 217).

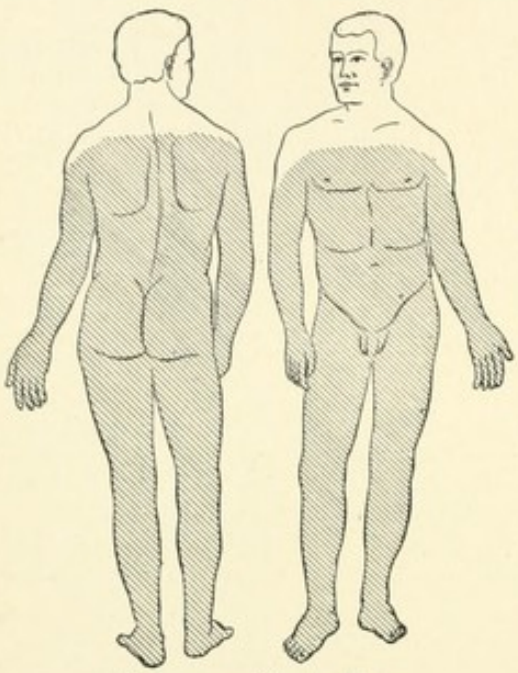


FIG. 217.—Cervical type.

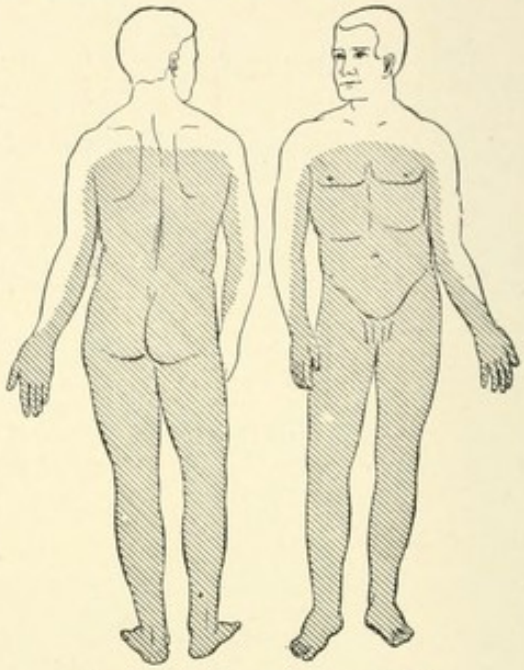


FIG. 218.—Superior brachial type.

(*b*) *Superior Brachial Type.*—Besides the region cited in the preceding type, anesthesia spares the external part of the arm and the fore arm as far as the extremity of the radius. In addition to those of the neck and diaphragm, some of the muscles of the upper extremity are preserved—*i. e.* the supra- and infra-spinati, the biceps, the brachialis anticus, the deltoid, and the supinators. By action of these preserved muscles, which are not balanced by their antagonists, the upper extremities take a position very characteristic in abduction and slight external rotation of the arm with flexion and supination of the forearm. *The lesion is situated at the middle part of the sixth cervical segment* (Fig. 218).

(*c*) *The Inferior Brachial Type.*—The anesthesia, which crosses the trunk at a level three or four fingers' breadth below the clavicles, is limited in the upper extremity to a band occupying the axilla, the internal surface of the arm and forearm, and about half of the hand. Not only are the muscles enumerated in the preceding type preserved, but a certain number of others—*i. e.* the supra- and infra-scapulars, the pronators and extensors of the wrist, the triceps, the pectorales, the latissimus dorsi and teres major—in short, the muscles affected in the upper extremity are the flexors of the wrist and the intrinsic muscles of the hands. The shoulder and the neck are capable of performing all their movements, but the wrist, which can place itself in pronation,

remains in extension. *The lesion is situated at the middle part of the eighth cervical segment* (Fig. 219).

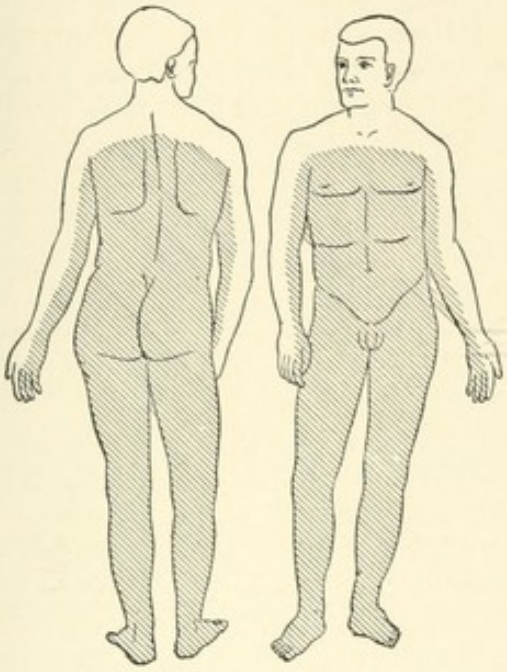


FIG. 219.—Inferior brachial type (after Chipault).

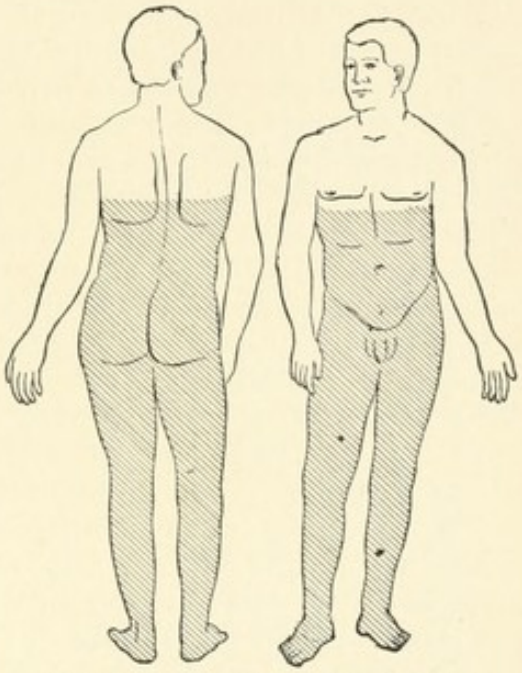


FIG. 220.—Fracture in dorsal region.

When the fracture is situated at any point from the first dorsal to the last lumbar segment, the anesthesia will be found at a corresponding point, as seen in Figs. 220, 221.

3. *By Determining the Condition of the Reflexes.*—When the patellar tendon is quickly struck by the ends of the fingers, the stimulus is conveyed by the sensitive nerves to the posterior cornu of the cord, thence by the anterior cornu to the motor root, and finally to the extensor muscles of the thigh, causing the leg to jerk involuntarily. This can occur only when the cord is intact. These quickly-passing contractions can be brought out by the skin as well as the tendons; hence we have *skin*-reflexes and *tendon*-reflexes. The third column of the table on page 515 gives the various reflexes and the manner in which they can be produced. The patellar and other reflexes are of special value in determining whether a lesion of the cord is total or partial. If the cord sustain an injury which produces a total transverse destruction, there will be total motor paralysis below the level of the injury, complete anesthesia, and

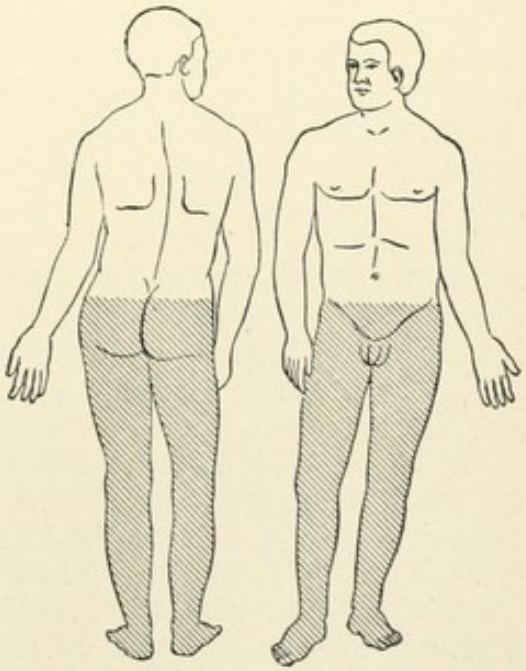


FIG. 221.—Fracture in lumbar region.

a total abolition of the reflexes. If the lesion of the cord be but partial, the paralysis and anesthesia will be incomplete, and the reflexes may be only impaired or may even remain normal. Generally speaking, the cases in which there is total loss of motion, sensation, and the reflexes are not suitable for the operation of laminectomy. A few cases, however, are recorded in which there was total abolition of the patellar and other reflexes, and yet recovery followed the operation.

Treatment.—When the patient is examined at the scene of the accident, there is little difficulty, as a rule, in arriving at a diagnosis of the injury; the manner in which he fell or was struck, the intense localized pain in the back and the inability to move the lower limbs, give almost an assurance of fracture, and the case should be treated with the care which that injury demands. In removing the patient to his home or to a hospital a smooth stretcher, a door, or a shutter should be provided. When the clothing is removed, a careful and thorough final examination should be made, so that further disturbance may be avoided. The patient should, if possible, be placed on a water-bed, but, if this cannot be obtained, a smooth hair mattress covered with waterproof sheeting makes a good substitute. Reduction of the fracture can only be attempted by gentle traction on the lower limbs, while counter-extension is made from the shoulders by assistants, the surgeon meanwhile bringing about coaptation by direct manipulation of the fragments. In some cases it is necessary to keep up extension by means of weights and pulleys, as employed in fracture of the thigh. For keeping the parts in apposition it has been recommended to suspend the patient and apply a plaster-of-Paris jacket extending from the axillæ to the trochanters. I have in two cases used a much simpler device with great benefit. It consists of two straight splints three inches wide and long enough to reach from the scapulæ to the pelvis. They are placed, properly padded, one on each side of the spinous processes, and united at intervals with strips of zinc or tin. If the fracture is in the cervical region, the head should be steadied by sand-bags.

Throughout the case the greatest care must be observed to prevent bed-sores, to keep the bladder emptied, and to ensure perfect cleanliness.

The results of treatment of fracture of the spine have been so unsatisfactory that an attempt should be made in suitable cases to cut down upon the injured area and remove all pressure from the cord. To this operation the name laminectomy is applied. In deciding upon the propriety of the operation we must be guided by the following considerations:

1. The condition of the reflexes. It is generally conceded that if the patellar and other reflexes are entirely lost, the case is not one for operation. At the same time we must remember that in a few cases of such a condition recovery has followed operation.

2. The higher the lesion the less favorable the conditions; and, as a rule, it may be said that operations above the seventh dorsal vertebra will rarely prove successful. The most favorable situation is below the second lumbar vertebra.

Regarding operations in the region of the cauda equina Chipault draws the following conclusions: "(*a*) In case of lumbar or sacral frac-

ture with permanent or irreducible displacement of the bony fragments we should interfere at once. (*b*) In case of fracture which is reduced, either spontaneously or by surgical manipulations, wait. If the course of the case is toward recovery, wait; if the case remains stationary, intervention is justified toward the end of the first month—not earlier—since functional restoration may not begin till toward this period; not much later, since incurable spinal degeneration may be established."

3. The time at which the operation should be resorted to. Compression of the cord very speedily brings about destructive changes, and, if the case is one for operation at all, the earlier it is performed the better.

Operation.—Having prepared the field of operation in the usual way, the patient is placed in the Sims position; an incision is made in the middle line not less than four inches in length, which can afterward be extended if required. The muscles are then exposed and separated from the arches upon one side. Horsley has shown that this can best be done by clean cuts of the knife rather than by blunt instruments. In this part of the operation there is usually hemorrhage. On this account the dissection should be carried on as rapidly as possible, and the cavity packed with sponges wrung out of water as hot as can be borne by the hands. Vessels of any considerable size must of course be caught by forceps and afterward ligated. Having packed one side, the muscles on the other side are separated and packed in a similar manner. The first packing is now removed and the periosteum reflected. To do this an incision is made along the angle formed by the spinous processes and the laminæ; the edge of the periosteum is grasped with a pair of dissecting forceps and separated by the aid of a curved periosteal elevator. The opposite side is similarly treated. The muscles are held apart by retractors, which must be small and so shaped as to be out of the operator's way. When the bone has been fully exposed the spinous processes are divided close to their bases by strong bone-forceps set at an obtuse angle. The laminæ are next divided in the following manner: Begin with the vertebra at the middle of the incision, and by the tips of the fingers find the vertebral spaces above and below; then apply the forceps as near the transverse process as possible, and divide the lamina by a number of short nips of the instrument. Having removed the laminæ, the dura mater comes into view and should be carefully examined. If there is no pulsation, we may infer that the subdural space is obliterated at that point, probably by adhesions or by swelling of the cord. Increased tension is suggestive of a tumor. A yellow color would indicate the existence of pus beneath the membrane, while a purple tinge would suggest extravasated blood. In either case the membrane should be opened by picking it up with toothed forceps at the middle of the incision, opening it with knife or scissors, and dividing it for the required distance up and down upon a director or with blunt-pointed scissors. The dura mater is then retracted, and the subdural space explored by the tip of the finger or by the aid of a bent probe or pedicle needle. Splinters of bone or any other cause of compression of the cord should be removed. When the body of a displaced vertebra is producing pressure, the cord itself can be held aside, as recommended by Chipault, and the projecting

portions cut off with gouge, chisel, or curette. A tumor on the surface of the cord should be removed, but if it infiltrate the substance of the latter, it is best to let it alone. Having completed the operation on the spine, the dura is closed, either by interrupted or continuous catgut stitches, a small rubber drainage-tube and a few strands of chromicized catgut are laid along the length of the wound; over this the muscles are sutured by buried chromicized catgut, and the skin and fascia closed by silkworm gut, silk, or silver wire.

Gunshot Wounds of the Spine.—In the diagnosis of gunshot wounds of the spine great difficulty may be experienced in determining the location of the missile and the injuries produced by it. The bullet may wound the bone alone, it may partially or completely sever the cord, or it may divide one or more of the large vessels near the column and cause death by hemorrhage. Vincent divides gunshot injuries of the cord into three classes: 1. The cord may be compressed by extravasated blood, by fragments of bone, or by the projectile lying outside the medulla or canal. 2. The projectile in passing through the spine has injured the cord. 3. The projectile is lodged in the spinal canal. In the examination the disinfected finger and probe, although useful in certain cases, must not be relied upon. The degree of paralysis, the extent of the anesthesia, and the state of the reflexes will serve to localize the injury, as already described under Fracture of the Spine.

When the bullet enters by way of the chest or abdomen one or more of the important organs of these cavities will probably be wounded, and thus greatly increase the gravity of the situation.

Treatment.—When the injury is confined to the bone, the cord remaining unharmed, all loose spiculæ of bone and foreign bodies, such as clothing, should be removed and a rubber tube or strip of iodoform gauze placed in the position which can best maintain drainage. When there is compression of the cord the cause should be removed by an operation. The compressing agent will prove to be a clot, a fragment of bone, or the projectile itself. The most serious cases are those in which the projectile is lodged in the spinal canal. These cases, if allowed to take their course, are almost sure to result in myelitis, meningitis, cystitis, and death, and, although affording little hope, an operation gives the only chance for recovery. Cases in which the cord is severed had better be let alone.

Dislocation of the Spine.—Although this accident is generally a complication of fracture, there are many cases recorded of pure dislocation. The injury occurs most frequently in the cervical region, owing to the smaller size of the vertebræ and their less intimate apposition. The fifth cervical seems to be the most liable to displacement. In the dorsal region the twelfth segment is the one most frequently displaced. In the lumbar region the accident is very rare. The dislocation is generally bilateral, but a number of unilateral luxations are recorded. The causes of the injury are forced flexion or extension, extreme lateral motion or rotation.

Symptoms.—The symptoms so closely resemble fracture, in a large proportion of cases, that it is very difficult to arrive at a diagnosis. The presence of deformity and the absence of crepitus cannot be relied upon, for deformity may be present in fracture, and crepitus we cannot with

propriety look for, lest serious injury be done to the cord. Our main reliance must be placed upon the following points: The neck is rigid and the head turned to one side in unilateral luxation; the spinous and transverse processes may be felt to be displaced. If the dislocation is in the upper cervical region, respiration is difficult, or it may even be suddenly arrested, producing death. The finger should explore the pharynx for displacement of the body of a vertebra. For the rest, the paralytic symptoms will afford some evidence. Dislocation above the brachial plexus causes paralysis of both upper and lower extremities, as well as of the trunk. Motor is more marked than sensory paralysis, and may range from slight paresis to complete paraplegia. The attitude assumed by the patient is sometimes very characteristic, as in a case reported by Ayres, in which the head was thrown back, the neck perfectly rigid, and the larynx projecting forward.

Treatment.—This dislocation is a serious injury, and the patient's friends should be warned of two dangers. If reduction is attempted, instant death may result, especially if the displacement is in the upper cervical region. On the other hand, to allow the pressure of the displaced vertebra upon the cord to continue is certain to result in destructive changes and probably death. An attempt at reduction should therefore be made. This is effected by gentle and steady traction upon the occiput and chin. If a displaced vertebra can be felt in the pharynx, the finger of the operator should make firm pressure upon it while steady traction is kept up. Should the luxation be unilateral, rotation of the neck should accompany extension.

Deformities of the Spine.—Deformities of the spine are congenital or acquired. The congenital varieties embrace the following:

1. **Spina Bifida.**—This is the most frequent of all defects of the spine, and, roughly speaking, occurs in 1 of every 1000 children born. Its mechanism is thus explained: In the embryo a furrow represents the spinal canal. The sides of the furrow unite to form the laminæ, which, in their turn, coalesce at the spinous processes. If the laminæ should fail to unite in the middle line, a cleft is the result, through which the membranes or the cord itself projects. The tumor thus formed is nearly always found in the back, but rare cases are on record in which the cleft was in the bodies of the vertebræ and the tumor formed in front of the spinal column. It is worthy of note that in the lumbo-sacral region the medullary groove closes at a later period than elsewhere, and this accounts for the clinical fact that in this locality three-fourths of all cases of spina bifida are found. Next in frequency is the neck; in exceedingly rare cases the cleft occupies the entire length of the spine. This malformation frequently exists in combination with other defects, such as club-foot, squint, cleft-palate, hydrocephalus, and imperfect mental development.

A form known as *spina bifida occulta* is difficult of diagnosis from the fact that no cleft in the spine can be recognized and there is no tumor. Many of these are characterized by a growth of hair over the part.

Varieties.—The classification of the varieties of spina bifida is based upon the contents of the tumor:

1. If the membranes alone escape through the cleft and are filled with the cerebro-spinal fluid, the tumor is called a *meningocele.*

2. If both the cord and its membranes protrude through the cleft, the tumor is called a *meningo-myelocele.*

3. If, in addition to the protrusion of the cord and membranes the central canal of the spinal cord is distended with fluid, the term *syringo-myelia* is applied to the tumor.

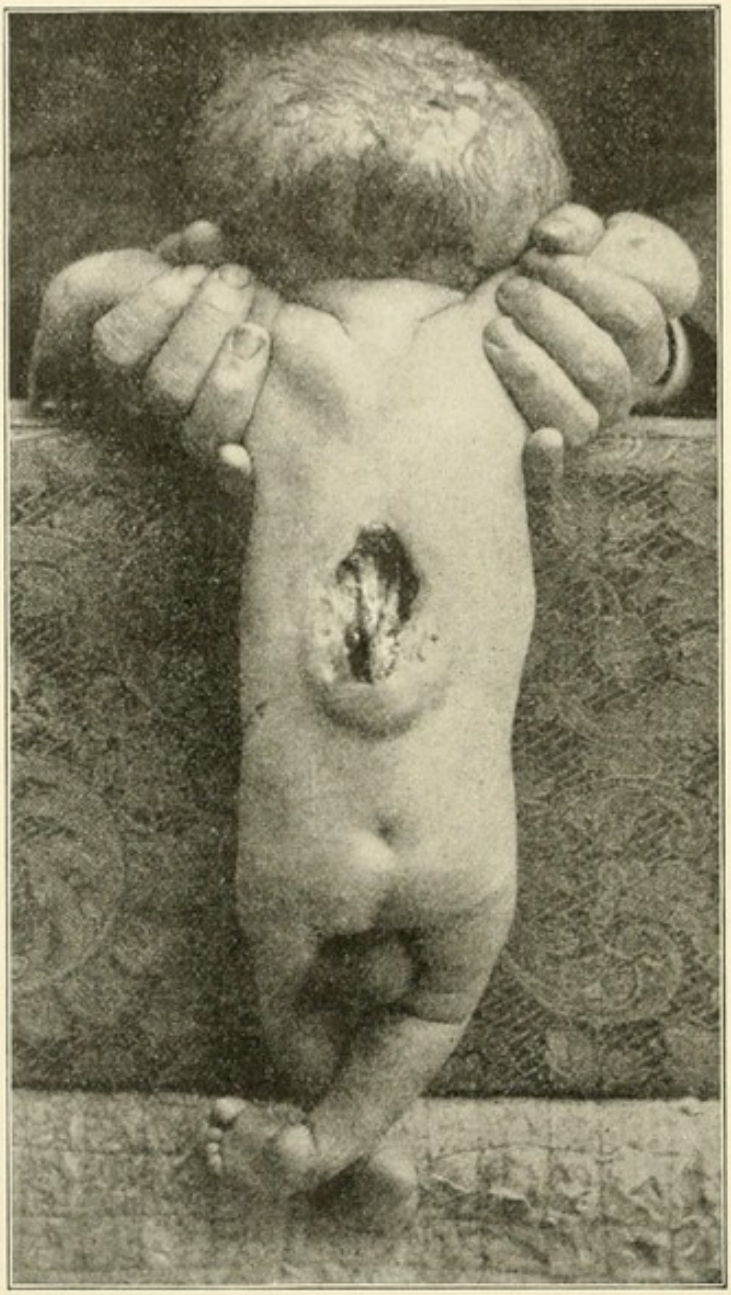


FIG. 222.—Spina bifida (from a photograph in the Cook County Hospital, Ill.).

The *diagnosis* of the variety is important in deciding the question of treatment.

Symptoms.—A congenital tumor situated in the lumbo-sacral region over the center of, and closely connected with, the spine can almost with certainty be pronounced a spina bifida (Fig. 222). On closer examination it will be found to have the following characters:

In shape it is usually round, uniformly smooth, or with a furrow running down its middle line and terminating in a pit-like depression above and below. Sometimes a groove runs on each side of the middle furrow like the meridians of longitude on a globe, wide apart at the equator, but meeting in the pit-like depression at each pole. The tumor may be of any size up to that of a child's head. The color of the skin over the protrusion is usually red, but it may be natural; the skin is thin, and in some cases covered with a copious growth of hair. Sometimes the sac is translucent, permitting us to see, by the aid of transmitted light, the nerve-cords coursing through it. The fluid is cerebro-spinal, and is therefore subject to changes of tension. If it is pressed upon, the impulse can be felt at the anterior fontanelle; when the child cries or coughs the tumor becomes more tense, and the same is observed when the sitting posture is assumed. In many cases the cleft in the bone cannot be palpated, but this is not essential to the diagnosis.

The diagnosis of the variety of spina bifida is not always easy. Meningocele is recognized by its fluctuation and by the absence of any nerve-cords when examined by palpation or with transmitted light.

Meningo-myelocele is often attended with atrophy, and possibly paralysis of the lower limbs and paralysis of the sphincter muscles. Syringo-myelia may be determined by the presence of a deep dimple, which denotes the termination of the spinal cord and its attachment to the skin, and by the presence of nerve-cords seen by transmitted light.

Treatment.—In a majority of cases the child is so ill-nourished and defective in development that death takes place at an early age. The skin over the tumor may ulcerate and slough, allowing the cerebro-spinal fluid to escape. If infection takes place, spinal meningitis is almost sure to prove fatal.

The treatment is generally simply palliative. A pad of absorbent cotton covered with vaselin or a moulded splint of rubber or celluloid should be placed over the tumor and kept in position by a broad flannel belt, so as to exert gentle pressure. A layer of cotton saturated with collodion is a good application and has a tendency to cause shrinking of the parts.

If at the end of two months the tumor is found to be increasing in size and the general condition is going on from bad to worse, the question of a radical cure by operation may be considered. Two operations are recognized by surgeons:

1. *The Injection of Iodin.*—Morton of Glasgow was the first to use a fluid which has since gone by his name. It consists of iodin gr. x, iodid of potassium gr. xxx, and glycerin ℥j. The skin over the tumor is disinfected in the ordinary way, and by means of a trocar one dram of Morton's fluid is injected at the side of the tumor, the trocar passing obliquely through the skin and sac. This gives a valve-like puncture which prevents escape of the cerebro-spinal fluid. As the trocar is withdrawn the skin should be closely pressed around it to prevent entrance of air or escape of fluid, and the opening closed with iodoformized collodion and absorbent cotton. In successful cases rapid

shrinking of the cyst takes place and the tumor is diminished in size. Should no improvement follow the operation, a second injection should be made at the end of ten days or two weeks.

2. *Excision.*—Two varieties of spina bifida are amenable to operation—viz. meningocele and favorable cases of meningo-myelocele; the third variety, syringo-myelia, is best let alone. In any case where the tumor is very large, the skin thin, and there is no likelihood of obtaining a sufficient flap to cover the parts, excision is not advisable. The operation should not be resorted to before the child has reached the age of two months. On this point Bayer draws the following conclusions:

1. The operation for sacral and lumbo-sacral spina bifida should be undertaken at once in all those cases with ruptured sacs that do not show paralysis and are not complicated by other malformations except club-foot.

2. It is to be done in cases that show paralysis as soon as the child is well developed.

3. In cases in which the sac is unruptured and covered by normal skin the period of infancy should not be selected for operation, although operation must not be postponed too long for fear of injuries.

The Operation.—In simple meningocele make an elliptical incision, leaving sufficient healthy skin on each side to cover in the parts. Dissect out the sac down to its neck or base. If the neck is small, it may be simply ligated and cut off; if the neck is broad, the sac is excised and the cut edges sutured together, serous surface to serous surface. The sutures should be close together, with the view of preventing escape of cerebro-spinal fluid, for if this take place a fistula will result, with an ever-present danger of infection and spinal meningitis. The flaps are then brought together as accurately as possible, the stitches being made to alternate with those in the sac, thus aiding to prevent escape of fluid.

In meningo-myelocele, after opening the sac the nerves must be separated from the posterior part of the sac to which they are usually attached and replaced within the spinal canal. The remainder of the operation is devoted to the formation of a proper covering for the canal, and can be carried out in one of two ways:

1. The muscles on each side of the spine are loosened and brought together in the middle line (Bayer). The fascia and skin are similarly sutured.

2. The arches of the vertebræ are divided close to their bases by means of bone-forceps, pushed close to the middle line, and retained by sutures (Dollinger).

Choice of Methods.—It is very evident that the operation of excision is gaining favor among surgeons, and will continue to do so, as better technique will fulfil two indications—viz. first, to prevent escape of cerebro-spinal fluid and subsequent fistula; and second, the securing of a proper covering for the defective portion of the spine.

Already statistics show a balance in favor of the operation as against injection with iodin. Morton collected 65 cases treated by injection, with 55 recoveries and 10 deaths, and Powers has shown a mortality

of 26.6 per cent. Powers also collected 34 cases treated by excision, from which he deducts 3 in which the cause of death was indefinite, leaving 31 cases with 24 recoveries—a mortality of 22.58 per cent. Robson reports 20 cases, of which 16 recovered—a mortality of 20 per cent.—and, according to Hildebrand's statistics, 66 per cent. recover after injection and 73.5 per cent. recover after the operation of excision.

2. **Sacro-coccygeal Tumors.**—These are congenital tumors, and in some instances are varieties of spina bifida. They occur in girls more frequently than in boys, the proportion, according to Malte, being 44 to 14.

In the diagnosis of these tumors the following points must be kept in mind. They differ from spina bifida by lying in front of the coccyx, while spina bifida lies behind the coccyx and continuous with the spinal canal. The tumor varies in size from a hazelnut to a child's head; it is usually cystic, and is therefore elastic and fluctuating in parts. The coccyx is pushed backward if the tumor is large, and the patient may experience considerable difficulty in sitting down; the anus and genitals may be displaced forward. The growth bears a strong resemblance to a fatty tumor, for which it has sometimes been mistaken. The treatment is excision, which must be complete, and the greatest care must be taken to prevent injury to the rectum.

3. **Curvature of the Spine.**—The spine may be abnormally curved in one of three directions: 1. Laterally—*scoliosis;* 2. Antero-posteriorly, with the convexity backward—*kyphosis,* or excurvation; 3. Antero-posteriorly, with convexity forward—*lordosis*, or incurvation.

Lateral Curvature.—Girls in delicate health who are growing rapidly, and who are obliged to keep up such muscular action as draws the spine to one or the other side, girls who sit for long hours at a desk or piano with insufficient support to the back, the poor girl who carries around a baby brother until she becomes lop-sided, the child with rickets or tuberculosis,—all these are liable to lateral curvature. Disease of the spinal cord when it produces atrophy of the muscles on one side, over-use of muscles causing one-sided hypertrophy, empyema resulting in contraction of one side of the thorax, obliquity of the pelvis, and sacro-iliac disease, are also exciting causes. In examining a case for curvature the child should be stripped to the waist; she should stand upon both feet, with head erect and arms hanging by the sides. If the spinous processes form a straight line in the middle of the back, if the shoulder-blades are at an equal distance from this line, if both sides of the thorax are symmetrical, and if the gluteal fold is at right angles with the middle line, there is no curvature of the spine. The patient should be asked to stand in this position for several minutes. If the back is weak, she will be observed to drop one shoulder as soon as she becomes fatigued, and the line of the spinous processes will curve to one side or the other (Bradford). This is the so-called flexible spine. The curve is readily rectified by voluntary effort on the part of the patient. The history of a case of lateral curvature will show that the patient belongs to one of the classes just mentioned. If a boy, the first indication of deformity is that his suspender is constantly slipping over his shoulder; if a girl, the dress-

maker is the first to notice that one side needs padding to ensure a good fit.

The outline of the curved spine can usually be detected by the eye. In fat subjects it may be necessary to run the finger with firm pressure along the spinous processes, which leaves a red line, indicating their position and demonstrating the presence of curvature. The most common situation of the curve is in the upper dorsal region and with its convexity to the right (Fig. 223). In the lumbar region there is a compensatory curve with its covexity to the left, and in marked cases there is frequently found another compensatory curve in the cervical region, its convexity being on the opposite side from the original curve.

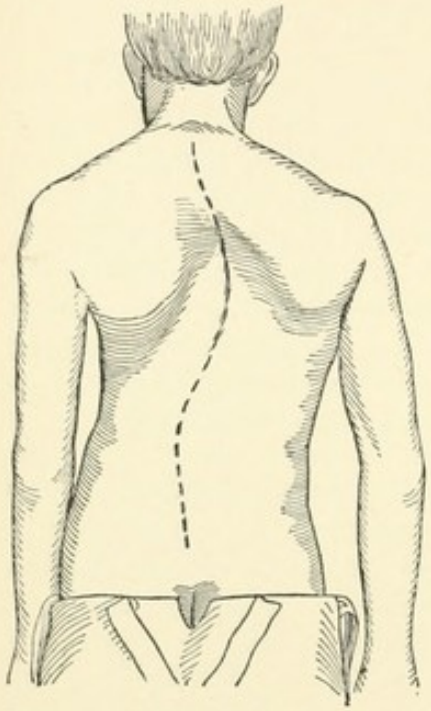


FIG. 223.—Lateral curvature of greater severity (Bradford).

Curvature is not the only deformity, for the spine is more or less rotated on its axis, the spinous processes pointing to the convexity and the bodies of the vertebræ to the concavity of the curve. The scapula on the affected side is slightly prominent, the ribs are abnormally separated, their direction horizontal, and their angles projecting.

On the concave side the obliquity of the ribs is exaggerated, so that in bad cases they touch the crest of the ilium. Bradford recommends that the four following points should be determined: 1st. Whether the spine is flexible; 2d. Whether there is any rotation; 3d. Whether the rotation can be corrected by any slight force; 4th. Whether any muscular weakness is present.

Rotation may be assumed to be present when one shoulder-blade, usually the right, is more prominent than the other, and rotation may also be assumed when one hip is higher than the other. The amount of fixed rotation can be roughly determined by placing the patient flat upon her face on the floor or upon a hard table. "An ordinary rule is placed directly across the back above the middle of the shoulder-blades or across the points of the greatest projection. If rotation be present, the rule will not be parallel with the plane on which the patient lies" (Bradford).

The question as to whether the deformity can be corrected by a slight amount of force is settled by suspending the patient or by making traction while he is in the recumbent position. Muscular weakness is best determined by a dynamometer fastened to the floor, the straps of which pass over the patient's neck. In the act of straightening the body the muscular force is recorded upon the instrument.

In the prognosis of lateral curvature the rate of growth of the child, the height and weight compared with tables of the average of children of the same age, the persistence of a faulty attitude in standing or sitting, and the general health of the patient should be taken into account,

If the child is growing rapidly and is ill-nourished, it may be fairly predicted that the curvature will increase, and the condition is more



FIG. 224.—Normal back, a lack of support from chair (Bradford).

serious if there is marked rotation. A slight curvature in a healthy child of normal rate of growth need not cause anxiety.

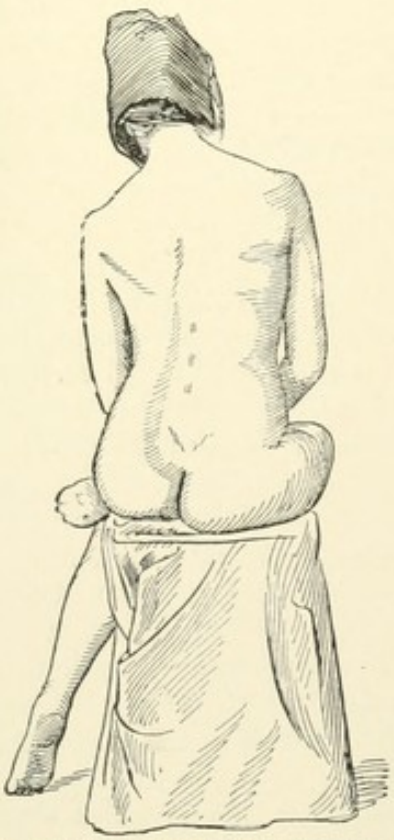


FIG. 225.—Normal back curved from sitting in a one-sided position (Bradford).

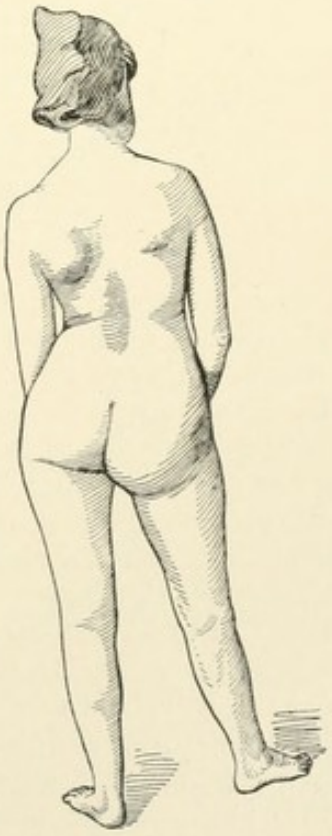


FIG. 226.—Normal back curved from standing on one foot (Bradford).

Treatment.—The practitioner will do well to heed two warnings: 1st. Do not tell the friends of the little patient that the disease is of slight

importance, and that under the use of tonics the spine will rectify itself. 2d. Do not employ braces, corsets, plaster casts, or other mechanical supports; these are required only in exceptional cases and where it is necessary to correct deformity. The muscles need development, which can be secured by exercise only. Mechanical appliances, therefore, by keeping the muscles at rest, do harm instead of good. The treatment must be directed toward three objects—first, to correct a faulty attitude or carriage; second, to increase the flexibility of the spine; third, to correct excessive deformity. Children with any tendency toward lateral curvature should be provided with suitable chairs. Fig. 224 shows the lack of support afforded by an ordinary chair; Fig. 225 shows how the normal back is curved from sitting in a one-sided position; Fig. 226 shows the effect upon the normal back of standing upon one foot. The bed used by such patients should be smooth and firm, and they should be restricted to one small pillow. Before deciding upon the necessary exercises the back should be examined while the patient is stripped to the waist. The faulty position should be corrected, as far as possible, by the patient's voluntary efforts, aided, if necessary, by the surgeon's hands. She should then be instructed to maintain the cor-

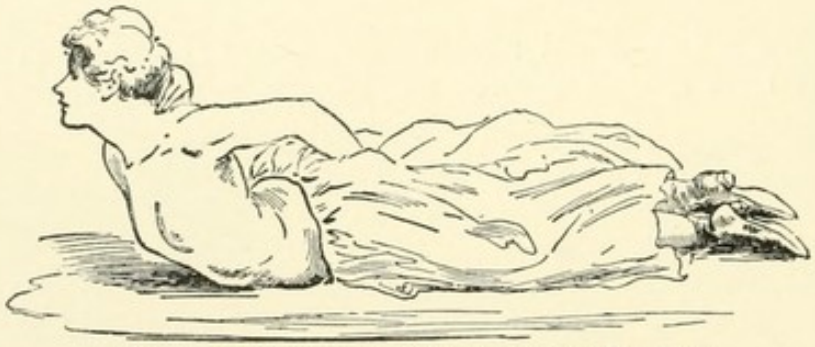


FIG. 227.—Recumbent backward bending (Bradford).

rected position as much as possible, and to always return to it after every movement during exercises. The simplest and perhaps the most useful movements are those which cause a backward bend of the body. This can be done by the patient's assuming the recumbent position and repeatedly raising the chest from the table or floor (Fig. 227); or the patient can lie on a table with the trunk projecting over the end and an assistant steadying the body at the hips and knees. She should then be directed to flex and extend the body at the hips while resistance is made by the hands of the attendant placed upon the shoulders. The patient should be instructed to lie upon a smooth flat surface for half an hour each day, to walk for a certain length of time daily carrying a light weight balanced on the head, and to swing for a few minutes by the hands from a cross-bar. Swedish movements, massage, and electricity are valuable aids to treatment.

2d. To increase the flexibility of the spine. When the deformity cannot be corrected by the voluntary effort of the patient, aided by moderate pressure of the surgeon's hands, or when it does not disappear while the patient is suspended or assumes the recumbent position, we must infer that a certain amount of fixed rotation is present. It then becomes necessary to use moderate force to stretch the contracted

tissues and overcome the deformity. Hoffa of Würzburg has devised a simple apparatus, which is shown in Figs. 228, 229. The ordinary suspension apparatus, aided by belts of webbing, can be employed to good advantage. In cases of severe deformity it is sometimes neces-

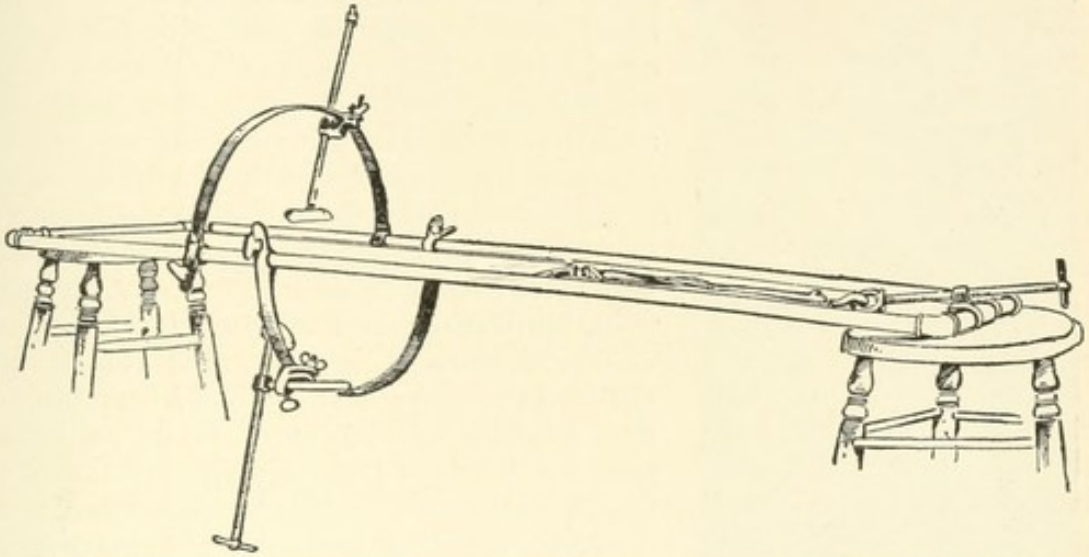


FIG. 228.—Recumbent correcting appliance for pressure-correction, made of iron piping. The patient lies on a stretched sheeting hammock, and correction-pressure is applied by screws (Bradford).

sary to apply a plaster jacket while the patient is in the corrected position. The plaster should be changed once or twice in the month, and this treatment persevered in until the deformity is overcome. After

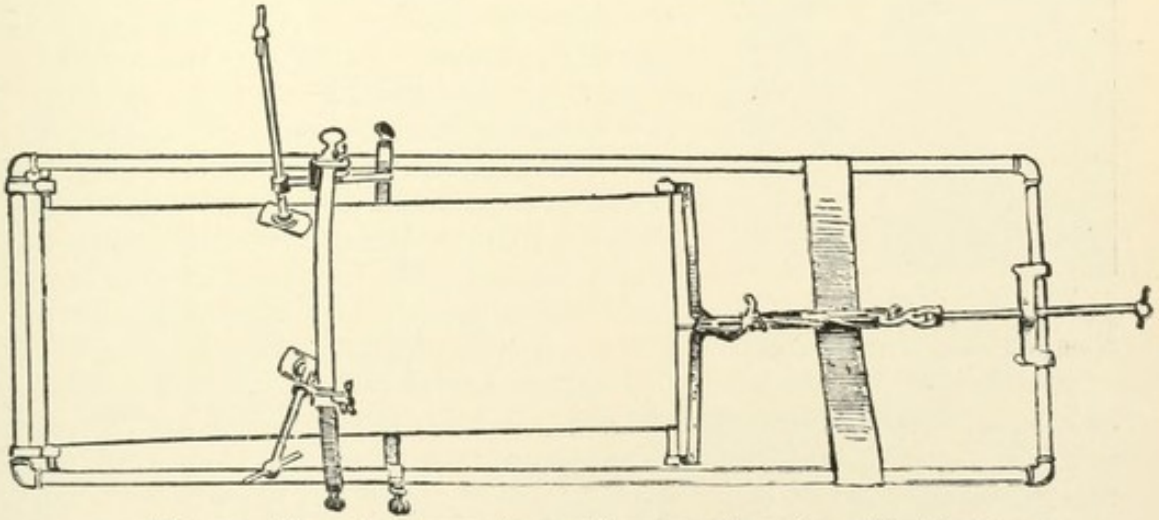


FIG. 229.—Recumbent correcting appliance seen from above (Bradford).

this suitable exercises and gymnastics should be employed, and the case kept under observation during the whole period of growth.

Posterior curvature, excurvation, or *kyphosis,* may occur at any age, but is more frequent in people of advanced life. The term should be restricted to cases of true curvature, and should not embrace the angular deformity so commonly seen in Pott's disease, and which has gone under the mathematically impossible term "angular curvature."

Kyphosis in children may be induced by permitting them to sit up

at a very early age, by nursing them in a sitting posture, or it may be a consequence of rickets. In adolescents it is produced by the same conditions that cause scoliosis. In adults it is found in persons whose occupation compels them to maintain a stooping posture, and especially if the subjects are ill-nourished and live under bad hygienic conditions. It is common in those subject to asthma, emphysema, and rheumatism, and is then due to the position voluntarily assumed for the relief of their sufferings. It is readily distinguished from the angularity of Pott's disease by the presence of a true curve, by the absence of muscular rigidity, pain, tenderness, and suppuration.

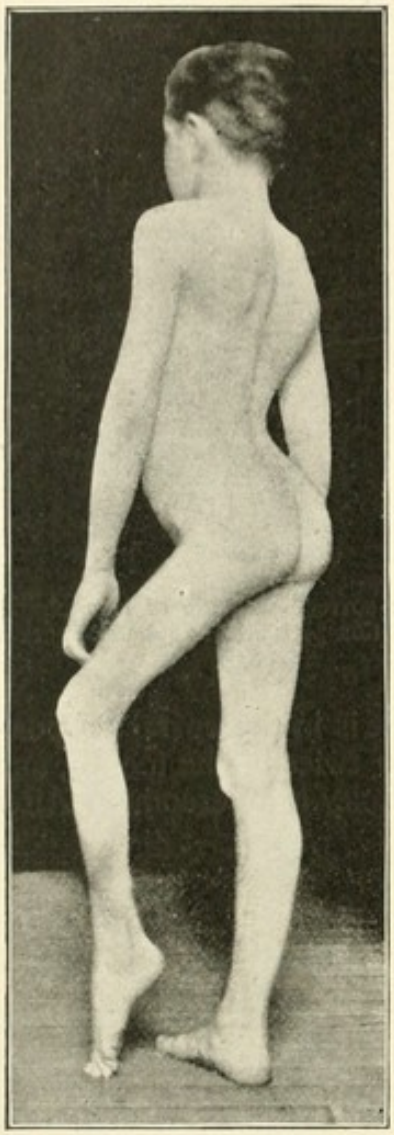


FIG. 230.—Hip-joint disease with lordosis (from a photograph in the collection of Dr. Gillette).

Treatment.—In infants and adolescents the muscles must be developed by judicious exercise, the correction of faulty positions, and on the general principles laid down under scoliosis. In old persons the condition is usually permanent, but in marked cases much benefit may be gained by the use of a suitable spinal brace.

Anterior curvature, incurvation, or lordosis, is an antero-posterior curvature with its convexity forward, and is usually found in the lumbo-dorsal region. It is often congenital. The most common causes of this condition are diseases of the posterior portions of the bodies of the vertebræ, ankylosis of the hip-joints, and rickets (Fig. 230).

Treatment must be directed to the disease that causes the deformity.

Tuberculosis of the Spine, Spondylitis, or Pott's Disease.—When the tubercle bacillus finds lodgement in the spine it selects the cancellous tissue of the bodies of the vertebræ, and produces there a group of changes similar to those found in tuberculosis of the hip or other joints. A brief survey of these changes will aid us in understanding the symptoms that mark the course of the disease.

The presence of the bacilli in sufficient numbers in tissues too weak to resist them is soon followed by inflammation in the bone. Pain is the result, greatly aggravated on movement. To guard against pain the muscles of the affected part become rigid, and this rigidity is one of the earliest signs of the disease. The patient by voluntary action assumes a posture that gives the greatest steadiness to the spine. He stoops, and places his hands upon his hips to relieve the diseased area of the weight of the head, shoulders, and all parts above; if he picks an object from the ground, he gets down to it by bending the knee, while the spine is kept rigid.

The inflammation in the bone may possibly be arrested at this point, and by resolution return to a healthy condition. Unfortunately, this rarely occurs. The inflammation is a rarefying osteitis, and destructive changes soon become apparent; caseation and disintegration of the bodies of the affected vertebræ take place, and the bony substance is replaced by granulation-tissue. The process extends to the intervertebral disks, and they also are destroyed.

Even from this point a return to health is possible. Fibrous tissue may take the place of the caseous masses, and ankylosis may result with little or no deformity.

If the disease progresses still farther, liquefaction of the caseous masses takes place and a collection of tubercular fluid (improperly called pus) is formed, which, following the path of least resistance, makes its way to the surface as a spinal abscess. Should this abscess be opened carelessly or burst of its own accord, infection by septic or putrefactive germs, or both, is sure to take place, and the dire consequences of suppuration are added to the already serious condition produced by the tubercular process. Whether the abscess appears or not, destructive changes in the bodies of the vertebræ and in the intervertebral disks go on apace. So much loss of substance must necessarily alter the shape of the spine, and, as the loss is at the anterior part of the bodies of the vertebræ, the healthy vertebræ above and below come nearer together, causing the spinous processes to project in angular prominences, the so-called "angular curvature." So important a feature is this deformity that "angular curvature" has long been recognized as one of the synonyms of Pott's disease.

The position of this angularity is generally the dorsal region, and it is not uncommon to find a compensatory curve below it in the form of lordosis in the lumbar region. If the disease occurs in the cervical or lumbar region, where there is a natural curve, the effect may be to cause this normal curve to disappear, and a straightening of the spine is the result. In diagnosis, therefore, a straightness of the cervical or dorsal portion of the spine and an obliteration of the normal curves must be regarded as of the same clinical value as "angular curvature."

Another symptom of spinal disease yet remains to be accounted for—*i. e.* paralysis. The inflammatory process is not confined to the osseous tissue. In many cases there is inflammation of the dura mater and of the connective tissue between it and the walls of the canal. A thickening of the tissues results, which by pressure upon the nerves produces paralysis. If the thickening is in front and affects the anterior roots of the nerves, motor paralysis only is observed. If both roots are involved, there is paralysis of both sensation and motion. Paralysis may also be caused by inflammation of the cord itself or by the pressure of a displaced vertebra upon it. It is an important clinical fact that the liability to paralysis is greater the higher the portion of the spinal column that is affected, owing to the larger size of the spinal cord and the smaller size of the bodies of the vertebræ.

Symptoms.—In typical cases the symptoms of Pott's disease are so characteristic that an error in diagnosis is scarcely possible. There are cases, however in which the symptoms are far from typical, and perhaps no disease assumes a greater variety of forms or appears under so

many different guises as tuberculosis of the spine. In the lumbar region it may so closely simulate hip-disease as to deceive the most careful observer, while in the cervical region the evidence may point to a simple wry-neck and nothing more.

Pain is present in nearly every case, and is one of the leading symptoms. It requires the most careful study, as it is sometimes misleading to both parents and surgeon. It is generally symmetrical, and is often confined to the peripheral ends of the nerves. Hence, instead of being felt in the back, it may be felt in the abdomen, giving rise to the belief that the patient has stomach-ache or some abdominal disorder; or it may be confined to the chest and pass for intercostal neuralgia; or it may run down the arms or lower limbs and take the name of "growing pains." Like all pains connected with bone, it is worse at night, and may even assume the character of the "starting pains" which cause such suffering in hip-disease. The location of the pain will vary with the part of the spine affected. In disease of the lumbar region abdominal pains are felt, and not infrequently there is irritability of the bladder; in the dorsal region the pain is felt in the epigastrium or along the course of the intercostal nerves, and the breathing is sometimes affected; in the cervical region the disease may cause pains or numbness in the arms, difficulty in swallowing, and a tickling cough. It will thus appear that pain is not a symptom of definite value. Its uncertainty should put us on our guard and lead us to a close examination of the spine itself. Persistent pain, worse at night, in any of the positions just mentioned should create a suspicion of Pott's disease.

The most significant characteristic of the pain is its being aggravated by movement of the spine, by jumping, or by twisting the body. The patient should be asked to jump from a chair to the floor; pressure should also be made upon the shoulders, so as to gently crowd the vertebræ together. If these tests are borne without pain, the spine may be considered free from disease. Another test consists in gently lifting the patient by placing the hands under the chin and occiput while he is in the erect position; this gives relief if the pain is due to Pott's disease.

Rigidity of the muscles is a symptom of the greatest value. Pain may be absent, or, if present, it may be misleading, while deformity does not occur until after much damage has been done; but rigidity is an early and ever-present symptom. It is an effort to keep the diseased bones at rest and prevent the movement that causes such intense pain. The patient should be stripped of all clothing and caused to walk across the floor. The gait is unnatural and the attitude is peculiar. Draw his attention to an object behind him, and instead of looking over his shoulder he will turn his whole body. Ask him to pick an object from the floor, and he bends the knee, while the spine is kept rigid (Fig. 231). This rigidity gives rise to peculiar attitudes varying with the location of the disease. When the cervical vertebræ are affected, the head is sometimes tilted, giving the appearance of torticollis. Disease in the upper dorsal region causes the patient to assume the attitude seen in Fig. 232. A very aggravated case is shown in Fig. 233, in which the patient assumes the attitude of a quadruped in all his locomotion.

Deformity.—The mechanism of the so-called "angular curvature" has been already described. It should be carefully sought for, as it is the earliest symptom of destructive change, just as shortening of the limb is evidence of the destructive process in disease of the hip-joint. It is advisable to keep an accurate record of the amount of deformity, and this can best be done by photographs. They do not give an idea of the amount of rotation in cases of lateral curvature, but this can be obtained if the patient stoops forward and a photograph be taken of the bent back, or if a mirror be placed directly on the patient's head at such an angle as to reflect the contour of the back below; if the reflection be photographed the rotation will be recorded (Bradford).

Abscess.—Many cases of Pott's disease run their course without suppuration, or without the formation of liquid collections improperly called "tubercular abscesses." Early and efficient treatment has much to do in the prevention of these disagreeable complications, though abscesses may form in spite of the most careful treatment. Beginning as they do in the anterior portion of the vertebræ and in close proximity to the important organs contained in the thoracic and abdominal cavities—viz. the esophagus, the lungs, the



FIG. 231.—Manner of picking up an object in Pott's disease (Agnew).

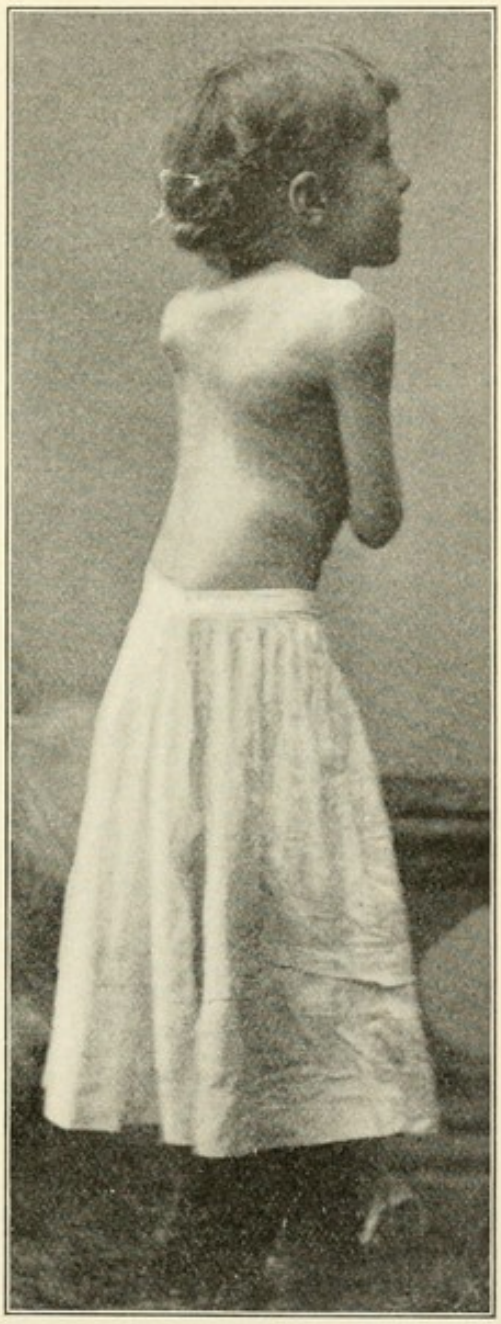


FIG. 232.—Disease in upper dorsal region (from a photograph in the collection of Dr. Gillette).

large vessels, and the contents of the peritoneum—it is remarkable that spinal abscesses are not more frequently followed by fatal results. They afford examples of the manner in which pus can travel far from its point of origin, seeking an outlet to the surface in the direction of least resistance.

When an abscess takes its origin from the bodies of the cervical vertebræ it may point to one of the following directions: (*a*) Retro-pharyngeal, the fluctuation being felt to one side of the middle line; (*b*) The fluid may burrow outward and point behind the angle of the jaw; (*c*) It may

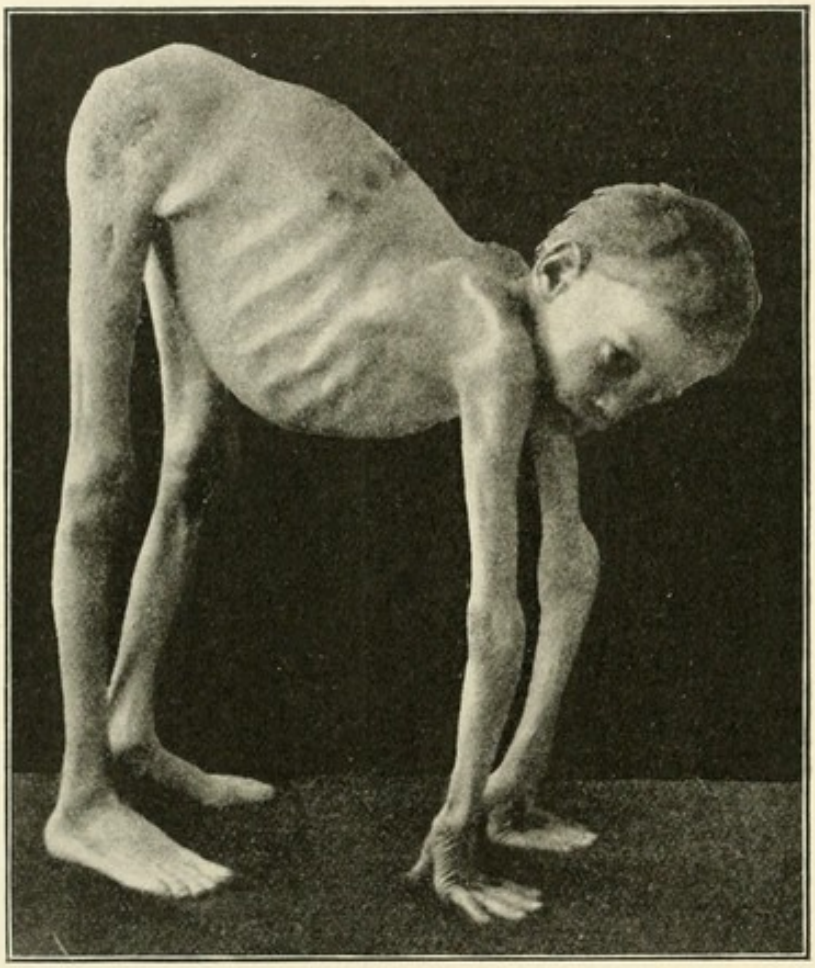


FIG. 233.—Quadruped locomotion.

follow the course of the esophagus and enter the posterior mediastinum; (*d*) It may burrow between the longus colli and scaleni muscles, and point in the neck at one or other side of the sterno-mastoid muscle. When the dorsal vertebræ are affected, which happens in the majority of cases, the first collection of fluid is in the posterior mediastinum. From this position it may travel in one of three routes: (*a*) Passing between the transverse processes, it may appear in the back—the so-called *dorsal* abscess. (*b*) It may burrow downward to the diaphragm, pass under the ligamentum arcuatum externum, and appear in the ilio-costal space and become a lumbar abscess (Fig. 234). (*c*) It may pass beneath the ligamentum arcuatum internum and between the two origins of the psoas muscle, and become a psoas abscess. Its place of point-

ing is generally in the groin below Poupart's ligament and the outer side of the femoral vessels. In some cases it points above Poupart's ligament, and by gravitation it may burrow down the thigh or even below the knee.

Disease in the lumbar vertebræ produces an iliac abscess which usually points in the abdominal wall a little above Poupart's ligament. We cannot place much reliance upon the position in which an abscess

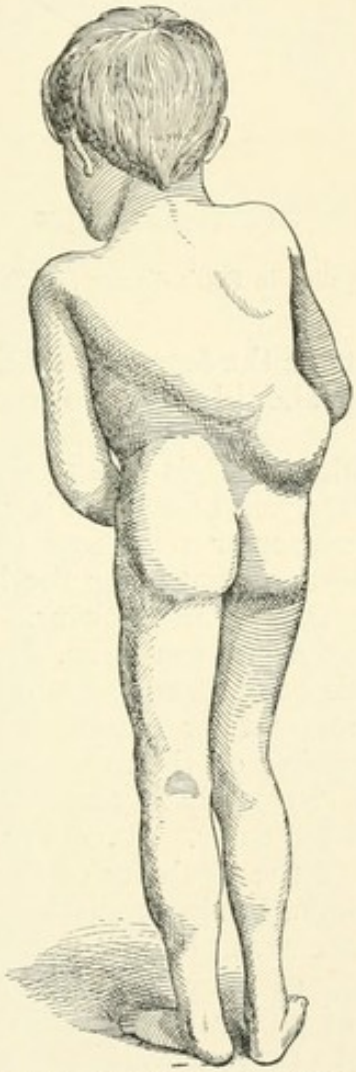


FIG. 234.—Lumbar abscess (Hoffa).



FIG. 235.—Severe grade of psoas contraction (from a photograph in the collection of Dr. Gillette).

points, for pus, with ever-increasing pressure, constantly burrows in the direction of least resistance.

It is very important to make a diagnosis of abscess before pointing takes place. The formation of an abscess may be suspected when there is a sudden increase of pain, loss of appetite and flesh, and general constitutional disturbance in a patient who had previously been doing well. As the psoas abscess is the most common form, contraction of the psoas muscle is an early symptom and a valuable diagnostic point. In some cases the contraction is marked and causes great deformity (Fig. 235). The manner of estimating mild forms of contraction is shown in Fig. 236. Psoas abscess must not be mistaken for

hernia. When an abscess appears suddenly, is egg-shaped, and free from tenderness and heat, as it frequently is, its resemblance to hernia

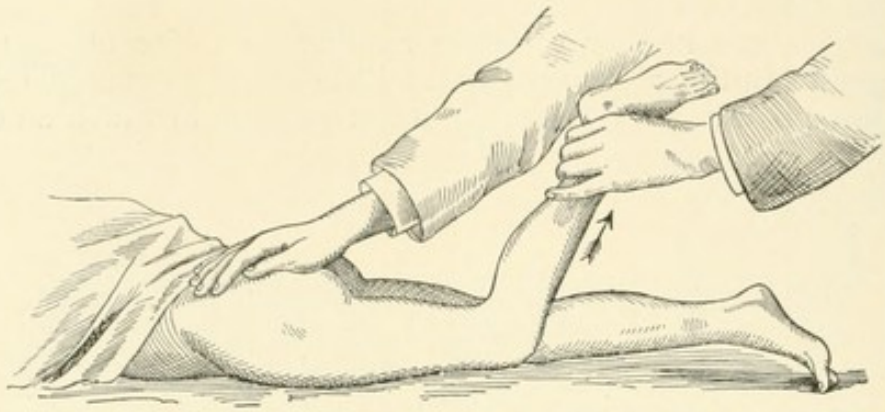


FIG. 236.—Method of examining for psoas contraction in Pott's disease (Hoffa).

may mislead the unwary. Its position outside the femoral vessels, corroborated by other signs of Pott's disease, should leave no room for doubt.

Paralysis.—This symptom, as already described, is due to a pachymeningitis or to a transverse myelitis. Paralysis of motion is usually the first to appear, varying from mere muscular weakness to complete paresis. The reflexes are exaggerated, except when the lumbar vertebræ are affected, and muscular spasms frequently occur. If the posterior roots suffer pressure, there is paralysis of sensation. Paralysis is greatly influenced by treatment. On this point Bradford and Lovett say: "It occurs without regard to the amount or character of the deformity, and is often preceded by much pain; on the average it lasts a little less than a year. Its prognosis is extremely favorable in mild cases, or in severe ones if they can be treated early. Recovery, when it occurs, is generally complete, no trace of the disability of the limbs being left. Incomplete recovery is uncommon, but incomplete paralysis often is present. In fact, the early commencement of efficient treatment will often seem to render abortive an attack of paraplegia, and change what threatened to be a complete loss of power to a comparatively trifling disability which is merely enough to prevent walking for a few weeks or months."

Differential Diagnosis.—A typical case of Pott's disease cannot be mistaken for anything else. There are cases in which pain is for a long time the only symptom, and these are fruitful sources of error. The surgeon, misled by the position of the pain, gives his attention to intestinal disorders, gall-stones, intercostal neuralgia, or rheumatism, and never thinks of examining the spine for rigidity or deformity.

Sprains of the spinal column may simulate Pott's disease by causing the patient to assume an attitude resembling the latter. There may even be rigidity of the muscles, and the patient in attempting to walk may place his hands upon his thighs to support the weight of the trunk.

Sprains seldom occur in childhood. The suddenness of the symptoms, their evident connection with a traumatism, and the speedy recovery under appropriate treatment settle the question of sprain.

Hysterical or hyperesthetic spine occurs in young growing girls and in neurotic persons. The spine is tender in spots, and there may be intense pain, but the attitude and gait of Pott's disease, the angularity, and to a certain extent the muscular rigidity, are absent.

Wry-neck is one of the symptoms of disease of the cervical vertebræ. Simple muscular wry-neck is distinguished by the rigidity of certain muscles and the absence of pain attending movements of all other muscles.

Lateral curvature, rickets, aneurysm, rheumatism, and many other disorders may simulate Pott's disease. If, however, the two characteristic symptoms, *muscular rigidity and deformity*, be carefully studied, it is hardly possible to make a mistake. Fig. 237 illustrates a case of rachitic curvature. Note the true curve instead of the "angular curvature" as seen in Pott's disease. The true curve also exists in chronic rheumatic arthritis, aneurysm, and malignant disease. Hump-back may be a marked feature of lateral curvature, but it is caused by a projection of the rotated spine and distorted ribs, and not by the spinous processes. In a case of any doubt repeated examinations should be made, and the case kept under observation pending development.

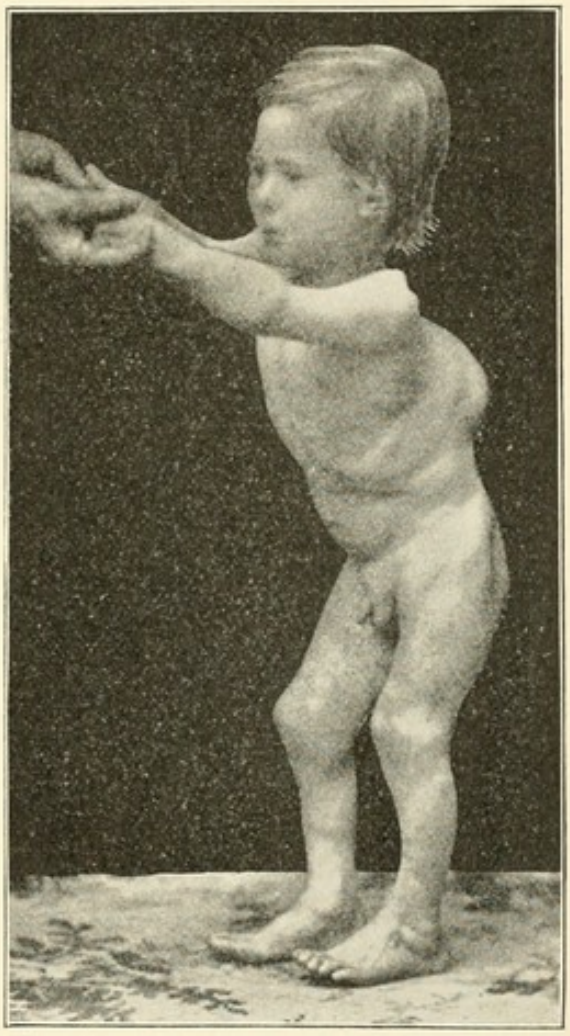


FIG. 237.—Rachitic posterior curvature (from a photograph in the collection of Dr. Gillette).

Treatment.—We have seen in the case of the hip-joint that if the parts are completely immobilized in the early stages, there is a good prospect of arresting the tubercular process; the same may be said of Pott's disease. Early and complete rest of the diseased part is one of the most effectual means of treatment. But the disease is full of complications; its course is a long one, and, whatever methods of cure are employed, they must be persevered in through months and years. In the early stages we must aim to arrest the tuberculous process and bring about resolution of the inflammation which has attacked the bone. Deformity must be prevented. In the later stages, when deformity has already occurred, it must as far as possible be corrected; bone-destruction having already taken place, we must aim at a cure by ankylosis; abscesses are to be evacuated, sequestra, if present, removed, and pressure upon the cord by pus, bone, or thickened dura averted.

Rest is the most valuable of all agencies in the early stages. The

diseased vertebræ suffer from the weight of the portion of the trunk which lies above them, and this weight it is necessary to remove. This is effectually accomplished by placing the patient in the recumbent position and keeping him there. The mattress must be smooth and hard, so as to prevent sagging of any part of the spine. To carry out this measure thoroughly the patient must lie either upon his back or his face; turning upon the side or bending forward while lying on the side

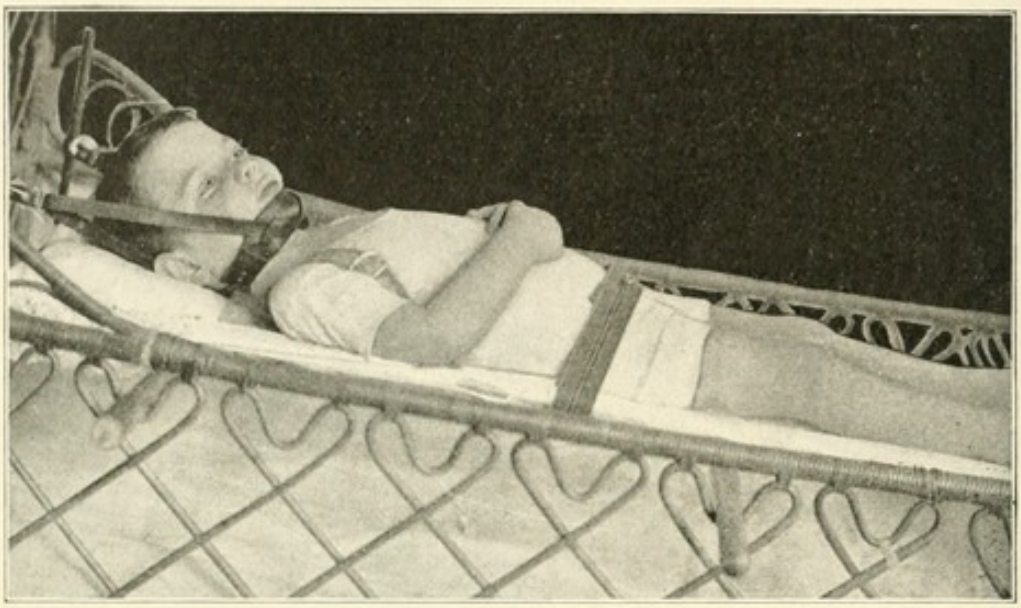


FIG. 238.—Extension in the recumbent position (from a photograph in the collection of Dr. Gillette).

twists and flexes the spine and disturbs the parts which we are trying to keep at rest. When the disease affects the cervical vertebræ, the head and neck should be steadied by sand-bags laid one on each side and kept in position by tapes. The sand-bags should extend from the top of the head to the shoulder. No pillows should be used. Extension is a valuable adjunct to rest in the recumbent position. It can be applied to the head and occiput by a sling connected with a weight and a cord which runs over a pulley at the head of the bed, as shown in

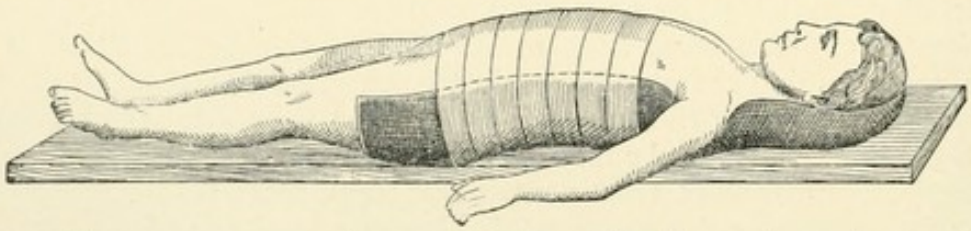


FIG. 239.—Frame to secure recumbency and fixation and to allow patient to be moved about (Hoffa).

Fig. 238. The head of the bed being raised to ensure counter-extension, the weight need not exceed one pound, or the foot of the bed can be elevated to the extent of several inches, and extension by Buck's method made upon the lower limbs.

Treatment by recumbency is indicated where the symptoms are acute, and especially when the disease is in the cervical or in the lower lumbar regions. It is often effectual in preventing paralysis or the

formation of an abscess. It also has its disadvantages, one of the most serious of which is the close confinement within doors. To obviate this and to allow the patient to be taken into the open air various contrivances have been devised, one of the simplest of which is the frame shown in Fig. 239. On this frame he can lie when in bed or be carried into the open air without disturbing the spine. This treatment should be persevered in until all signs of the disease have disappeared, either by resolution or by ankylosis. Constitutional treatment directed toward the tubercular condition should be kept up throughout. Sunlight, fresh air, nourishing diet, cod-liver oil, phosphates, and syrup of the iodid of iron are indispensable.

Treatment by Suspension and Plaster Jackets.—An endless variety of appliances has been devised for producing fixation of the spine. The simplest and most practicable of these is the plaster jacket, for the general adoption of which we are indebted to Dr. Sayre. This method of treatment is suitable when the disease is below the mid-dorsal vertebræ and is not in a very acute stage. The object aimed at is to steady the spine and to transfer the weight of the parts above the disease to the pelvis and hips. The spine is put in the best position for receiving the plaster jacket by suspending the patient in the apparatus shown in Fig. 240. The patient is stripped and a closely-fitting woollen undershirt put on. He is then suspended by means of the chin and occiput, and in the case of older persons by the axillary bands in addition. The pulleys are used to elevate him so that the heels, and if necessary the toes, leave the floor. The shirt is now pulled down so as to make all parts of it smooth; the bony prominences, such as the iliac spines and the crest of the ilium, are padded with cotton; and a towel, folded into the shape of a wedge, is placed with its broad end upward over the abdomen. This is called the dinner pad, and is to be removed after the application of the jacket, so as to leave a space which will permit the distention of the abdomen after eating. The bandages are then applied, beginning between the trochanters and the crest of the ilium and extending to the axillæ. The most convenient size of bandage is three inches wide and six yards long, and about three layers are sufficient. In about fifteen or twenty minutes after the plaster is ap-

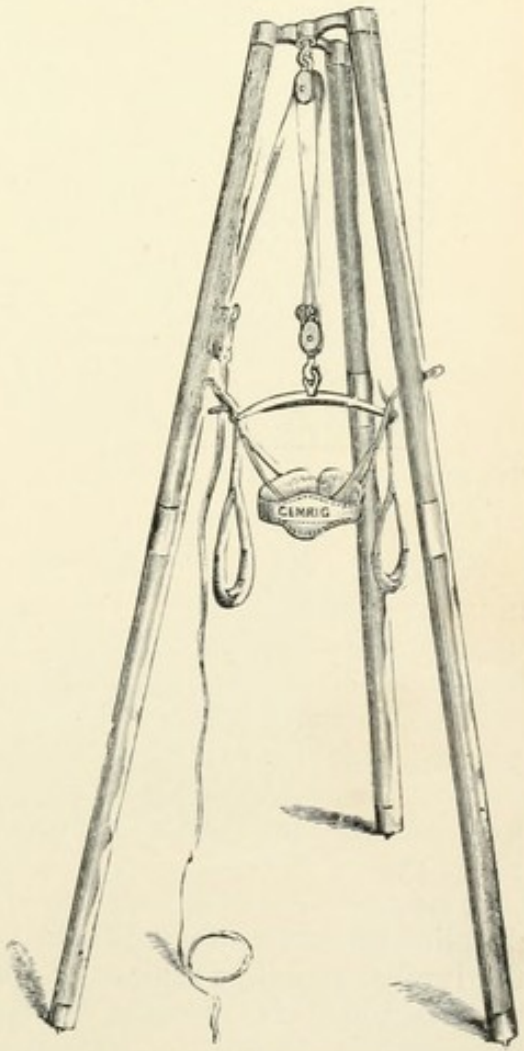


FIG. 240.—Tripod for the suspension of the patient (Sayre).

plied it will have set, and the patient can then be lifted by the arms and placed upon a smooth surface, where he must lie for about an hour to allow the jacket to become hardened.

The jacket, if skilfully applied, can be worn for ten or twelve weeks, but should there be any suspicion that an abscess is forming or that undue pressure is being exerted at any point, it should be removed, the parts carefully examined, and if found satisfactory a new jacket can be applied. Sometimes it is advisable to have a removable jacket. This can be done by cutting it down the front, binding the edges with adhesive plaster, and inserting eyelets at a suitable distance from the edge, by which it can be laced. A ready and useful position for receiving a plaster cast is shown in Fig. 241.

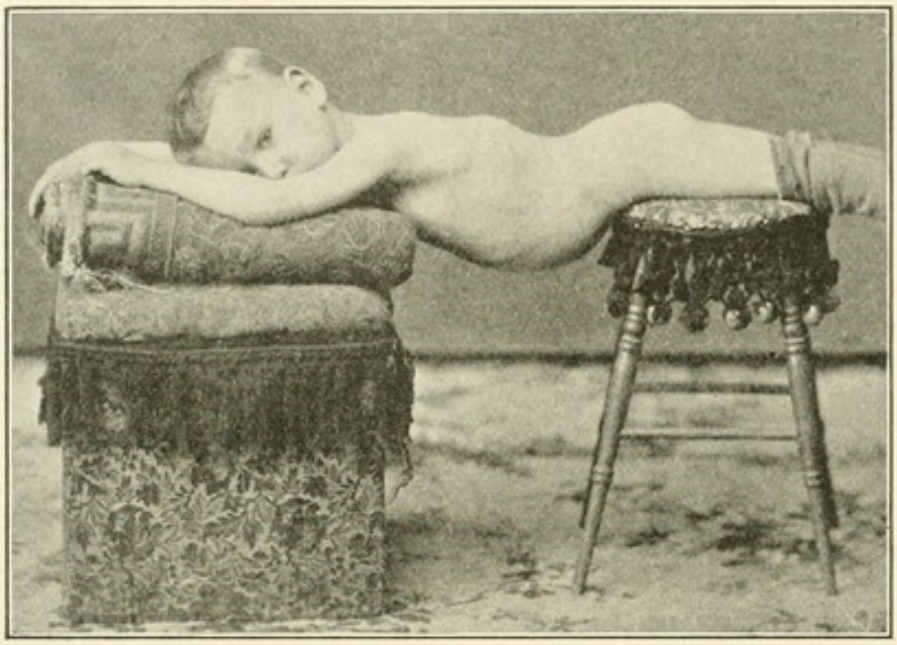


FIG. 241.—Position of patient for receiving plaster jacket (from a photograph in the collection of Dr. Gillette).

When the disease is above the mid-dorsal region, additional support must be given to the head and neck, and this is secured by the "jury-mast." It consists of a vertical steel bar shaped to the curves of the neck and head, and attached to which is the sling that supports the chin and occiput (Fig. 242). The lower end of the bar can be incorporated with the plaster jacket or riveted to the leather or poroplastic jacket. A great variety of appliances can be used instead of the plaster cast. A neat and comfortable support of this kind is seen in Fig. 243.

Treatment of Complications.—The most common and serious complication of Pott's disease is spinal abscess. The abscesses which form in the lumbar and iliac regions are probably the most dangerous and most uncertain in their course. When an abscess has formed it should not be temporized with by aspiration, for this has been thoroughly tried and found wanting. Two methods of treatment deserve attention: First. Tapping and injection of iodoform emulsion. When the abscess-cavity can be wholly evacuated and the emulsion made to penetrate every part of it, this form of treatment is fairly successful. Many

abscesses, however, burrow through the tissues and appear in situations far removed from their starting-point, and nothing but continuous drainage will effect total removal of the fluid. Second. Free evacuation and drainage. The treatment will depend upon the situation. Retropharyngeal abscess was formerly opened by way of the mouth, the incision being made a little to one side of the middle line and by means of a long straight bistoury. The objection to this



FIG. 242.—Jury-mast and leather jacket (Gillette).

method is that the tubercular fluid is almost sure to become infected, and true suppuration is thus added to the tubercular process. An external opening should be made when possible, and infection prevented by the strictest aseptic treatment. The incision can be made at either border of the sterno-mastoid muscle, and the abscess reached by dissection, care being taken to avoid the great vessels. When the abscess is in the dorsal or lumbar region, it should be laid freely open and explored with the finger in search of sequestra or outlying pockets.

Psoas abscess is generally a double abscess, divided in the middle by Poupart's ligament. The upper cavity is usually much the larger, and for these reasons it is difficult to drain. The opening should always be made in the lumbar region. An incision is made along the outer edge of the erector spinæ muscle, and all the structures divided down to the quadratus lumborum; the tip of the third lumbar transverse process is sought for, and opposite to this the fibers of the quadratus and the anterior layer of the transversalis fascia are divided. The finger is then passed along the anterior surface of the quadratus until

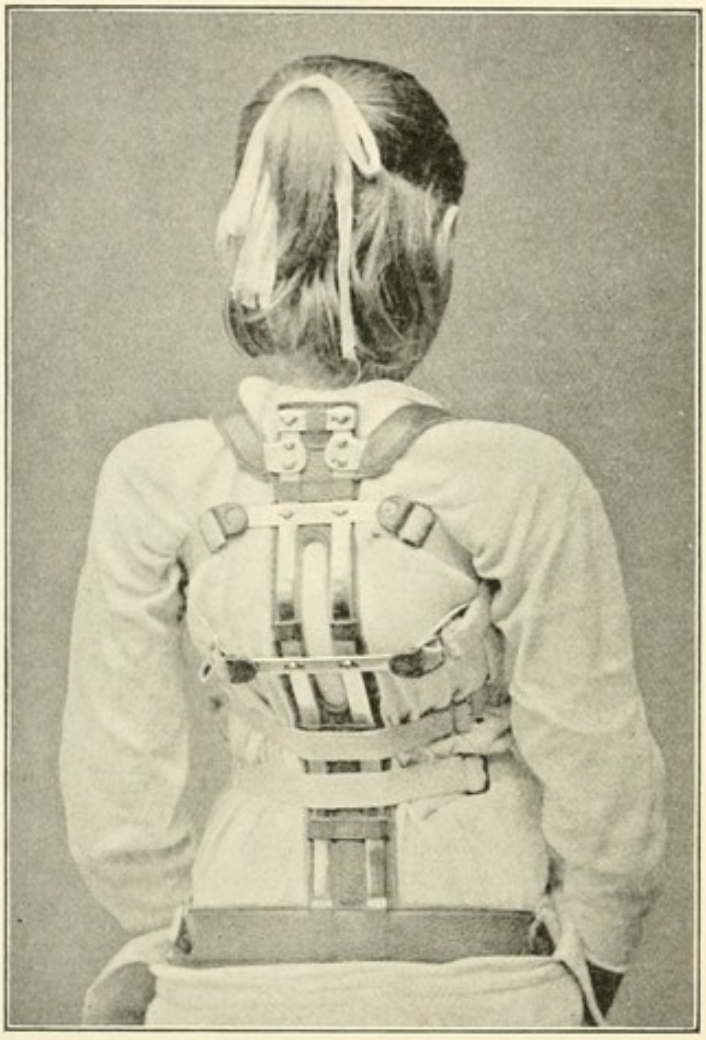


FIG. 243.—Antero-posterior support for Pott's disease in the lower dorsal region (from a photograph in the collection of Dr. Gillette).

the psoas and the abscess are reached. A second opening is usually required where the abscess points. If a drainage-tube can be made to connect these two openings, so much the better.

Paralysis.—If proper treatment be adopted in the early stages of the disease and faithfully persevered in, paralysis will seldom occur, and even if it be present when the case comes under the care of the surgeon, the prognosis need not be unfavorable: most excellent results have been obtained by rest in the recumbent posture, and especially when combined with extension. When these means fail and the paralysis is steadily increasing, the operation of laminectomy may be con-

sidered, with the idea of relieving pressure on the cord and possibly removing the diseased bone. The operation is open to serious objections, and is only justifiable when under other treatment the paralysis continues to increase, especially that of the bladder and rectum (Kraske).

CHAPTER X.

DISEASES AND INJURIES OF NERVES.

A NERVE, be it large or small, is composed of the following parts: 1. A nerve-sheath or perineurium; 2. A lymph-space between the perineurium and the nerve proper; 3. The endoneurium, composed of offsets from the perineurium, which pass to the interior of the nerve and there form the sheaths which surround bundles of primitive nerve-tubules; 4. Blood-vessels; 5. Nervi nervorum.

Neuritis, or Inflammation of a Nerve.—When a nerve becomes inflamed, one of the first changes is an increase in the connective tissue of the sheath or perineurium, which is further thickened and swollen by exudation of serum. Changes in the nerve-tubules rapidly follow; they undergo granular and fatty degeneration and are consequently softened. In rare cases suppuration occurs in the nerve-structure, and occasionally hemorrhage.

When inflammation takes the chronic form, the sheath becomes permanently thickened and adherent to surrounding tissues. By pressure it produces atrophy of the nerve-fibers, which disappear to a great extent.

Inflammation of a nerve may be idiopathic, but its most common causes are injury and exposure to cold. Certain diseases also give rise to it, such as gout, rheumatism, syphilis, typhoid fever, and the exanthemata. The nerves most commonly affected are the sciatic and the facial. Many of the cases of sciatica and of facial neuralgia are really due to inflammation of the nerve. Neuritis may be acute or chronic.

Symptoms.—These are constitutional and local. Unless the neuritis is severe and extensive the constitutional signs may be wanting. When present they are rigors, high temperature and pulse, with delirium in exceptional cases. The local symptoms are much more important and constant:

1. *Acute Neuritis.*—The earliest indication of acute neuritis is generally an aching pain along the course of the nerve, worse at night and increased by movement of the part. By digital pressure the nerve-trunk, if superficial, may be felt to be enlarged and exquisitely tender, while in rare cases the skin over it is streaked with redness. The pain radiates over the parts to which the nerve is distributed; the sensation may be a tingling or numbness, a dull aching or burning. The muscles, sooner or later, show the effect of disturbance of the nerve-current. The whole of a muscle or certain of its fasciculi may be thrown into contraction. This contraction may take the form of twitching, but tonic spasm is more common. At a later period the muscle loses its power, respond-

ing imperfectly to the faradic current, and in unfavorable cases advancing to complete paralysis and atrophy. When the neuritis is of traumatic origin it has a tendency to extend along the course of the nerve until it reaches the branches. These in their turn become involved, and so the nerves of an entire limb may be affected. From this condition the inflammation may subside, leaving no ill effects, or the disease may become chronic, the muscles wasted, the joints stiffened, and the general health impaired from prolonged suffering.

Diagnosis.—Rheumatism and neuralgia are sometimes difficult to distinguish from neuritis. The pain of neuritis follows the track of a nerve, and in confirmed cases there are sensory, motor, and trophic changes. Neuralgia is recognized by the absence of febrile symptoms and by the more diffuse character of the pain.

2. *Chronic neuritis* is often a sequel of the acute form. The sheath of the nerve becomes thickened and adherent to the surrounding tissues; the nerve atrophies, and may even disappear. The whole nerve is increased in size, but in the advanced stages it shrinks to less than its normal diameter.

Multiple neuritis is associated with alcoholism and syphilis, but it possibly arises from the same conditions which produce simple acute or chronic neuritis. As a rule, it begins on the extensor surface of the legs. From feet and hands it spreads to various parts of the body. Tenderness and redness of the skin along the course of the nerves are characteristic, and the nerves can frequently be felt as firm cords. The muscles lose their power and begin to waste, the reflexes disappear, and the movements simulate those of locomotor ataxia. The course of the disease varies. In some cases improvement takes place, but in others the condition goes on from bad to worse, until the spinal cord becomes involved or the patient dies of some intercurrent disease. The difficulty in diagnosis is to distinguish it from tabes dorsalis. There may be lightning or girdle pains and ataxic gait, but in spinal disease the muscles respond normally to the electric current, while in multiple neuritis they do not.

Treatment.—The first essential in the treatment is absolute rest. In the case of the nerves of a limb this can be best secured by the application of a splint. When due to rheumatism, syphilis, or other diseases these must receive proper attention. For the relief of the acute pain warm fomentations, belladonna liniment, or the subcutaneous injection of morphin are indicated. After the acute symptoms subside iodin, blisters, and acupuncture are useful remedies, but best of all is the constant galvanic current. Hot or Turkish baths at night often secure sleep. The constitutional remedies most to be relied upon are quinin, salicylic acid, iron, and tonics. Nerve-stretching has met with varying success, and undoubtedly has proven beneficial in many cases. When there is much hyperemia, or in the rare instances in which there is suppuration in the nerve-sheath, the nerve should be cut down upon and the sheath laid freely open.

Neuralgia signifies pain in a nerve. It is of an acute paroxysmal character, coming on suddenly, and as suddenly disappearing. Many of the cases diagnosed as neuralgia are really neuritis. It is only when the symptoms of inflammation are wanting, and when there is an ab-

sence of disease or injury to the parts supplied by the affected nerve, that we are justified in pronouncing the pain neuralgic. In a very large number of cases the cause is unknown. The following, however, may be set down as among the most frequent causes: 1. Injury to the nerve, often obscure; 2. Irritation by a foreign body; 3. Pressure of a tumor; 4. Compression by a cicatrix; 5. Certain toxic conditions of the blood, as in malaria, lead-poisoning, or mercury-poisoning; 6. Over-distention of veins near nerves as they pass through long bony canals, as in the intraorbital canal; 7. In some instances the neuralgia is reflex, irritation in one nerve producing pain in another.

Symptoms.—Pain of a burning, cutting, darting, or boring character along the course of a nerve, continuous, remittent, or intermittent, is the most prominent symptom. Pressure, as a rule, increases the pain, but in some cases gives relief. From a surgical standpoint neuralgia is seen chiefly in three forms: (1) neuralgia of the trifacial nerve or tic-douloureux; (2) sciatica; (3) the neuralgia of stumps and scars.

Tic-douloureux may be confined to one or all of the branches of the fifth pair, and is often attended with the most excruciating pain. The slightest cause, such as a draft of cold air, a slight touch, or a loud noise, may suffice to bring on a paroxysm. The movements of mastication are likely to start up the pain, so that the patient is in dread every time he eats.

Sciatica is a painful and common affection. It is frequently a functional neurosis, but autopsies have shown that in some cases it is an organic disease characterized by softening of the nerve-tissue, dilatation of the vessels, and exudation of serum into the sheath. In cases due to functional neurosis no anatomical changes are found.

For diagnostic purposes it is convenient to divide sciatica into three varieties: 1. Sciatic neuralgia; 2. Sciatic neuritis; 3. Symptomatic sciatica—*i. e.* sciatica which is the result of some other disease.

Symptoms.—Pain is the leading symptom. It is usually worse at night, and in some cases this appears to be because the patient cannot bear to extend the leg while in bed. During the day there is less suffering, especially if the patient remains quiet; but standing or walking speedily aggravates the pain. Tenderness can generally be detected at the four following points: the sciatic notch, the lower margin of the gluteus maximus, the popliteal space, and the head of the fibula.

When, even after years of suffering, the disease produces no atrophy of the muscles of the limb (except what we might naturally expect from want of use), we may safely assume that the disease is of the neurotic type. If there be a *neuritis*, trophic changes will develop, especially atrophy of the muscles with reaction of degeneration (Nonue). The patellar reflex is diminished. Double sciatica is very significant of spinal disease or of general disease of the nervous system, as tabes, or it may be associated with syphilis or diabetes. The urine should be examined for sugar. "It has been shown by Braun and others that sciatica may react upon the vaso-motor nerves and cause a small amount of sugar to appear in the urine, which may subside as the pain ceases to be troublesome. Robson Roose reports 3 cases in which this symptom was present. If, then, we find sugar in the urine, two things may enable us to determine whether the sciatica is a cause

or a symptom—viz. the knowledge as to whether any sugar was present before the appearance of the sciatica, and inquiry as to the amount of sugar present, and whether it is controlled by the cause of the sciatica."[1]

Neuralgia of scars may be divided into two classes. In one form there is localized pain, excited by pressure on a particular spot, and there can generally be felt an induration or adhesion of the scar to the underlying bone. In the other form the pain is more widely diffused, attended with superficial hyperesthesia, intermittent in character and accompanied by jerkings. This form is found in anemic individuals, mostly women, and is of constitutional origin, while the first is purely local. The importance of diagnosticating between these two forms is that the local variety can be best treated by operation, while the constitutional form will not be benefited until the system is put into better condition. In a case of this kind mentioned by Moullin amputation was resorted to four consecutive times, and the nerves stretched almost to the point of tearing them out of the stump, and still the pain continued.

Treatment.—When the cause can be discovered its removal is the first point in treatment. If the disease is due to malaria, quinin is indicated, large doses often being required. When there is anemia iron should be employed. In the majority of cases the suffering can be relieved by full doses of quinin, acetanilid, phenacetin, chloral, or morphin, while applications of aconite, belladonna, veratria, or menthol can be used locally. The general health should in all cases be improved by tonics, fresh air, and easily digested food. In sciatic neuralgia subcutaneous nerve-stretching is indicated when ordinary means fail. The patient is put under an anesthetic, and while the leg is kept in full extension the thigh is forcibly flexed upon the body. Stretching of the nerve through an incision has a more marked effect, probably from the fact that adhesions of the nerve and its sheath are more completely broken up.

Epileptiform neuralgia is another form requiring careful study. It often resists every form of treatment except operative, and even that often produces only temporary benefit. It is distinguished from other forms by the twitching of the facial muscles. The teeth may be extracted, one by one, without affording a particle of relief. Morphia only makes the condition of the patient worse and worse, and other anodynes are useless. Galvanism, persistently employed, will benefit some cases.

Nerve-stretching has had its advocates, and many satisfactory results are reported. When the superior maxillary is the branch involved, excision of Meckel's ganglion is a justifiable procedure, although even after this formidable operation the relief obtained will not probably last more than a few months. The ganglion can be reached and excised from the front by trephining the antrum. A crucial excision over the infra-orbital foramen is made down to the bone. From immediately below the foramen a half-inch disk is removed by a trephine. The nerve is then traced back to the posterior wall. Through this wall a second trephine opening is cautiously made and the ganglion is ex-

[1] Dr. D. O. Thomas: *Pacific Med. Journ.*, 1895.

posed. The ganglion should be removed, together with its posterior dental branches, and the whole of the infra-orbital.

When the inferior dental is the nerve involved, it can best be reached by the mouth, and operation in this region has the advantage of leaving no unsightly scar. Having first inserted a gag and forced the mouth as widely open as possible, make an incision along the projecting fold of mucous membrane which passes from one jaw to the other behind the last molar tooth. By pushing the finger between the internal pterygoid muscle and the ramus the sharp spine of bone can be felt which is the landmark for the orifice of the dental canal. A blunt hook or an aneurysm needle is then used to draw the nerve forward, when it can be separated from its attachments and divided.

Injuries of Nerves.—Although, as a rule, nerves are well protected, they nevertheless are liable to a variety of injuries. Tumors may compress a nerve, as, for instance, aneurysm of the aorta pressing upon the recurrent laryngeal. In dislocation of the shoulder the head of the humerus may compress and contuse the brachial plexus. When fracture occurs, one of the fragments may compress and even lacerate a neighboring nerve. A drunken man falling asleep with his arm over the back of a chair has had the limb paralyzed from pressure upon the brachial plexus. The pelvic nerves are frequently injured from long-continued pressure during delivery, and the seventh nerve of the child has been injured during the application of forceps, with facial palsy as a result.

Symptoms.—Compression or contusion of a nerve is recognized by the tingling sensation, which is commonly spoken of as "pins and needles." In more severe contusions the functions of the nerves may be lost and more or less marked paralysis be manifested, or a neuritis may be developed along the course and distribution of the nerve. Much information can be gained by the employment of the faradic current. Should the muscles respond readily, the injury is probably slight. Should there be no response and should the muscles begin to atrophy and degenerate, the prognosis is unfavorable.

Treatment.—Removal of the cause, when possible, is the first indication. To restore the function of the nerve absolute rest is of the utmost importance. In the case of a limb complete immobilization by a splint is good treatment. When pain is intense hypodermic injections of morphin and atropin will be required. In prolonged and obstinate cases arsenic and the use of the galvanic current will prove valuable remedies.

Wounds of Nerves.—A nerve may suffer complete division or it may be only lacerated. In many cases it is a complication of a large wound which divides other structures. It is very important to bear in mind that when a nerve is severed degenerative changes immediately begin, hence the importance of uniting the divided ends of a nerve at the earliest possible moment. Indeed, it is just as important to perform this operation as to approximate the fragments of a broken bone. Common causes of nerve-wounds are fragments of glass, gunshot wounds, and punctured wounds produced by knives, scissors, needles, or splinters of wood.

Symptoms.—The best evidence of all is afforded when the divided

or partially divided nerve is visible in the wound. In many cases the wound is small or punctured and we cannot see the nerve. Diagnosis must then rest upon the effects produced, not only upon the nerve itself, but upon the area to which it is distributed. These may be considered as immediate and remote:

1. *Immediate Effects.*—Pain is of varying significance. In some cases it is so slight as to be scarcely noticeable; in others, even when the nerve is small, the suffering is so intense as to produce profound shock. Such a condition is common in gunshot wounds. A marked symptom immediately after the injury is anesthesia, and in most cases it can be traced over the parts supplied by the nerves in question. At the same time too much reliance must not be placed upon this evidence, for it is possible to find sensation remaining after complete division of a nerve-trunk.

Blindfold the patient and place the limb at full extension on a firm support, so that no vibration can be communicated. Tactile, thermic, and electrical stimuli can then be successively applied and their effects carefully noted. For the examination of tactile sensation a light touch, such as that communicated by a pencil, a feather, or a pin, may be used. The esthesiometer is an instrument for testing sensation, and consists simply of a pair of compasses fitted with a graduated scale which measures the distance to which the two points are separated. An ordinary pair of dividers will answer the purpose. In using the instrument care must be taken to touch the skin at the two points simultaneously, and each time the result must be compared with the corresponding part on the opposite side of the body. The test is to ascertain the ability of the patient to distinguish the ends of the instrument as two points or as one. Different parts of the body in health give different results when thus tested. At the end of the finger two points can be recognized when the distance between them is only 2 to 2½ mm., while on the back 40 to 70 is the minimum. A difference will also be observed, depending upon whether the instrument is placed transversely or longitudinally to the axis of the limb. In a typical case three areas can be distinguished: (*a*) the area of anesthesia (total loss of sensation); (*b*) the area of paresthesia (partial loss of sensation); (*c*) the area of normal sensation. In some cases there is observed an area of supplementary sensation. This is where a nerve-trunk is divided and its current cut off, yet sensation is not impaired. It has been explained on the theory that the nerves anastomose, and the nerve-current is maintained just as the collateral circulation in the case of a divided artery. In studying a case it is customary to mark the area of total anesthesia by a dark shading, while that of partial anesthesia is indicated by a lighter shade.

Having completed the examination by the sense of touch, other stimuli may be employed. Heat is used by taking a sponge and dipping it in hot water or by placing the limbs in water of a known temperature. A very simple and ready method is to first breathe upon the part and then gently blow upon it. If more accuracy is desired, the thermesthesiometer can be employed. It consists of two cylindrical wooden vessels with metal buttons, into which water of differing temperatures is poured; a thermometer in each registers the degree of heat.

Two test-tubes can be utilized in the same manner. Lastly, electricity is employed. When tactile and thermic stimuli fail the nerves will often respond to the electric brush.

Examination as to loss of motion is much simpler. In the case of the forearm the patient is asked to grasp the hands of the surgeon, when any difference of muscular power is readily detected. Any given group of muscles may be tested by asking the patient to use the muscles while the examiner resists the movement.

Reflex paralysis is a very interesting phenomenon observed in some cases. Wound of a nerve in the lower extremity may produce paralysis of the opposite limb, or even of both limbs on the opposite side. This has been explained on the theory that the nerve-centers of motion and sensation have become exhausted.

2. *Remote Effects.*—To the observations of Drs. Mitchell, Morehouse, and Keen during the American Civil War we are indebted for much valuable knowledge on this point. Loss of motion is more marked and more persistent than loss of sensation. The muscles soon show signs of weakness and wasting, which steadily increase to the degree of complete palsy. Gradual and steady contraction is observed in some cases, and deformity is the result. The changes in sensation are marked by anesthesia, or it may be hyperesthesia or intense pain. In the area supplied by the nerve, and at a distance from the seat of injury, characteristic changes may be observed. The skin has an appearance as if varnished. It is generally red and dry, or it may secrete an acid, foul-smelling perspiration. The hair of the part becomes scanty and the nails curve in both directions. Sometimes ulceration takes place under and around the nail, and even gangrene of the ends of the digits has been observed. A peculiar burning pain has been described by Mitchell under the name of "causalgia." So exquisite is the sensibility in this condition that even to point at the limb so affected causes the patient to draw away in terror. Keeping the part cool and moist relieves the causalgia, and patients often wrap the hand in a moist handkerchief or wear a glove which is kept constantly wet. In certain cases eruptions resembling chilblains or eczema are observed.

One of the most striking effects of nerve-degeneration is perforating ulcer of the foot. It is observed in leprosy, in locomotor ataxia, in fracture of the spine, but it may occur when there is nerve-degeneration from any cause. The ulcer is painless and usually attracts little attention. It begins as a corn, the center of which breaks down, forming a small opening. It may remain small in circumference, but if a probe be inserted it will be found to pass deeply into the tissues or the metatarso-phalangeal articulation. Placing the foot in an elevated position and enjoining perfect rest will, in most cases, effect a speedy cure. The ulcer is liable to recur, however, as soon as the patient resumes the use of the limb.

Treatment.—In any wound in the vicinity of a nerve-trunk a careful examination should be made of the divided tissues. If the nerve is found to be severed, its two ends should be brought together in as close apposition as possible and united by chromicized catgut or fine silk. In the case of small nerves the suture must pass through the substance of the nerve. When the trunk is large the sheath should be sutured

as well. The needle should be round and as small as possible. Perfect immobilization of the limb on a splint is necessary, and the wound must be treated with strict asepsis. In favorable cases the function of the nerve is restored with remarkable rapidity; in others it may be long delayed. The time varies from two days to many months. Sensation is the first to return. In cases of long standing the proximal end of the nerve becomes bulbous, while the distal end is slightly changed. After dissecting out the divided ends of the nerve the bulbous portion must be removed and a small portion cut off the distal end. They can then be stretched sufficiently to bring their freshly-cut surfaces together and sutured as already described.

When the ends are so widely separated that they cannot be brought together with a moderate degree of stretching, one of several methods may be resorted to. One of the ends of the severed nerve may be split for a certain distance, and the nerve-flap turned over to bridge the intervening space. The space has been bridged across by catgut sutures with the idea of furnishing a "scaffolding" along which the new nerve-tissue may be reproduced. This method has not fulfilled the hopes formed of it.

Transplantation of a section of nerve has been fairly successful. This is done by taking a piece of nerve from one of the lower animals, accurately fitting it to the breach, and stitching it there, or the nerve can be removed from a freshly amputated limb.

Injuries of Special Nerves. — 1. **Facial.** — The intra-cranial lesions of this nerve have already been referred to. The injuries which affect the nerve after it has left the Fallopian canal (extra-cranial lesions) are of great importance and of common occurrence.

The nerve may suffer injury by gunshot wounds or other traumatisms, but the paralysis of this nerve most frequently met with is due to the influence of cold, and is sometimes called the rheumatic form. A person who is exposed to a draft of cold air, as in sitting by an open window or travelling in an open carriage and exposed to a strong side wind, or passing from a heated room into the extreme cold of a winter's night, is surprised after a few hours to find that the appearance of his face is changed in a remarkable manner. He can only wrinkle one side of his brow; one eye remains open in spite of his efforts to close it; he cannot whistle, for in attempting to do so one side of his mouth is properly puckered, while the other just forms a loop; the mouth is drawn to the sound side. While eating the food gets between the cheek and the teeth on the affected side, and has to be removed with the finger.

The diagnosis must settle the following points:

1. *The Side of the Face which is Affected.*—This question may seem superfluous, but there are cases in which care is necessary before coming to a decision. In old persons the skin is so wrinkled and inelastic that the muscles of the sound side cannot alter the expression, and the only change in appearance is a rounded, more youthful expression on the paralyzed side.

2. *The Part of the Nerve Involved.*—When the paralysis is due to an *intra-cranial* lesion there is facial paralysis, but there is something more, such as disturbance of the sense of hearing and of taste, paraly-

sis of the velum palati, etc. The following points, formulated by Hirt and based upon Erb's diagram, will aid us:

"(*a*) If the lesion be between the exit of the facial stem (from the pons) and the geniculate ganglion, we shall find a paralysis of the velum palati, abnormal acuteness of hearing, and diminished salivary secretion.

"(*b*) If the facial be affected in the region of the geniculate ganglion itself, then we find, in addition to the just-mentioned symptoms, alterations in the sense of taste.

"(*c*) A lesion between the geniculate ganglion and the stapedius nerve produces the symptoms described in (*a*) and (*b*), but no abnormality of the velum palati.

"(*d*) A lesion between the origin of the nerve to the stapedius muscle and the giving off of the chorda tympani give alterations in the sense of taste and diminished salivary secretion, but no abnormality of hearing or the velum palati.

"(*e*) If, finally, the nerve is diseased below the giving off of the chorda in the Fallopian canal, we only find paralysis in the distribution of the posterior auricular branch, without any trouble with taste, hearing, the condition of the velum palati, or the secretion of saliva."

When it has been determined that the nerve-affection is extracranial and due to exposure, an electrical examination of the muscles should be made before expressing an opinion on the probable duration of the affection. The following are the chief points to guide us:

"1. If we find no changes either in faradic or in galvanic excitability, the prognosis is favorable; recovery in from seven to twenty days (light form).

"2. If we find the faradic and galvanic excitability of the nerve diminished, but not lost, the galvanic excitability of the muscles, however, increased, and the usual formula of contraction changed (A. C. C. > C. C. C.), then the prognosis is relatively favorable; recovery in from four to six weeks (intermediate form of Erb).

"3. If the reaction of degeneration be found—*i. e.* if the faradic and galvanic excitability of the nerve and the faradic excitability of the muscles be lost, while there is an increase in the galvanic excitability of the muscles associated with qualitative changes and changes in the mechanical excitability—then the prognosis is relatively unfavorable, and for recovery two, four, six, eight, even twelve, months may be required (grave form). These are those bad cases in which secondary contractures and spasmodic twitchings of the muscles also appear, which, according to Hitzig's opinion, are to be referred to an obscure abnormal irritation of the medulla oblongata. It is well to know that as convalescence begins voluntarily motion may return long before the electrical excitability, so that often the patient is able to perform some slight voluntary movements before faradic stimulation provokes the least contraction."[1]

Treatment.—In the majority of cases of facial paralysis brought on by exposure to cold no treatment is needed, as the nerve returns to a

[1] *Op. cit.*, p. 90.

healthy condition and the paralysis passes off in due time. When the disease is more protracted, electricity affords the best results and should be persevered in. Both galvanic and faradic currents are valuable. The motor points from which the principal facial muscles can be stimulated are shown in Fig. 244.

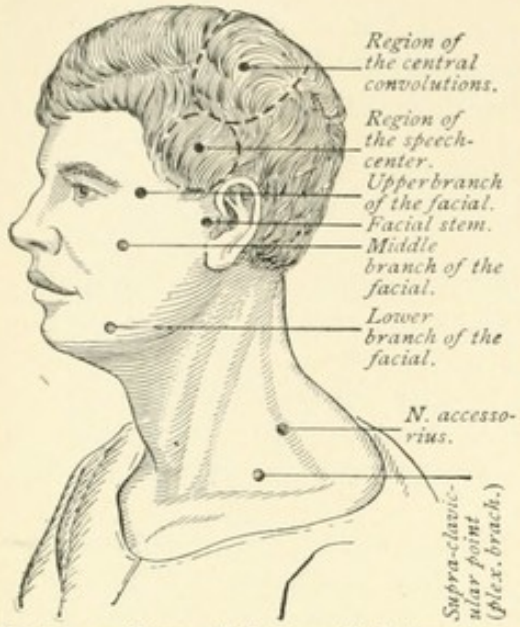


FIG. 244.—Some of the so-called "motor-points" on the face and neck (after Hirt).

2. **The Pneumogastric.** — The pneumogastric nerve has been ligated in operations for tying the carotid artery, and its recurrent laryngeal branch has been divided in removing goiters. The effects of this accident are hoarseness and change in the voice from paralysis of the vocal cord of the injured side. Should both recurrent laryngeal nerves be severed, suffocation would result from paralysis of the larynx, and an immediate tracheotomy is necessary to save the patient's life. Division or ligation of one pneumogastric is not a very serious matter, as it only produces hoarseness.

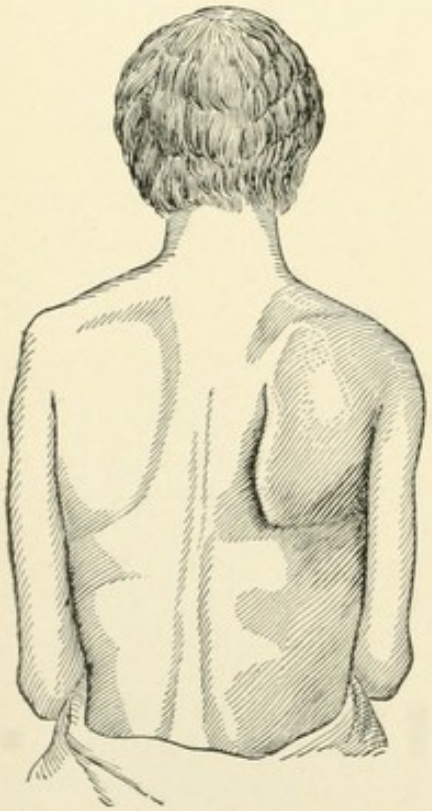


FIG. 245.—Right-sided serratus paralysis (after Eichhorst).

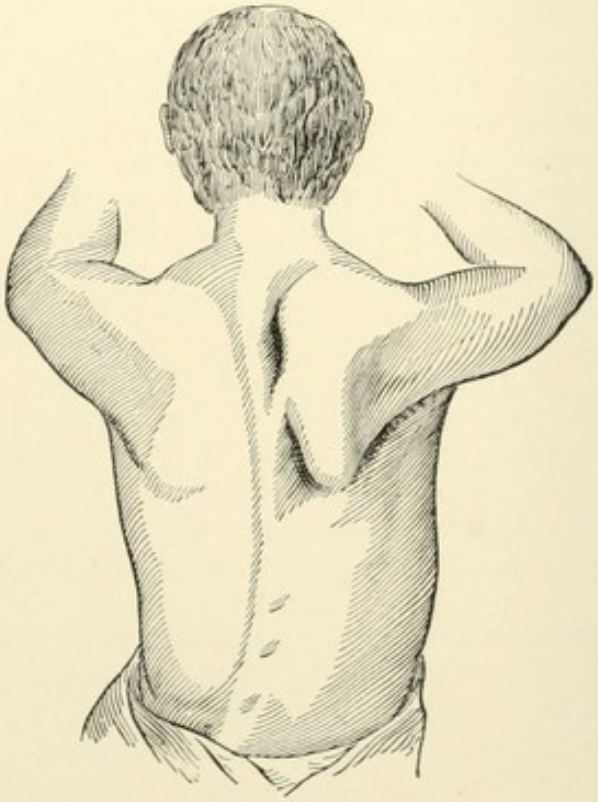


FIG. 246.—The same case with the arms raised (after Eichhorst).

3. **The posterior thoracic** arises from the fifth and sixth cervical nerves, and supplies the serratus magnus muscle. A lesion of this

nerve, producing paralysis of the muscle, is sometimes observed in persons who carry heavy loads on the shoulder, or in certain occupations, such as mowing, shoemaking, and tailoring, which produce over-exertion of the serratus; sometimes the paralysis appears to follow an exposure to cold.

Symptoms.—When the arm is at rest the scapula appears elevated, and its lower angle is abnormally near the vertebral spines (Fig. 245), this position being due to the action of the rhomboids, the levator angulæ scapulæ, and trapezius, which are the muscles antagonizing the serratus. When the arm is raised in front of the chest the posterior border of the scapula is tilted outward, so that the inner surface of the bone can be felt (Fig. 246). This form of paralysis is extremely obstinate, and may last for weeks, months, or even years, in spite of all treatment.

4. **The Musculo-spiral Nerve.**—Paralysis of this nerve produces the very characteristic deformity known as wrist-drop (Fig. 247). Its most common cause is a fracture of the humerus, which involves the musculo-spiral groove. The extensor muscles become paralyzed and the patient is unable to raise his hand into line with his outstretched arm. When the injury is above the branch supplying the supinator longus, flexion and supination are impaired, but not entirely lost, as the biceps and supinator brevis are still intact.

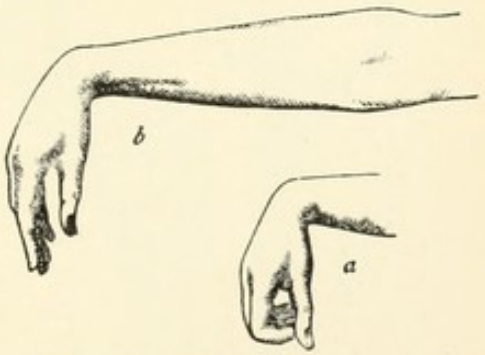


FIG. 247.—Paralysis of musculo-spiral nerve after fracture of the humerus ("wrist-drop"); but when fingers have been flexed into palm, *a*, they can be extended, *b*, at first inter-phalangeal joints by lumbricals and interossei, which are supplied by the ulnar and median nerves (Erichsen).

5. **The Radial Nerve.**—This nerve is sometimes divided just above the wrist on the back of the forearm. It produces no paralysis, as it supplies no muscles: it is marked by loss of sensation in the skin over the metacarpal bones and first phalanges of the thumb and fore finger.

6. **The Median Nerve.**—This nerve may be divided in any part of the forearm, but especially above the wrist. If the injury be above the elbow, all the flexors and pronators of the arm will be paralyzed, except the flexor carpi ulnaris and the ulnar half of the flexor profundus. The muscles of the thumb, except the adductor and half of the flexor brevis pollicis, will also be affected; flexion of the wrist on the radial side will be lost, and the thumb cannot be opposed to the other fingers. The changes in sensation are as follows: On the palmar surface anesthesia or paresthesia will extend over half of the palm and the palmar surface of the thumb, index, and middle finger, the radial side of the ring finger except a small part at its tip. On the posterior surface anesthesia affects the whole of the fore and middle fingers and the radial side of the ring finger (Figs. 248, 249).

7. **The Ulnar Nerve.**—Paralysis of this nerve occurs in certain occupations in which the workmen are obliged to press the elbow firmly upon a hard surface or to use the ulnar side of the hand in striking instruments. It may also suffer injury or division at the

elbow, the upper arm, or, most frequently, just above the wrist. Paralysis of both motion and sensation follows.

Motor Paralysis.—In the forearm the flexor carpi ulnaris and the inner half of the flexor profundus are paralyzed. In the hand the

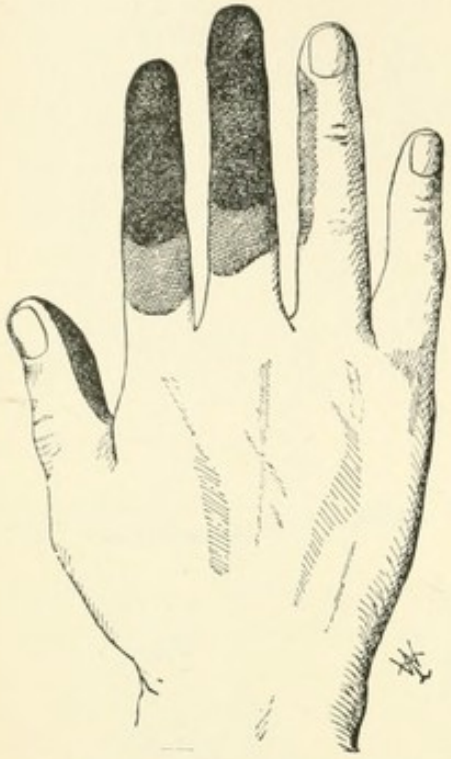


FIG. 248.—Section of median nerve: regions of anesthesia and dysesthesia on dorsal surface of hand (Bowlby).

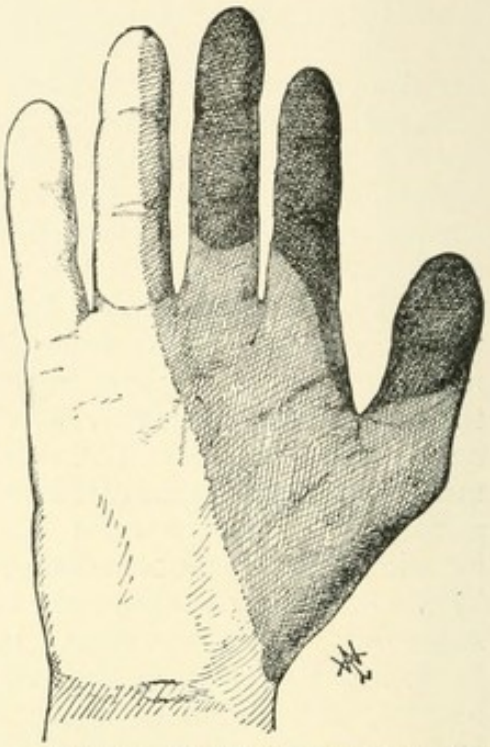


FIG. 249.—Section of median nerve: areas of anesthesia (heavy shading) and of dysesthesia (light shading) on palmar surface of hand (Bowlby).

whole group of muscles forming the hypothenar eminence, the two ulnar lumbrical muscles, the adductor pollicis, half of the flexor brevis pollicis, and all of the interossei are affected. The muscles soon become atrophied; the interosseal spaces on the back of the hand

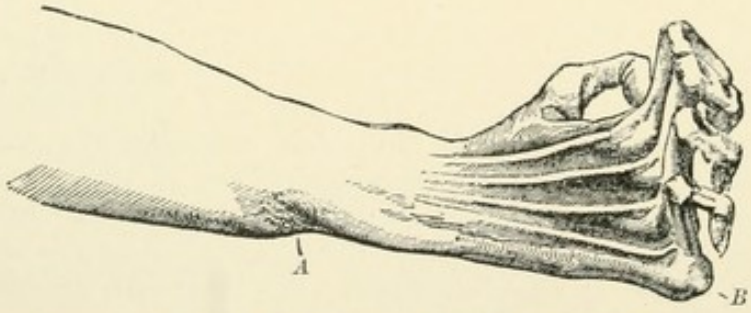


FIG. 250.—Paralysis of ulnar nerve from wound at *A*; contracture of common extensor with posterior luxation of first phalanges; *B*, head of metacarpal bone (Duchenne).

become hollowed; and, if wasting is confined to the interossei and lumbricales, their antagonists, the extensor communis digitorum and the flexor digitorum, produce that disagreeable deformity known as claw-hand or *main en griffe*. It consists in a dorsal flexion of the first

phalanges and a complete palmar flexion of the second and third (Fig. 250).

Sensation.—Allowing for changes in the distribution of the nerve in different individuals, sensation will be lost over the ulnar portion of the skin of the hand, the whole of the little finger, and the ulnar half of the ring finger, except a small point at the tip which is supplied by the median nerve (Fig. 251).

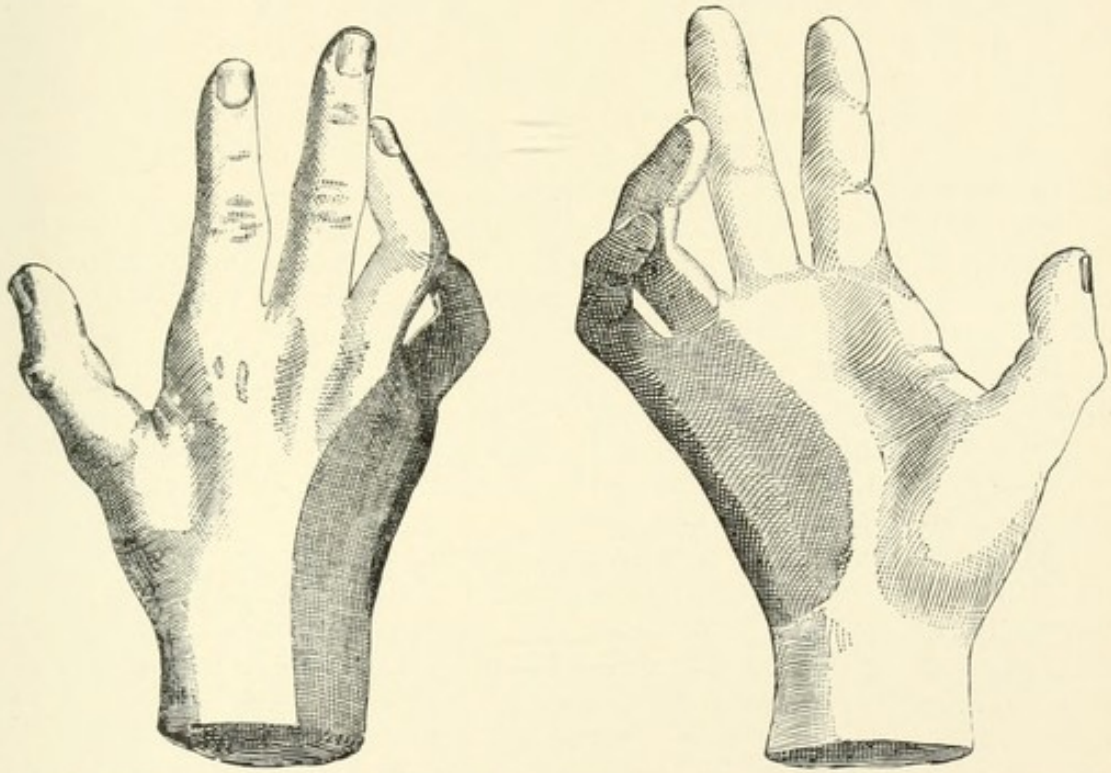


FIG. 251.—Loss of sensation on anterior and posterior surfaces of hand after division of the ulnar nerve (Bowlby).

8. **The Sciatic.**—This nerve is seldom injured except in gunshot wounds. When the external popliteal branch is divided, as sometimes happens in tenotomy of the biceps, the muscles of the anterior surface of the leg are paralyzed, so that the foot drags in walking. It can be neither flexed, abducted, nor adducted. The toes are constantly tripping over prominences on the floor, and to overcome this the patient forms the habit of raising the thigh higher than usual. In the course of time the contraction of the calf-muscles are apt to produce talipes equinus or talipes equino-varus. This nerve may be injured by pressure where constant kneeling is required, as in asphalt-paving.

The internal popliteal branch supplies the muscles of the back of the leg and the sole of the foot. Injury to this nerve interferes with plantar flexion of the foot and with flexion and lateral motion of the toes. The patient is unable to stand on tiptoe. If the interossei muscles are paralyzed, the first phalanx of each toe is dorsally flexed, while the second and third are in plantar flexion, and a deformity is produced similar to the claw-hand already described.

CHAPTER XI.

INJURIES AND DISEASES OF THE RESPIRATORY SYSTEM.

I. THE NOSE.

External injuries of the nose are of importance in the surgery of the respiratory tract only as they affect the nasal orifices. They may be the result of falls, blows, gunshot wounds, burns, and scalds, and if deep and extensive tend to bring about, by the contraction of the resulting cicatricial tissues, the partial or complete closure of one or both nasal orifices.

Treatment is preventive rather than curative. Occlusion should be prevented and the caliber of the nostril maintained by the insertion of sponges, bougies, etc. Repeated dilatations may be necessary, and also incision of the cicatricial tissue at various points.

Elephantiasis occurs very rarely—only in middle and old age, attaining at times excessive proportions.

The *treatment* is excision. It has little or no effect upon the respiratory tract, being unlike in that respect the much graver affection which we shall next consider—viz:

Rhino-scleroma.—This disease, starting at the edge of the nostril, may invade not only the external parts of the nose, but also the upper lip, septum, and nasal passages, and even the mouth, larynx, and pharynx. It is due to the action of a bacillus which is capable of inoculation. It is really a tumor of a densely hard, smooth sort, raised somewhat above the cutaneous or mucous surface, and may appear as one patch which enlarges slowly, or as several with slight separations between, giving them a lobulated appearance. There is little if any ulceration or pain. It may not differ markedly from the skin in color, or it may be somewhat darker of a grayish-pink color. The growth, whether within or without, gives excessive deformity to the nose, and hence tends to occlude the nasal passages.

It differs from other tumors and malignant growths by its great hardness, and can be differentiated from syphilis by its slow growth and resistance to specific treatment. Treatment is of little avail. Doutrelepont reports a case which was cured by repeated inunctions of lanolin containing 1 per cent. of corrosive sublimate.

If the nasal passages are obstructed, portions of rhino-scleroma therein can be removed by excision or caustics, and tracheotomy must be performed if it reach as far as the larynx. Operations in the nasal passages must be frequently repeated, for the growth recurs after removal.

External tumors of the nose may be either benign or malignant, epithelioma being a common type of the latter class. Lupus is also common. These diseases present no characteristics differing from those that they manifest in other parts of the body, and their treatment is the same as elsewhere. They have no bearing upon the respiratory tract, except when by the contraction of cicatricial tissue they cause obstruc-

tion to respiration. In that case the treatment is the same as for external injuries.

Internal Injuries.—The internal parts of the nose may be implicated in traumatism of the soft parts of the face, or internal injuries may be due to the entrance of foreign bodies through the anterior nares, occasionally through the posterior nares. Through the integument various substances may be introduced as the result of an accident, as pieces of glass, splinters, fragments of weapons, bullets, shot, etc. Through the posterior nares an act of vomiting may force foreign bodies into the nose. Through the anterior nares various articles, as buttons, beads, peas, beans, bits of wood, etc., are often pushed by children and insane people.

Symptoms.—If these foreign bodies are rough and jagged, an acute rhinitis is set up. If they absorb moisture and swell, great discomfort and distress from pressure and pain may result. If they are smooth and hard, no immediate discomfort may be felt. In addition to rhinitis, more remote symptoms may manifest themselves, as pain, headache, facial neuralgia, and finally a fetid catarrh. When the latter condition exists, a thorough washing of the nasal cavity is necessary more accurately to determine the nature of the offending substance, and particularly if no history of a foreign body in the nasal passage can be elicited. If the patient can furnish a history of a foreign body, the case is comparatively easy.

Necrosed bone in the nasal cavity may produce a like train of symptoms, though probably in that case others of a constitutional sort would afford ground for a differential diagnosis.

In any event, the existence of a profuse nasal discharge, giving evidence, as it does, of intense irritation, would lead the surgeon to institute a thorough examination of the nasal cavity and thus bring to light the foreign body.

Treatment.—The foreign body must be removed. Local anesthetics may be sufficient, but in the case of children, with whom the greater number of such accidents occur, ease, certainty, and rapidity of operation are best secured by completely anesthetizing the patient. Then a small pair of forceps, especially one consisting of separate blades that may be carefully adjusted, is usually sufficient for its removal. A snare, a hook, a probe, a curved bougie, a loop of wire, or other contrivance suited to the nature, size, and situation of the object and the ingenuity of the operator, will each at times serve the purpose. Generally the foreign body can be best reached from the anterior nares. Sometimes, however, all attempts in this direction are unavailing, serving only to push it farther away. Then other methods of procedure are open to the surgeon—either that of pushing it backward through, or of withdrawing it from, the posterior nares by some suitable instrument, or of pushing it forward by a curved, slender, flexible instrument thrust up behind the velum. If you push it backward, be careful that it does not enter the larynx.

If the foreign body is not firmly impacted, some simple method may effect its dislodgement. Sneezing may loosen it. The action of an emetic when the mouth is closed has been known to force it forward. A thorough douche or strong injection through the nostril or through the posterior nares may drive it forward. Sometimes by the softening

of the surrounding parts from ulceration its removal is in time effected without instrumental interference.

If the irritation which it produces is very intense, and none of the methods mentioned effect its removal, it may be necessary to resort to an operation the character of which will be determined by the location and size of the foreign body. The ala of the affected nostril may be dissected away from the face and lifted up, or there may be a median incision, or the whole nose may be raised after an incision through the margin of the upper lip.

Parasites within the nasal cavities constitute a species of foreign bodies fortunately less common in temperate than in tropical climates. Ascarides lumbricoides may find entrance through the posterior nares, either during the act of vomiting or by creeping up through the alimentary tract. The Lucilia hominivora is a common insect of the class of Muscidæ which deposits its eggs even in healthy noses. A fetid catarrh by its odor attracts flies, and they lay their eggs within the nostrils while the person is sleeping. The larvæ develop rapidly, favored by the warmth and moisture. Centipedes, earwigs, leeches have all been demonstrated within the nasal cavities.

The mucous membrane is first intensely hyperemic from the presence of such intruders, then it ulcerates, and is finally destroyed, its destruction being followed by necrosis of bone and cartilage even to the point where meningitis is set up.

Symptoms are, first, itching, then a sense of fulness and discomfort, soon followed by headache and a severe throbbing, and often agonizing pain. Delirium, coma, and death may rapidly ensue.

The nose, throat, face, palate, and eyes are swollen and distorted, and bloody and fetid discharges occur; abscesses form through which maggots are discharged.

Diagnosis is clear upon demonstration of the parasites.

Treatment.—Morphin may be used to relieve the intense pain. Calomel by insufflation, and injections of turpentine, alcohol, and tobacco, have been found useful. Chloroform, either diluted or of full strength, is used as a wash in the nasal passages. Because of the violent irritation which this drug produces upon mucous membranes, it is best to produce local anesthesia by cocain before using a douche of full strength. Disinfectant washes should follow the use of chloroform. If the parasites make their way into any of the sinuses, an operation will be necessary.

Rhinoliths are nasal calculi, and they differ from calculi formed in other parts of the body only in so far as they are modified by location. The nucleus is a particle of solid foreign matter lodged in the nasal passage. It may be something which finds its way into the nostril from without, or it may be a bit of inspissated mucus or a pathological product which has been retained within the cavity. Successive strata of calcareous matter derived from the alkaline salts of the secretions and blood are deposited around it until a calculus is formed, its size depending upon the shape and dimensions of the space in which it originates. Rhinoliths may be so small as not to be noticed, or they may be so large as completely to occlude the nasal passages and weigh even so much as four drams. They are sometimes very hard, but gen-

erally are quite friable, and may even have a central portion not so hard as the outside. They are generally found in the lower portion of the nose, either next to the septum or in the inferior meatus, though it is not uncommon for them to lie in the middle meatus. They are usually unilateral.

The commonest symptoms are those which attend partial or complete occlusion of the nasal passage, although, since the process of formation of a rhinolith is gradual, the symptoms assert themselves more slowly than in other forms of occlusion. Pain is constant, increasing in severity and in the extent of its effects with the growth of the calculus.

If the concretion is large, the external appearance of the nose may be altered. A constant symptom, due to the irritation, is a nasal discharge, muco-purulent or even sanious. Respiration is interfered with, and there may be anemia.

In *diagnosis* perhaps the commonest mistake is to regard the case as one of ozena or a common fetid catarrh, judging from the character of the discharge. If the nose is seen to be distorted or if a thorough rhinoscopic examination is made, this error may be avoided. Calcareous degeneration of the mucous membrane is to be differentiated by the fact that the rhinolith is movable; osteomata, by their being immovable and by their greater hardness. Necrosis of bone is usually less painful locally, attended by pronounced constitutional symptoms, and inspection gives different results. Polypi must be differentiated by inspection. Absence of the characteristic cachexia and their slow growth distinguish them from cancer.

The *treatment* is removal, differing in no respects from that of other foreign bodies.

Polypi occur more frequently in the nasal fossæ than do all other growths combined. They are mucous or gelatinous in character, and are to be regarded as myxomata, or, if slightly fibrous, as fibro-myxomata. In color they are pale pink, grayish, or of a blue tinge. They are soft, pulpy, semi-transparent, and easily torn. They contain few if any blood-vessels, and no nerves. A simple polypus has no connection with bone or cartilage, but grows only from the mucous membrane, most commonly from that covering the middle turbinated bone; the next most common site is the superior turbinated bone and middle meatus, and rarest of all the septum. They are covered with epithelium, that of the mucous membrane, and hence are often ciliated. They are pendunculated, and really have but one original place of attachment. If they have or appear to have more, it is because, from their large size, they have become pressed against the other polypi, the septum, or other parts, and by ulceration and healing have either formed a second attachment at some late period in their growth or merely seem to do so—an appearance corrected on close inspection. They may be single, either large or small in size, but are quite as apt to be multiple, and they are of varied form, determined by the space in which they grow. A single small polypus is pyriform in shape, the larger portion downward because of the weight of its contents. The constant pushing downward and forward of the epithelium of the mucous membrane from a single point makes a narrow stem-like part

near the place of origin. Pressure from one or several directions naturally alters its shape and appearance.

The *cause* of polypi is a matter of much doubt. In general it may be said that the immediate cause is some irritation in the nasal passages, possibly a purulent discharge from the sinuses, and only theories can be advanced to explain why an irritant should produce polypi in one case and not in another. Something additional as a predisposing cause must exist.

Some authors, Mackenzie among them, find a predisposing cause in a constitutional condition, in an inherited dyscrasia, as tuberculosis, syphilis, malarial poison, etc. It is generally believed that polypi occur more frequently in men than women. They are exceedingly rare in children. It would seem that the irritation arising from exposure or overwork is an exciting cause.

Symptoms.—During the very earliest stages there are probably no appreciable symptoms. As a polypus develops, an indefinite sense of local discomfort is present and the amount of secretion is increased. When of sufficient size to occlude wholly or partially the nasal passage, respiration is more or less interfered with, especially when the polypus is swollen from damp air. At times breathing is audible, almost snoring. The voice gives the nasal "twang" heard in all obstructions of the nasal chambers.

The discharge from the nostrils becomes more irritating and offensive in character, and may even be mixed with blood, or frequent and severe attacks of epistaxis may be the strongest indication of an abnormal condition.

Reflex symptoms are common, such as hemicrania, facial neuralgia, partial or complete loss of hearing, anosmia, and cough. The nose may become large and distorted, and the polypi may press backward into the naso-pharynx.

Diagnosis is usually unattended with difficulty or embarrassment, at least when the disease has advanced beyond the first stage. Other pathological conditions of the nasal cavities are so unlike this that they need scarcely be considered if attention be given to the distinctive characteristics of polypi. By rhinoscopic examination they are seen to depend from the nasal cavity, and are easily movable, even swaying or flapping with a slight sound at times under the impulse of a current of air. If this sort of movement is not present, some delicate instrument in the hands of the surgeon easily produces motion of the dependent pyriform portion.

Prognosis as to life is favorable, but not as to recurrence. Since the cause of their occurrence is so obscure, it is difficult to predict that polypi will not return. The cause may still exist and produce a new crop, or the mass may not be wholly removed, and still continue to grow; or if a large mass is thoroughly eradicated, small ones may be overlooked and grow rapidly.

Treatment.—Various methods of removal have been employed, but a surgical operation only is to be recommended, simple or complex according to the conditions of the case and the adaptation and inventive genius of the surgeon.

Avulsion probably stands as the operation most generally employed,

and consists in removal by forceps, rotary motion being used to twist the polyp from its pedicle.

The forceps should be light, strong, and curved to keep the surgeon's hand from obstructing his view. The nostril is dilated with some suitable nasal speculum and well illumined. The instrument (one with separate blades is sometimes an advantage) is made to grasp the base of the polyp as firmly as possible, and by a steady twisting motion sever the growth from its connection. Bleeding is generally slight, and depends upon the position of the growth. The surgeon ought to see or feel the pedicle in order to secure rapid and accurate adjustment of the forceps. If this is impossible, as when the growth is large or far back or not very friable, he may be obliged to take it away a little at a time. If it is well formed and of firm consistency, it may be partially drawn out of the nostril and its pedicle cut with knife or scissors. Stoker's forceps were invented especially for the removal of nasal polypi, and are well spoken of.

Avulsion by the écraseur or wire snare is a convenient method of treatment. The loop of the instrument is first adjusted about the pedicle and then tightened until it cuts through. It is a slower process than that in which forceps are used, but the hemorrhage is probably less. Jarvis's snare (Fig. 252), invented for this particular kind of surgery, is the best now in use.

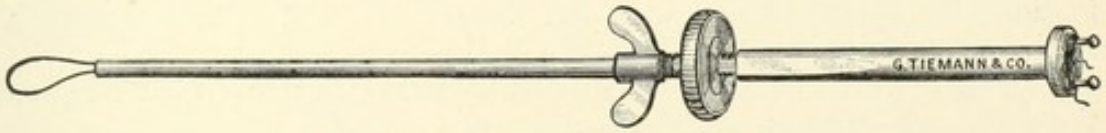


FIG. 252.—Jarvis's wire snare-écraseur.

The galvano-cautery presents also a possible method of eradication. Objections to it are the great pain, the difficulty of adjusting it in many cases, and the fact that it makes no traction, and hence may leave a fragment *in situ* and make repetition necessary.

With any of these methods cocain is locally applied, disinfectant washes should be used, and if hyperemia and inflammation follow the operation, astringent applications are indicated. If the patient decline the operation, attempts at removal may be made, as they were in former years, by the action of caustics or astringents applied or injected.

For applications are recommended tannin (by insufflation), iodin, perchlorid of iron, nitrate of silver, zinc chlorid, gallic acid, etc.

The drugs employed for injection are carbolic acid, glacial acetic acid, chromic acid, or some strong astringent, as Lugol's or Monsell's solution.

Fibro-myomata and Fibromata.—Between the simple gelatinoid polypus and the true fibroma may be found mixed tumors of all grades, from those containing the slightest trace of fibrous material to those difficult to differentiate from a true fibroid; the gravity of the case varies in proportion to the amount of fibrous substance, because that is very vascular, and the chief danger of removal lies in the hemorrhage. Pure fibromata within the nose are very rare.

A naso-pharyngeal fibro-myxoma is recognized by its occupying the position indicated by its name, and arises generally from the basilar

process of the occipital bone and from bony structures in its immediate vicinity. It grows rapidly and to a large size.

Other nasal fibrous polypi arise from any portion of the walls of the nasal fossæ, generally farther back than is the case with mucous polypi, and their favorite site is the superior turbinated bone, the roof of the nose, and rarely the vomer or the foramen lacerum anterius (Roberts). They may originate in some of the sinuses and extend into the nose, protruding at the anterior nares, and may have several places of attachment as the result of as many points of ulceration. In pathological structure they differ in no way from similar growths in other parts of the body.

Fibrous polypi often attain enormous proportions, distorting hideously the nose and face, often producing the so-called "frog-face" and even exophthalmos. By pressure also they destroy adjacent parts, thereby endangering the brain, producing convulsions, coma, and death.

The *symptoms* are those of foreign bodies in the nasal passages if we emphasize the constant epistaxis, the greater severity of all symptoms, and the magnitude of the displacement and distortion.

The *diagnosis* from other foreign bodies and growths heretofore described is plain if we keep in mind the distinctive characteristics of the latter. From malignant growths, and even from those of syphilitic origin, the diagnosis at times presents difficulties. Microscopic examination of a detached portion in the former case and specific treatment in the latter will clear the diagnosis.

These growths occur more frequently in males than in females, and their cause is entirely unknown.

Prognosis as to life must be guardedly given, for they tend to become malignant. On removal fatal hemorrhage may supervene, and finally they may recur with new complications. Attempts at removal may betray a connection with the dura mater or reveal a hernia of the brain through the distended cribriform plate of the ethmoid bone. Cases have been recorded of the spontaneous detachment and expulsion of such growths, but the proportion of such cures is too small to modify the general law that surgical interference affords the only true remedy.

Treatment.—Complete extirpation is the only proper course, and few conditions present greater obstacles to the surgeon, both from the difficulty of reaching them and from the liability to hemorrhage. When they are found in the anterior nasal chambers the same methods are available as in the case of the gelatinoid polyp.

When, outgrowing the nasal, it has invaded contiguous cavities and displaced or destroyed neighboring structures, or when, arising more or less remote from the nasal chambers, it has invaded and distorted them, the question of removal becomes a very grave one.

Avulsion, the écraseur, caustics, electrolysis, the ligature either simple or the galvano-caustic ligature, have each their advocates, and with each successful operations have been performed. Preponderance of modern surgical opinion is decidedly in favor of the use of the knife in radical operations, these older methods being merely accessory, choice as to one or the other depending upon the location, size, place of origin, extension into other cavities, involvement of other structures,

and as to whether eradication with the knife alone is possible or whether complete ablation must be accomplished by some additional means.

Operations through the mouth produce no deformity, but afford too little space for checking the hemorrhage and for removing the growth if it be of large dimensions. The nose may be divided or lifted or the nasal bones may be resected, either alone or with the superior maxillary bone; the upper jaw may be wholly or partially excised.

Partial excision of the superior maxillary bone is the common operation, giving the best exposure of the polypus, the largest space for operating and removing the growth and for managing hemorrhage, as well as the least disfigurement after repair takes place.

Papillomata are found at the junction of the skin and mucous membrane, being somewhat soft in the latter position, hard in the former. Caustics easily effect their removal, though a loop of wire, the knife, or scissors may be used.

Adenomata and **cysts** are to be regarded as modifications of mucous polypi, with similar symptoms and treatment, though the former may take on the characteristics of carcinoma, and the latter do not tend to recur when once their contents are evacuated.

Enchondromata are usually found on the anterior portion of the septum, and are to be regarded as outgrowths or thickenings of its cartilaginous portion. Careful slicing with the knife easily effects their removal.

Osseous growths present two or three varieties. They occur farther back in the nasal fossa than do enchondromata, and spring from the bony part of the septum, from the vomer, from the palatine plate of the superior maxillary, or from the floor or roof of the nose. Exostoses differ in no way from those found in other parts of the body. Other growths, osteomata proper, are either of a density like ivory or they are composed of cancellous bony tissue with frequent admixture of cartilaginous tissue, or of a mucus-like substance within relatively large cavities.

Treatment.—When the growth is very hard it can be sawn or chiselled away or removed with the dental engine, or, if the pedicle be slight, with scissors, wire loop, forceps, or knife. Only occasionally it is an opening larger than that afforded by the natural cavity required, and then usually some minor osteoplastic operation is employed. Osteomata of cancellous tissue are friable, and may be removed piecemeal without enlarging the nasal opening, and generally do not recur.

Angeiomata are rare, with epistaxis as the chief, persistent, and even dangerous symptom.

Malignant growths are not infrequently found in the nasal passages, sarcomata more frequently than carcinomata. Either may be primary, but most of the benign varieties of tumors already described show a tendency to malignant degeneration, particularly the fibrous polypi, the adenomata, fibromata, papillomata, and even the simple mucous polypi. Osteomata are often of mixed type—osteo-sarcomata. They originate from all parts of the nasal cavities, sarcomata preferring the septum.

Of the two, **sarcoma** is the more frequent, and quickly declares itself, even to external inspection, by its red, lobulated appearance,

its extreme vascularity, and its being sessile. It spreads rapidly to the contiguous or connected cavities, often invading the throat, mouth, orbit, or cranium. Its ulceration gives rise to frequent and alarming epistaxis.

Carcinoma begins more insidiously as an insignificant growth, wart, or pimple. The local symptoms are in general the same as those of benign growths, and the constitutional symptoms are those which distinguish malignant tumors elsewhere. If they are secondary in the nose, the constitutional symptoms have, very likely, existed for a considerable time.

Microscopical examination of a portion finally determines the *diagnosis.*

The *prognosis* is most unfavorable.

In *treatment* extirpation is the only rule, either with the knife or the galvano-cautery. However, access to the posterior regions is so difficult, and invasion of the lymphatics in this vicinity so certain, that the surgeon can rarely be sure of the success of his operation. Not only is recurrence the rule, but imperfect attempts at removal stimulate and accelerate the growth, and so tend to shorten rather than prolong life.

Epistaxis.—Hemorrhage from the nose, though in the majority of cases a trifling matter, may become of very grave import. It is not a disease, but a symptom. It may occur spontaneously without discoverable cause as an expression of personal dyscrasia or idiosyncrasy. It is sometimes a symptom of local pathological conditions; frequently it is the result of external injuries, blows, falls, etc. It may be the symptom of a constitutional disorder either recognized or unknown, or it may be congenital. The hemorrhage is either active or passive—active when there is a sudden determination of blood to the head; passive when the cause exists for a considerable time, as in the case of acute specific diseases and in subjects of the hemorrhagic diathesis.

It is common in those of plethoric habit, either children or adults, and likewise in those suffering from anemia. Slight erosions of the nasal mucous membrane, deviation of the septum, growths and ulcers in the nose, picking at the nose, inhalation of irritant gases, blows and falls upon the nose, face, or head, over-exertion, passing from a dense to a rare atmosphere, coughing, sneezing, blowing the nose, excitement, mental emotion, are all mentioned as common causes of epistaxis.

Various acute diseases and morbid conditions of the blood predispose to it, as scarlet fever, measles, leukemia, typhoid fever, and the like. Cardiac, renal, and hepatic diseases may lead to it; so also, occasionally, may tuberculosis. It is commonly a concomitant of hemophilia, and also is often vicarious. The Schneiderian membrane is very vascular, and its vessels have comparatively slight support from surrounding tissues; hence it has a greater tendency to bleeding than other mucous membranes.

Symptoms.—The blood coming from the nostril is of course the main symptom This may be preceded by a sense of fulness or dizziness in the head, headache, tickling in the nose or a sensation of warmth, so that a subject prone to attacks of epistaxis is warned of their approach. Usually the flow of blood is from only one nostril,

though when it is a constitutional symptom it may proceed from both. It is arterial in color, and coagulates easily. When the epistaxis arises from a grave constitutional disorder it is, of course, far more apt to be excessive and to resist treatment than when the cause is merely within the nose itself, and especially if it is only a temporary condition.

There is usually no confusion in the *diagnosis*. If the ruptured capillaries are far back in the nares, and especially if the hemorrhage occur during sleep, the blood may flow backward and be expectorated as if coming from the lungs or stomach. A close inspection of blood that thus makes its appearance, if there is no previous history pointing to possible hematemesis or hemoptysis, will make the case clear. In cases where the origin of the bleeding is in the sinuses its exact location may be extremely difficult. Sometimes when the flow is profuse, though its origin is in only one nostril, it flows from both, and until the flow is checked it may not be possible to establish the fact of its unilateral origin.

Prognosis is grave in exact proportion to the gravity of the cause and to the depletion of the system before the patient is seen.

Treatment.—Most of the common methods of preventing "nose-bleed" are known to the laity, such as pressing the ala against the septum, the application of ice or cold water to the bridge of the nose or back of the neck, dropping a cold key down the back, raising the arm of the corresponding side above the head, placing a wad of paper lightly under the upper lip, pressing the finger against the facial artery, plugging the anterior nares, the use of hot water in the nose, washing the face in hot water, and even the application of the drugs most common in domestic use, as borax, alum, etc. The patient should remain erect or nearly so; he should not bend the head or blow the nose. If the subject is of plethoric habit or the hemorrhage arises from some obstruction to the circulation, as in cardiac disease, or is vicarious, moderate bleeding is beneficial rather than harmful. If it passes the bounds of moderation or is an accompaniment of a depressing constitutional disease, and if the simple methods above mentioned are of no avail, more vigorous measures should be undertaken by the surgeon.

In many cases the blood comes from a single point, and, when possible, this point should be found, wiped with a piece of dry cotton, and touched with silver nitrate, chromic acid, or the galvanic cautery.

Astringents—nitrate of silver, tannin, perchlorid of iron, antipyrin, etc.—either as sprays or applied upon cotton, are sometimes of service. Ergot, internally, is usually given in obstinate cases. Quinin is given if malaria is seen to be the main feature in the case, and cases rescued by transfusion have been reported.

When all such measures prove unavailing plugging is resorted to.

Various devices have been invented for this purpose, among them the dilatable air-bag with two bulbs an inch apart. It is inflated after having been placed in the nares, and fits all parts with equal pressure. It is easily removed after allowing the air to escape. So suitable an instrument is, however, seldom at hand at the critical moment, and the surgeon is left to meet the situation with instruments of more common use. If the hemorrhage is believed to be in the anterior nares, that may be plugged either with iodoform gauze or lint as tampons pressed

gently and snugly into place with a probe. To make removal easy and certain they are tied at intervals to a string whose end is external to the anterior nares. If their use is inadequate, then the posterior nares must be subjected to like treatment, and if the details are well in mind it is not a difficult procedure.

Passing the index finger behind the velum, the surgeon notes the exact location and size of the aperture to be plugged and the presence of abnormalities if any exist. The most convenient instrument for this operation is Bellocq's cannula (Fig. 253). If it is not at hand, a soft-

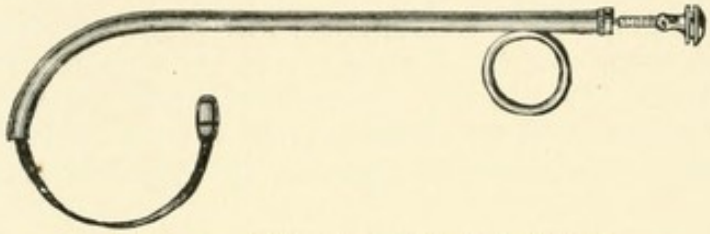


FIG. 253.—Bellocq's cannula for epistaxis.

rubber catheter serves the purpose. This, thoroughly disinfected, is threaded with a stout sterilized thread of good length and passed along the floor of the nose until it enters the pharynx and can be seen. One end of the thread is then brought out through the mouth by means of a pair of forceps, and the catheter is withdrawn from the nose. The string is now in position. A plug of antiseptic cotton or sponge is then fastened to the string, guided through the mouth and pharynx by the surgeon's finger, and fixed firmly in position in the posterior nares by traction on the string through the nostril, aided by gentle pressure with the finger from behind. The ends of the string are now tied. When the plug is to be removed gentle traction on the end of the string which emerges from the mouth is usually sufficient. If desirable, anterior plugs may be placed in position after the posterior nares is fitted.

To avoid decomposition and consequent ulceration none of these should remain *in situ* longer than two full days. If epistaxis still threaten, the operation must be repeated after using antiseptic and astringent douches. Appropriate constitutional treatment should be maintained meanwhile.

Ulcers.—Simple catarrhal ulceration as a result of acute or chronic coryza is a rare thing, and consists of nothing more than an erosion of the mucous membrane easily amenable to cleanliness, antisepsis, and general remedies.

Ulceration is common when two mucous surfaces are brought together, as in deviated septum, hypertrophy or pressure of the surfaces of two polypi, or other benign tumors pressing against the septum. Removal of the cause disposes of them. Surfaces of malignant growths are especially prone to ulceration, both from the same causes that produce ulceration of such growths in other parts of the body, and from the fact that they are quickly subjected to pressure from the relatively small space in which they develop. Bleeding and offensive discharge are the symptoms of ulceration.

Extirpation of the malignant growths is their only cure, but much may be done to make the patient more comfortable and the pain en-

durable if the necrotic tissue be thoroughly removed by curette, cautery, or knife.

Traumatism, as from the introduction of foreign bodies, may produce ulcers that will disappear with the cause. Exhausting diseases, as severe fevers, small-pox, scarlet fever, or scurvy, may produce ulceration in the nasal cavity. Rodent ulcer, beginning externally, may be so severe as to destroy the entire nasal organ, or, if checked, may impede respiration by its cicatricial tissue.

Modern scientific research has declared the bacillus of tuberculosis and that of lupus to be identical, so that they must be regarded as different manifestations of the same disease. The former is said to be very rare as a lesion in the nasal cavity, only a few cases having been reported, and none at all until 1877. Even of these rare cases only one or two were absolutely proven to be primary. The nodules or tubercles are at first of a grayish color and are covered with epithelium. When this is softened ulceration occurs, nodules and small ulcers existing side by side. There is increased secretion, but the pain is insignificant, and obstruction seldom takes place.

Diagnosis depends upon microscopical examination.

Prognosis.—Life is not endangered by the mere presence of tuberculosis in the nasal cavity. In most cases it is secondary to an advanced stage of the disease in other parts of the body. If primary, removal by the curette or wire loop, though difficult, might eradicate the disease, but it generally recurs.

Antiseptic douches or the insufflation of powders may contribute to comfort. Radical extirpation is the only cure, and usually this is not advisable, considering the general condition of the patient.

Lupus on the cutaneous surface of the nose is a serious matter, because of the cicatricial tissue resulting from its ravages, and the consequent effect upon respiration. If it occur as a primary lesion on mucous membrane, scars are less common and thorough eradication comparatively sure.

Lupus must be differentiated from epithelioma and sarcoma, and particularly from syphilis. Sarcomata grow very rapidly and are usually not multiple.

Epitheliomata begin as tiny papillomata, and even break down in ulceration with involvement of neighboring glands. Microscopical examination will establish the character of sarcomata or epitheliomata.

The *diagnosis* from syphilis presents peculiar difficulties, and may be settled by recourse to specific treatment. The age of the patient, history of the case, absence of signs of syphilis in other parts of the body, the slow advance of the disease, the tendency to heal in one place and progress in another, and the fact that necrosis of bone occurs at a late stage in the disease, are points to be taken into consideration in differentiating lupus from syphilis in the nasal cavities.

Treatment.—Thorough eradication is the only course. This may be accomplished by scraping or curetting, followed by caustic applications to ensure complete removal of the tissue. Some authorities advocate the application of caustics alone; zinc chloride, potassic hydrate, chromic acid, lactic acid, silver nitrate, terchloracetic acid are all of use in different cases.

The galvano-cautery, the actual cautery, multiple scarification, and puncture are possible methods of eradication. The irritation set up by any of these radical measures should be treated on the general principles for allaying inflammation.

Syphilis in the nasal cavities is far from uncommon, though doubtless its manifestation in the tertiary stage is much more frequent than in either of the others. Chancre of the nasal passages has been occasionally reported, and Burow has drawn attention to several cases due to infection by Eustachian catheters. The commonest manifestation of secondary syphilis is simply an acute coryza of persistent type. This may be the only symptom, and so rarely are mucous patches seen on the nasal mucous membrane that their existence there has been doubted. However, they may be found—upon the septum as a rule, and not so near the junction of skin and mucous membrane as is the case on the buccal mucous membrane. Ulceration is never deep, unless it is in the latter part of the secondary stage, when the early indications of the tertiary stage may be suspected.

It is in the tertiary stage of syphilis that its presence in the nasal passages is most plainly and seriously manifested. Gummata form either upon the periosteum or occur as an infiltration in the mucous membrane. Upon the septum they occasion little pain, but upon the turbinated bones they are somewhat painful. They may obstruct respiration, and on examination they may at first be mistaken for other tumors, as they show little tendency to ulceration. However, the general condition of the patient is usually such as to leave no room for doubt as to the character of the tumor. When ulceration begins destruction of tissue goes on very rapidly. Perforation of the septum is an early result of gummatous periostitis, and its complete obliteration may rapidly follow. The turbinated bones, the vomer, the perpendicular plate of the ethmoid, and the roof and floor of the nose are destroyed. Perforation of the hard palate is not uncommon, either by extension from the nose or else from independent gummata in its periosteum. The cartilaginous tissues are rapidly destroyed as well. This of course leads to great deformity, and the cranial cavity may be invaded, and very rarely septicemia may follow from exposure of bone. While this rapid destruction is going on bits of necrosed bone and shreds of tissue either block the passages or are discharged with the secretion, which is bloody and purulent-fetid to an almost intolerable degree.

The kind and amount of deformity depend upon the location of the first gummata and the point at which the process of destruction is stayed. Slight perforation of the septum or destruction of the turbinated bone may not produce deformity. If necrosis proceed farther than this, a varying degree of deformity will result, even to complete obliteration of the nose. Contiguous bones, as the malar or maxillary or palate, are occasionally destroyed, but this may be due to original infiltration into their own substance rather than to extension from the nose.

The *diagnosis* of syphilitic lesions in the nasal passages presents few difficulties. The history of the case and the presence of the syphilitic cachexia are sufficient to establish the diagnosis. Lupus, cancer, or ozena may be mistaken for syphilis. The microscope or specific treatment will differentiate the first two (together with the history of the

case, age of the patient, and absence of characteristic cachexia). The foul odor of ozena may be taken for syphilis in the secondary stage, but douching and syringing will temporarily remove the odor of ozena, whereas the decaying tissue in syphilis gives a persistent odor.

Prognosis in all respects is favorable in the secondary stage and at any time before necrosis of bone has commenced. When this has been established the prognosis is serious as to future deformity. As to life, it is the same as for the tertiary stage generally under the same conditions.

Treatment must be both local and constitutional, the first to limit the ravages of the disease in the nasal cavity, the latter to effect a complete cure.

If the local manifestation is only that of an acute coryza, antiseptic sprays and syringing, combined with the use of mercury, will be sufficient. To mucous patches some caustic must be applied. If a gumma has not begun to ulcerate, constitutional treatment should be pushed in the hope of causing its absorption before ulceration with its consequent necrosis takes place. If necrosis has begun, cleansing and removal of dead tissue must be most thorough. Ulcers, even if superficial, should be cleansed and disinfected regularly and frequently. If they are deep, more energetic measures are necessary, even to curetting. The discharge should be checked and all scales and crusts removed. If the bone has been attacked, all detached portions must be removed, for they act like foreign bodies, maintaining a constant irritation. They may be loosened from their positions by a strong spray or syringe in some cases, but generally the probe or forceps must be employed.

If a portion of necrosed bone has even slight attachment, it is generally best not to use force in separating it, but to wait for further necrosis to loosen it completely, because of the danger of hemorrhage.

After the parts have been thoroughly cleansed an insufflation of iodoform may be used.

Iodid of potassium in full doses three or four times a day, with or without mercury, constitutes the treatment. Cod-liver oil, iron, and other tonics may be indicated if the patient is greatly reduced. Various rhinoplastic operations may be resorted to with the view of concealing or repairing deformities, or an artificial nose may be worn.

In hereditary syphilis the infant appears at first to be merely suffering from a severe attack of acute coryza with profuse discharge, or is said to have the "snuffles." Other indications of syphilis are, however, usually present in the old look and emaciated condition of the child, in the hoarse cry, cutaneous eruptions, and mucous patches on tongue, cheeks, lips, and around the anus. The discharge becomes muco-purulent and excoriates the lip and nose.

In the coryza of infantile syphilis the mucous membrane is hyperemic and swollen, and there is a thin, watery discharge. This condition so interferes with respiration that nursing becomes difficult, and adequate nourishment of the child is almost impossible. Constitutional treatment must at once be begun, supplemented by thorough and systematic cleansing of the nasal passages by antiseptic sprays. If the thickened discharge completely blocks the nasal passages, the accu-

mulated secretion may be forced from one nostril by the compression of air in a rubber ball within the other. The excoriated portions of skin must be dressed with soothing applications. A child thus afflicted should not be allowed to nurse the breast of one untainted with the disease nor use drinking vessels to which others have access.

If the health of the child be not too completely undermined, vigorous treatment from the time of the first indications of the disease—usually within the first month of life and seldom later than the third—may prevent its further development. As a rule, however, it goes on to the third stage, when the same course of treatment must be adopted as for adults, and, should the child survive this period, it is rare indeed that it escapes all evidences of the ravages of the disease.

The **ulcers of leprosy** in the nasal cavity are not unknown. They are similar to those found in other parts of the body. Cleanliness and antiseptic sprays will lessen in some degree their offensive character.

They are found only when the whole system is invaded and undermined by the disease. Treatment is of no avail.

Rhinitis.—Acute.—This is the condition produced by an acute inflammation of the pituitary membrane. There is tumefaction accompanied or followed by a secretion, at first thin and acrid, later of a thicker consistency, due to discharge of epithelial débris. In the last stage of rhinitis the secretion again becomes thin, and disappears as the nasal mucous membrane returns to its normal condition.

The commonest form of rhinitis is that known as "cold in the head," due to sudden chilling of some portion of the body. Other causes less generally recognized may also produce an acute coryza. That caused by syphilis is discussed elsewhere. It is quite frequently a symptom of the early stages of the exanthemata and influenza. It may also be due to inhalation of irritating gases, as bromin, also to powders, dust, and odors—to the pollen of plants, as in that condition popularly known as "hay fever." It is set up by the presence of foreign bodies and growths in the nasal cavities, and by extension from other mucous membranes, as from the conjunctiva. The internal administration of certain drugs, particularly iodid of potassium, will also produce it. It often occurs at the same time with asthma. It is impossible also from its epidemic character at times to escape the conclusion that its origin may be microbic. This may almost be assumed when it is only a forerunner of an acute general disease that develops later.

Symptoms.—There may be no sign of the presence of an acute coryza until the patient begins to sneeze or until the discomfort arising from the congestion and the swelling of the membrane is noticed. In most persons, particularly in the case of the aged and feeble or if the exposure be prolonged or severe, a marked chill may be present or at least a feeling of chilliness. This is followed by a rise in temperature, usually somewhat proportionate to the severity of the chill. In some cases there is a general feeling of malaise, or the whole body may ache as a preliminary symptom. Frontal headache is common. In any case, after the congestion of the mucous membrane has lasted a few hours, the discharge of the secretions begins, assuming the characters noted above.

Nasal respiration may become impossible; smell and taste lose their acuteness. Commonly, these symptoms increase in severity for two or three days, then begin slowly to disappear. However, by the involvement of other structures the case may become much more complicated. By extension the pharynx may be involved, producing "sore throat." The frontal sinuses, the antrum of Highmore, the nasal duct, the Eustachian tube may all be affected to a greater or less degree, each giving the characteristic symptoms of inflammation in that locality. Discomfort and uneasiness, rather than pain, are the symptoms of uncomplicated acute coryza. If the complications just mentioned are severe, pain becomes a marked feature.

Treatment.—Many cases of acute coryza require little or no treatment, for the disease, unless it is a part of some acute general malady, runs its own course in a few days. Often, however, slight exposure, after it has once commenced, adds to its intensity or brings on a relapse after convalescence has begun, so that the case becomes very protracted unless checked by prompt treatment. This may be both local and general, both abortive and curative.

Quinin in large doses sometimes aborts a "cold," particularly if *sudorific* treatment is combined with it. Tincture of aconite is used for the same purpose. A recent writer recommends the use of bicarbonate of soda to abort a "cold," on the theory that the Schneiderian membrane is irritated by some acid in the blood. Fifteen to thirty grains are given in water every half hour until three doses have been taken, and a fourth dose at the end of an hour. At the end of three or four hours these doses are repeated if there are still left any signs of the coryza. Even a third or a fourth trial may be made at suitable intervals if desired.

Cathartics at night, followed by a saline purge in the morning, is good treatment, whether the object is to abort or cure. With the first object in view opium in $\frac{1}{8}$- to $\frac{1}{4}$-gr. doses may be taken. Dover's powder both relieves pain and produces sweating. Some form of belladonna may also be combined with the opium.

Hot drinks, a hot mustard foot-bath, after which the patient is kept very warm in bed for several hours, will in many cases be sufficient to cut short a threatened attack of acute coryza, especially if it is due to exposure to cold only. To this may be added the inhalation of steam, medicated or otherwise. A sponge saturated with the hot liquid is held to the nose, and through it the patient breathes. Persons accustomed to them find Turkish baths useful in aborting a cold.

However, after the coryza is fairly established measures to control and limit inflammation are indicated, both internally and locally. Phenacetin, antipyrin, lactophenin, or aconite may be used to control the fever. Atropin or belladonna and opium are useful in the later stages, as in the beginning.

Astringents, locally applied, are of little use in acute coryza, their value being greater in the chronic form; cocain, either as a spray or as a powder, is far better. A powder composed of subnitrate of bismuth, with a little morphin, inserted as an insufflation occasionally gives great relief. Silver nitrate used in the same way is recommended. If the discharge becomes muco-purulent, antiseptic spray may be used. Rhi-

nitis due to irritating vapors yields to the administration of opium. In the acute form of rhinitis, known as hay, rose, or June fever or the catarrh of autumn, no specific treatment is known, and what avails with one patient may be of no use to another or with the same person at another time. Change of climate is probably of more service than any other one thing, and general nutrition must be kept at as high a point as possible.

Opium should not be employed in the acute coryza of childhood. Care must be taken to see that the nourishment of the child is maintained, even if feeding through a tube is necessary. A soft-rubber tube may be inserted into the nostril if there is severe dyspnea.

Chronic.—Different clinical aspects of chronic inflammation suggest a simple classification. If there is a simple catarrh without structural alterations, it is known as chronic nasal catarrh, coryza, or chronic rhinitis. If the Schneiderian membrane and the underlying structures are thickened and enlarged, it is called *hypertrophic catarrh* or hypertrophic rhinitis. If, on the other hand, the nasal passages are unusually wide and open, the turbinated bones small, and the overlying tissues thin and atrophied, the condition is known as *atrophic nasal catarrh.*

Simple nasal catarrh is generally due either to an acute attack which does not go on to complete recovery, but which, neglected or improperly treated, continues with mitigated severity, or to the habit or condition established by repeated acute attacks, perhaps in a patient peculiarly susceptible. The symptoms are mainly those of the acute attack modified and lessened in severity. If it confines itself strictly within the limits implied in its definition, it is scarcely to be considered in itself a surgical disease at all, but comes more properly within the domain of the medical therapeutist. However, it is so frequently the precursor, if not the cause, of the other forms of chronic rhinitis that it must not be overlooked. It is rare indeed that a long-continued simple nasal catarrh does not involve the naso-pharynx and the posterior pharynx. So generally is this true that with some authors a chronic coryza is understood to include a retronasal and a retropharyngeal catarrh. In such a condition as this the Schneiderian membrane is not thickened, although the vault and posterior pharynx, owing to the large amount of glandular tissue, may be somewhat hypertrophied, giving rise to a large amount of thick mucous secretion. By extension also the Eustachian tube may become involved, and partial or complete deafness, either temporary or permanent, follow.

True hypertrophic nasal catarrh consists of a thickening of the epithelium of the pituitary membrane, and also of the underlying adenoid and connective tissues, together with enlargement and dilatation of blood-vessels. The nasal mucous membrane is well supplied with glandular tissue, and the distention of the mucous glands is no small factor in the hypertrophy of this membrane.

The secretion is thick and viscid, and is generally increased in amount, though the discomfort from its presence in the narrowed passages and the constant efforts at removal may make it appear excessive when it is really normal or diminished. Sensibility and smell are impaired; nasal respiration is interfered with; retronasal and retropharyngeal catarrh are practically the accompaniments of this disease.

The lower and middle turbinate bones are the ones most affected, particularly the lower. The membrane over these bones, as viewed from the anterior nares, is hyperemic and swollen, and upon the lower of a dark-red color that brightens up somewhat in the middle. The hypertrophy is neither wholly smooth nor regular, but is raised, inclined to be nodular, and of irregular outline. It may be so great as to extend from the turbinate bones across to the septum and depend toward the floor. In such a case respiration would be completely obstructed from the blocking up of the anterior nares. Obstruction to respiration is more apt, however, to occur from hypertrophy of the membrane around the posterior nares than from the anterior nares, for it is most pronounced in the retronasal region at the posterior portions of the inferior turbinated bones. If there is a deviated septum, early irritation of its protruded portion by the encroaching spongy tissue of the hypertrophy may cause also hypertrophy at that point, particularly opposite the posterior end of the inferior turbinated bone, and impede respiration very early in the progress of the disease. The appearance of the membrane posteriorly is paler than at the anterior end of the turbinated bones; also above it is less vivid in color. The middle turbinated bone may not be involved at all, or the membrane may be so grossly hypertrophied as to resemble a polypus.

Since the result of chronic inflammation in other parts of the body is hypertrophy, analogy forces the inference that hypertrophic nasal catarrh is no exception. Acute coryza is followed by the simple chronic form, and this, if unrelieved, gradually merges into genuine hypertrophy. This seems to be the history of this condition, although some observers claim that the acute and chronic coryzas which apparently precede and cause the hypertrophy are simply early and characteristic manifestations of the incipient hypertrophy. Without doubt the rapid and extreme changes of climate that are characteristic of most parts of the temperate zone are to be reckoned as factors.

Occupation in trades or arts where irritating vapors or dust are constantly present may be a cause.

The *symptoms* are the obstruction to nasal respiration, the thick discharge, impairment of sensibility, smell, and perhaps hearing; when the inflammation has extended to the pharynx there may be a change in the quality of the voice, sore throat, coryza and hawking and raising of mucus. In cases of long standing the inflammation will extend to the larynx and trachea, with additional symptoms referable to those parts.

Anterior and posterior rhinoscopy will reveal the pathological conditions in the nares already described, usually bilateral.

The vault of the pharynx has been called "the pharyngeal tonsil" because of the abundance of its glandular tissue. So prone is this to hypertrophy that adenoid vegetations as the result of inflammation are exceedingly common, and hypertrophic nasal catarrh is believed sometimes to originate by extension from pharyngeal inflammation, and may become very extensive—so much so that the vault and the posterior pharynx are completely filled with the adenoid hypertrophies, and can be seen through the mouth by lifting the edge of the velum.

In the majority of cases, however, such excessive hypertrophies are

not found, but there is marked thickening of the membrane, even so much that it lies in ridges. The hypertrophied mass is soft and varies in color from a flesh tint to a turgid red. As a general thing such hypertrophies are found only in children and young adults.

Diagnosis is easy from the symptoms and careful rhinoscopy. Hypertrophy of the nasal mucous membrane at first glance might resemble polypi, but the latter usually are pedunculated and originate on the upper part of the middle turbinated bone. Perichondritis is more apt to begin on the septum.

Prognosis is good as regards life and relief from the disease, and recovery may be complete. Most observers claim, however, that long-continued hypertrophic rhinitis terminates generally in the atrophic form of rhinitis.

Treatment.—Clinically, as regards treatment, cases of hypertrophic rhinitis fall naturally into two classes—those in which the process is only slight and which may be checked by topical applications of one sort or another, and those in which the hypertrophic process has progressed more extensively and decidedly, and in which removal of redundant tissue by instruments or caustics is the only suitable measure.

In either case there must be thorough cleansing of the passages of the secretion and of crusts, though the latter are not common. This may be accomplished in many cases by the patient's blowing his nose, and where possible this is the better way, because it is less irritating to the delicate and sensitive membranes.

In case the aid of a surgeon is required he has at his command both instruments and the spray. The probe with a bit of cotton at the end may be used to remove adherent secretions. No great force should at any time be used, but it may be necessary gently to push aside the obtruding parts in order to make a way for the entrance of the spray. Generally, however, unless the hypertrophy be very great a solution of cocain will sufficiently contract the membrane to afford a passage for the spray. A coarse spray of some alkaline solution is the one commonly used for cleansing. For the removal of the tenacious mucus in the vault of the pharynx or at the posterior nares a nasal syringe may be more serviceable. In the first class of cases, where the hypertrophy is only slight, after thorough cleansing astringent and antiseptic remedies may be used, preferably in the form of a solution through the nasal-spray apparatus. Soluble bougies, ointments, and snuffs each have their advantages in certain cases, particularly as no apparatus is necessary for their application. Gradual dilatation with bougies is a possible mode of treatment, and, when combined with systematic cleansing and local treatment, may be of value.

As a rule, it is the more pronounced cases which come into the surgeon's hands, those where there is much redundant tissue, where occlusion of the nasal passages is almost wholly complete, and where nasal respiration is nearly or quite impossible. In order to restore respiration the removal of tissue in one or both nostrils is indicated, and here the surgeon has his choice either of instrumental interference or of caustics.

Cocain is first used to anesthetize the parts. Caustics may be applied on a bit of cotton, the greatest caution being observed. Chromic

acid, nitric acid, glacial acetic acid, or trichloracetic acid will serve the purpose. Nitrate of silver is slow in action, and also has a stimulating effect—just what is not desired—and is now seldom used. Alkaline washes should follow the application of any of these acid escharotics.

The galvano-cautery under skilful manipulation does good service, and instruments of different shapes, suited to the cavity and to the tissue to be removed, can be adjusted to the various electrodes. It is not, however, of universal application—as, for instance, at the posterior extremity of the inferior turbinated bone it is not always possible to estimate precisely the degree of heat, and too extensive and too deep an eschar may be produced.

Electricity is said also to sometimes produce anosmia, and sometimes perversion of smell. Until sloughing and healing of the surface are complete, cleanliness and asepsis must be carefully maintained, as is also the case when chemical caustics are used. Besides the relief gained immediately by the removal of tissue, much may be hoped from the subsequent contraction of the cicatrix.

In most cases, however, some instrument which cuts away the redundant tissue without profuse hemorrhage provides the most desirable method of treating the membrane in hypertrophic rhinitis. Of these the écraseur—of which Jarvis's snare is the best form—is the most satisfactory (Fig. 240). After careful study of the location of the parts the wire loop is slipped over the portion to be removed, tightened around it, and then slowly made to cut its way through. Scissors or forceps may be employed, but the tearing of the forceps is painful and the bleeding profuse. In the vault of the pharynx a sharp spoon, curette, or sharp-bladed cutting forceps, if the vegetations are anything more than slight thickening, may be used. New blood-vessels are a characteristic feature of rapidly-forming hypertrophic tissue, and scarification or puncture by destroying these may put an end to the process. If there is much hemorrhage, whatever the mode of treatment, application of hot water should first be tried. If bleeding is excessive, plugging of the nares must be resorted to.

Atrophic Nasal Catarrh.—In this disease instead of hypertrophied tissues and occluded passages there is present precisely the opposite condition—atrophied tissues and abnormally wide nasal passages. Nevertheless, most authorities claim that the last condition is only a secondary phase of the first. In fact, all shades of opinion find expression. By some it is held that it never exists as the result of hypertrophic rhinitis; others regard it as occasionally being caused by that form of catarrh. Still others regard it as an entirely independent affection, in no way connected with that disease. Certainly we may conclude that its etiology is obscure, and, while the weight of evidence is in favor of its being a later stage of the hypertrophic variety of chronic catarrh, there may be constitutional conditions which produce it or it may possibly result occasionally from unnoted injuries.

Hyperplasia of connective tissue in other parts of the body usually results in atrophy of parenchymatous elements both from its weight and from the pressure it exerts in contracting. So in the Schneiderian membrane this pressure from hypertrophied tissue is exerted to the destruction of the abundant glandular tissue. The surface becomes

dry and covered with thick crusts, which again tend to bring about the same result from their pressure upon the epithelium and underlying parts. Not only the mucous and submucous tissues, but the turbinated bones themselves, are partially absorbed from the weight of inspissated secretions and the weight and contraction of connective and elastic tissue. All this makes unusually wide nasal chambers, so that at times the posterior wall of the pharynx may be viewed from the anterior nares. When the hardened secretions and crusts are removed, together with the muco-purulent and often bloody secretions that lie underneath them, the membrane is hyperemic at first, but soon may look pink and almost healthy or even almost colorless. If no crusts are present, it has a glazed appearance. Crusts are more commonly adherent toward the anterior nares than at the posterior, and may be so large or abundant as to stretch across or block the nasal passages, causing temporary occlusion and interfering with nasal respiration.

Symptoms.—There are usually discomfort and itching and an inclination to remove the crusts, even forcibly. Erosions, ulcerations, and epistaxis are therefore not uncommon, and perforation of the septum has resulted from such causes and treatment. The most distinctive feature of this disease, however, one so common as to characterize it, is the fetor almost constantly present. This arises from the decomposition of the secretions retained under the crusts and within the blocked meatuses.

Diagnosis is easy from the symptoms.

Prognosis as to recovery must be guardedly given, for it is a most obstinate disease to cure.

Treatment is cleansing, disinfecting, and stimulating. Cleansing can generally be effected by persistent spraying and douching. Occasionally, however, mechanical interference is necessary. The surgeon, using gentle force, removes with a probe adherent scales and crusts, cleansing any underlying ulcers and erosions, removing all muco-purulent secretions. At all events, after thorough cleansing disinfectant sprays and douches must be used to remove the fetor. Their name is legion—boracic acid, a weak solution of carbolic acid, iodin, permanganate of potash, resorcin, chlorid of ammonia, and salicylate of soda. Powders are often used, among which iodoform perhaps stands first. Disinfectant sprays should be followed by stimulation. For this purpose cotton tampons are used, either dry or moistened with glycerin or other stimulant. They exclude germs and air and prevent the formation of crusts, and by their use a more natural condition of the mucous membrane is maintained. Such treatment is certainly more rational than the application of astringents to a surface already deficient in reaction, or than caustics and scarifications on a surface already depleted.

Ozena is a term rather loosely used to describe either a symptom or a disease according as the author means only the fetor which arises from a diseased condition or the disease which gives origin to the fetor. Some writers employ it to include also all fetid ulceration due to any disease whatever, while others restrict its meaning to where it becomes merely a synonym for atrophic nasal catarrh, otherwise known as fetid nasal catarrh or fetid rhinitis; and this is probably the signification

more commonly given it, although almost as frequently it is used to mean only an odor.

The fetid odor arising from caries of bone or malignant growths or a decaying foreign body differs from that usually termed ozena, as it accompanies atrophic nasal catarrh, yet ozena is sometimes present when there is no atrophic rhinitis. It is then supposed to be due to a similar condition existing within the sinuses. In any case, the fetor is believed to be due to the decomposition of retained secretions. Unlike fetors arising from decayed bone, it temporarily disappears after thorough cleansing and spraying.

Giving to the term its narrower meaning, the symptoms and treatment are the same as for atrophic nasal catarrh. If it includes all fetid ulceration, then the treatment is that of the disease giving rise to it.

Diphtheritic and Membranous Rhinitis.—Should the micro-organisms of diphtheria first find lodgement on an abrasion of the Schneiderian membrane, there is no reason why a true diphtheritic membrane should not be developed there as well as in the throat. Sometimes the diphtheritic membrane passes from the pharynx into the posterior nares. More commonly, however, an abundant sero-fibrinous exudation, caused by acute rhinitis, rough surgical treatment, or an injury, deposits a false membrane, which may be quickly diagnosed from true diphtheria by the fact that it is easily removed without hemorrhage. There may be some fever, but constitutional symptoms are less marked than in diphtheria. It should be treated as an ordinary acute rhinitis, with more than ordinary attention to the removal of the exudation and disinfection of the nasal passages.

Purulent rhinitis is, as a rule, due to gonorrheal infection; in the case of the infant it results from contact with the maternal secretions, in the case of the adult from auto-infection. Other causes are possible, such as injuries, the presence of foreign bodies, the exanthemata, and incipient ozena. The exact character of the discharge may perhaps be determined by microscopic examination.

Treatment resolves itself into thorough cleansing by spraying, douching, syringing, disinfection, and the application of astringents.

Diseases and Injuries of the Septum.

Most of the affections of the nose already treated of belong to the septum in common with the parts covered with the Schneiderian membrane. But there are certain lesions (to which it alone is subject) dependent upon its anatomical character and position.

Of such lesions **deviation of the septum,** either congenital or acquired, is certainly the most noticeable, and, considering the long train of evils to which it may give rise, the most important.

A perfectly normal septum, being on the median line of the body, should divide the entire nasal cavity into two symmetrical halves. Any departure from such a position is termed a deviation. It may be of all degrees, from the merest inclination to one side or the other, to a single or double bend in the septum, either horizontal, vertical, or both, sufficient to completely occlude the nostril and exert considerable pressure upon its outer wall. One lateral curve constitutes, as a rule,

the deviation, but there may be two, giving a sigmoid curve to the deviation. Quite naturally, from its greater flexibility, more and greater deflections occur in the cartilaginous portion of the septum than in the bony part, and quite frequently, when the deviation is the result of traumatism, it occurs at the junction of bone and cartilage. Only the perpendicular plate of the ethmoid may be warped or the vomer alone, and finally the septum as a whole, including bony parts and nasal cartilages, may curve toward one side. As much as one nostril is occluded by the distorted septum is the other enlarged as a general rule, but in addition to the occlusion caused by the bulging on the affected side there is often hypertrophy of the turbinated bones. At the sutures of the various parts there is sometimes an unusual degree of thickening, virtually an exostosis extending antero-posteriorly. This gives the effect in one nostril of a deviation both in appearance and results. It may also be bilateral. There may be quite an extensive deviation of the septum without any appearance of external asymmetry. At times the nose is badly twisted from its normal contour. Much attention has been given in recent years to the deviated septum, and study of skulls has established the fact that symmetry of the septum is the exception, and not the rule. While there is not perfect agreement in the conclusions reached, there is substantial unanimity in placing the proportion of asymmetrical septa at about 75 per cent.

In many cases, at least, such statistics have referred to the bony septum alone. Hence, certainly the conclusion is a safe one that during life anterior rhinoscopy would reveal a much larger percentage, owing to the greater readiness of the cartilage to yield to pressure. Dr. Hegman places it as high as 99 per cent. of all persons examined. Deviation of the septum may be congenital, may occur suddenly from traumatism, or may result from causes that act more slowly and constantly. There is no agreement of authorities as to the causes of deviated septum of the last sort mentioned. Should it happen, for any reason, that the bony walls between which the septum is placed are of unequal thickness and resistance, it would naturally be affected by such pressure and yield somewhat, moving in the direction of the least resistance. Since the deviation is more commonly toward the left, some find an explanation of the condition in the fact of wiping and blowing the organ most frequently with the right hand. Foreign bodies may have their influence in determining it to one side or the other; so also unilateral new growths. Some authors deny that it is ever congenital. But it is a well-established anatomical fact that there is a lack of perfect symmetry in many skulls. As the body develops some cause or other, either forgotten or totally obscure and inappreciable, determines a greater development on one side than on the other. It is certainly to be expected that the septum will be exposed to its share of all such untraceable influences.

Symptoms.—If the deviation is only slight and tends to remain so, there are no diagnostic symptoms. If it encroaches to any great extent upon the nostril, we have all the symptoms of occlusion that are produced by any other cause. Most important of all, respiration is interfered with. Secretions are retained, rhinitis is set up. Pressure on the

turbinated bodies and the overlying mucous membrane causes them to atrophy, and the result is atrophic rhinitis.

The usual *complications* and *sequelæ* of rhinitis may be present in their turn, together with headaches and reflex symptoms.

Diagnosis is easy by comparison of one nostril with another, and by using the probe to ascertain by the tactus eruditus that the protuberance is of bone and not a new growth.

Treatment.—The object in treatment is, first, to relieve obstruction, and, second, to restore the septum as nearly to an ideally normal position as possible, and thus preclude the possibility of recurrent obstruction from this cause.

Much depends upon the skill and ingenuity of the surgeon. Furthermore, inasmuch as this branch of surgery is of comparatively recent date, the profession do not seem, as in many other departments of surgery, tacitly to have settled upon one or more operations as practically superior.

One of the earliest proposed methods was that of Adanus. He grasped the deviated septum between the blades of forceps and reduced it to its proper position by crushing and fracturing. After this procedure rather elaborate apparatus was necessary in order to maintain the proper position until repair was complete—head-bands, screw-compressors, plugs, etc.—and this is the case always where forcible compression is employed. If the deviation is only slight and in a young subject, retentive plugs or something similar may serve a useful purpose.

Excision, in some way, of the bulging portion seems to be the better plan. This may be done with various instruments, as saw, scissors, chisels, etc. Even a dental engine has been proposed. Steele employs

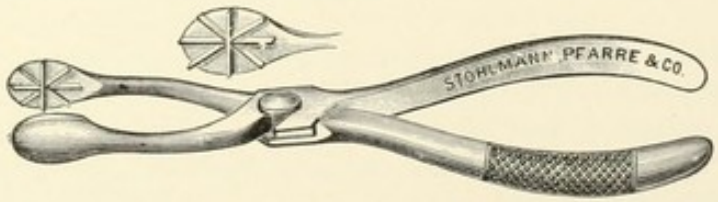


FIG. 254.—Steele's stellate forceps for deflected septum.

forceps (Fig. 254) by which he cuts a stellate incision and also forces the septum back into position. He retains it there by ivory or wooden plugs.

Another plan is to lift the mucous membrane, and sometimes the perichondrium with it, excise a portion of the septum, replace the mucous membrane, and keep it in place by a sponge until repair is complete. Some operators by punch or forceps remove a portion of the septum. This leaves a perforation which heals possibly at the edges, so far as the mucous membrane is concerned, but is open to the same objections that apply to a perforation caused by other means, and if large it may cause external deformity. Slicing away portions of the deviated cartilage has been quite successful, as a number of incisions made antero-posteriorly make the cartilage lose its resiliency, so that it can easily be retained in place until it has healed.

Steel pins are used, thrust through from the outside, so pressing upon the septum as to force it into position. They must be retained for some days.

Hematomata.—As the direct result of traumatism, especially when the septum is fractured, separating the cartilaginous part from the bony portion, extravasation of blood often occurs between the cartilage and mucous membrane. Having a relatively broad base, they vary in size from minute spots to tumors so large as to protrude from the nose. They are of a dark-red or bluish color, usually with marked fluctuation, although tension may be so great as to prevent it. If small and promptly treated with cold applications, they may be absorbed. If absorption does not occur, they must be incised at the most dependent portion. They are usually bilateral and communicate through a perforation, so that one incision will empty both lobes of the tumor if gentle pressure be applied; otherwise, each side must be incised. They are apt to degenerate into abscesses unless promptly treated, and perforation from them may be so large as never completely to close.

Abscesses are either *acute* or *chronic*. The **acute** abscess is generally the immediate result of injury. It is red, tender, painful, bilateral, and fluctuating, and often by extension involves the lips and cheeks and the internal parts of the nasal cavity, though the abscess proper is situated anteriorly on the cartilaginous part of the septum. Slight fever is common. Early and free incision on one or both sides is the only treatment. If delayed, periostitis and perichondritis are likely to result. Perforation of the septum is the common sequel.

Chronic abscesses are of slower development, and the intensity of all the symptoms is less marked; indeed, the patient may not even be aware of their existence. They may occur without known origin, yet are usually caused by syphilis. Prompt incision and constitutional treatment are the indications.

Perforation of the Septum.—The most common cause of this condition is syphilis, and formerly it was believed that it was the sole cause—that, given a case of perforated septum, it was safe to assume a previous history of syphilis even if wholly beyond the patient's knowledge or memory.

Other causes are now admitted: traumatism resulting in blood-extravasations or abscess will indirectly produce it.

Erosions caused by the continual removal of crusts upon the cartilaginous part of the septum often deepen into perforations. A localized perichondritis or periostitis may be followed by it. Some believe that it may be congenital.

Usually the edges of the perforation heal well and they are of slight importance. Sometimes they are so large and so placed that a current of air produces a slight whistling as it passes through. Rhinoplastic operations to repair the deficiency have been tried, but have met with but little success.

Deformities, Congenital Malformations, and Defects of the Nose.

As has been seen in the discussion of Diseases and Injuries of the Nose, deformities of various sorts are common, due to alterations in

either the external or internal parts. Such structural changes may be the result of accident or disease. By far the greater number are due to destruction of tissue and to cicatricial contraction following the ravages of destructive diseases. Among these syphilis stands first, both in frequency of occurrence and rapidity of advance.

To such as are caused by destruction of tissue may be added those resulting from the opposite cause—the development of an abnormal amount of tissue, as in elephantiasis and rhinoscleroma, already described—or, finally, those in which the nose is distorted by the presence of neoplasms within the nasal cavity. A good example of the latter class is seen in the so-called "frog-face" associated with naso-pharyngeal polypi.

Congenital malformations fall naturally into three groups: 1. Those in which a whole or a part of the organ has not kept pace in development with other parts of the body, and is relatively small or asymmetrical; 2. Those in which development has gone on more rapidly than in other parts of the body, making the nose abnormally large; 3. Those in which there is arrested development, leaving gaps between parts which are fully developed, perhaps in one direction, but have failed to unite properly with contiguous parts in other directions.

Absence of the nose is not unknown, the site of the nasal organ being a plane surface, with or without perforations for nostrils. The nose may fail to develop in its long axis, making it too short—a "snub nose." The nostril may be contracted also at birth. Should one side of the nose develop and the other not, the organ then lacks symmetry and gives a most peculiar appearance to the face. Slight asymmetry of the nose is not uncommon, but can scarcely be called congenital. Nor is it the result of disease, but is due to greater pressure on one side than on another when the organ is blown and wiped.

Sometimes a nose is abnormally large from disproportionate development, and the organ may even be double or be furnished with three nostrils or with a small outgrowth at the root or on one side that simulates a nose on a small scale. Sometimes one or both nostrils are occluded by the development of adventitious tissue at the opening or within the cavity. Should this extra tissue remain, the result will be not an abnormally large nose, but an undersized one, because the nostril, being shut from the air, contrary to Nature's designs, suffers from diminished nutrition. Sometimes the nasal cartilages do not unite in the middle line, or the alæ are too much separated at their bases from the face, leaving clefts or fissures. Such deficiencies are usually found in connection with hare-lip and cleft-palate, being a continuation of the fissure in lip or palate.

Plastic operations may be undertaken to close such fissures and also to correct some deformities that are due to cicatricial contraction.

Outgrowths, making abnormally large noses or double noses, may sometimes be removed. Rhino-scleroma and hypertrophy have already been discussed.

If the nose has failed to develop from contracted or occluded nostrils, dilatation or removal of adventitious tissue is indicated.

When the entire organ is lost by accident or destructive disease an artificial nose may take its place.

Rhinoplasty.

Rhinoplastic art has for its object the restoration of the whole or such part of the nose as may be wanting. Deficiencies of the nose may be congenital, the result of accident or of destructive ulceration, and they may be limited to the soft structures, or there may be implication of bony tissue as well. Thus, rhinoplasty, varying from a trifling operation where a slight fissure is filled in to where the entire organ is constructed, naturally divides itself into partial and complete rhinoplasty.

Whatever the operation, it should not be undertaken until all diseased and necrosed tissue is removed, nor until the destructive process is clearly at an end without prospect of renewal. Tissues to repair deficiencies are taken from the cheek or lip, the forehead or the arm.

If the restorative process is to be only slight and on the side of the nose, it is best generally to take the graft of skin from the cheek; if it is of considerable extent, from the forehead. If a new columna nasi is to be formed, a graft is cut from the median portion of the upper lip, and the lip is closed and dressed exactly as in hare-lip. Such a flap may be made to do further duty in forming the ridge of a nose by dissecting the mucous membrane of the lip away from the skin, and extending it as the prolongation of the skin up to the root of the nose, the mucous membrane in its unwonted situation taking upon itself the characteristics of cutaneous tissue. When this is done the sides of the nose may be supplied by flaps from the cheeks. Something might depend upon the fulness of the upper lip and cheek in deciding upon such an operation. Commonly, however, if a considerable portion of the nose is to be restored, the forehead furnishes the desired graft. If only a small portion of the lower part of the ala be wanting, the upper part of the nose itself may be made to furnish the skin for transplantation. Fistulous openings, the result of scarlet fever and other exanthemata, are repaired usually with flaps from the cheeks.

In all these operations some pattern of the desired graft must be traced out on forehead or cheek, allowance being made for retraction of the skin. A pedicle must be left to ensure a blood-supply, and care must be taken not to twist the pedicle too severely, since that alone, by cutting off the circulation, will frustrate an otherwise successful operation. When the engrafted tissue has grown firmly in its new position the pedicle is severed. Some trimming and adjustment of edges may then be necessary, also a suture or two to complete the operation.

A nose too short has been improved by cutting transversely across it, drawing it down to a suitable position, where it is held in place by pins, and filling in the triangular space with tissue cut from each cheek and meeting in the median line on the ridge of the nose. The bare mention of such an operation suggests the thought that the opposite procedure, removal of a similar shaped portion of tissue in a too protuberant proboscis, might afford an opportunity for a more brilliantly successful operation.

Some of the earliest attempts at plastic surgery were made in the effort to construct an entire nose, and both of the methods now most in vogue are with more or less modifications those that were employed when other operations of modern surgery were hardly dreamed of.

Whichever is selected, a definite idea must be obtained as to the amount and size of tissue needed to construct the organ. Generally upon the face of the patient a form is made of wax or other plastic material. From this a pattern is made pyriform in outline, from which the graft is traced out, allowance being made for the retraction of the skin. It is usual to allow one-third for retraction.

Tagliacozzi was a learned Italian surgeon of the latter part of the sixteenth century, and just at the close of the century he published a description of the operation that now bears his name—the Tagliacotian. He cut from the upper arm a skin-graft of the required size and shape, leaving it attached by a pedicle. After this was done he left it for about two weeks, that it might thicken and granulate. Then he freshened the stump of the nose to which it was to be attached, adjusted the flap, and fastened it with sutures. Since absolute immobility of the arm must be maintained for about two weeks, numerous slings, bandages, and appliances were necessary to keep it immovably fixed. At the end of that time the pedicle was severed, the arm released, and a columna nasi fashioned from the upper lip. Modern operators use a flap from the



FIG. 255.—Indian method of rhinoplasty (Prince).

forearm instead of the upper arm, and, though this operation possesses the advantage of not disfiguring the forehead, it is exceedingly difficult to secure absolute immobility, and then very tiresome to maintain it for the necessary length of time.

The other method, known as the Indian because originally practised in India, is now more generally employed than any other. The size and shape of the flap are determined as in the other operation. Beginning at the root of the nose, the narrow end widens into the broad end of the pyriform flap, either in the middle or on one side of the forehead (Fig. 255). If made to one side of the median line, the operation gives a fairer promise of success, because there necessarily is less rotation of the flap upon its pedicle.

All the soft tissues are incised down to the periosteum of the frontal bone. Some authorities recommend that the periosteum also be included in the tissues, and even some fragments of the outer table of the frontal bone, so that bone may be developed from the osteoblasts, and a better shape for the nose be ensured. The stump is then freshened and bevelled, to be united with the properly bevelled edge of the

flap, or the skin may be slit and the flap, after being bevelled on its outer surface, may be inserted into this groove. Numerous fine sutures are employed to hold the flap in place; the alæ and nostrils are shaped and stitched, and a septum made by drawing down the inner part of the flap and stitching it to the upper lip. The nostrils are kept open with tubes or plugs, and the nose supported with dressings which are kept on for several days. The patient is confined to bed, and the temperature of the room kept warm and even. When union is firm the pedicle is severed, the edges trimmed, and final adjustment made of the flap at the root of the nose. The columna nasi is made from the upper lip, as before described. Some operators by prolonging the original flap at the middle of the base provide a covering for the columna nasi. The objection to this plan is the unnecessarily long forehead incision.

The forehead wound is drawn together as much as possible, and left to heal by granulation.

Too much allowance should not be made for shrinkage, or the nose may be so extraordinary in size as to constitute a deformity almost as bad as the one it was intended to remedy. Various surgeons have made modifications of these operations, for the details of which the student is referred to special works.

If there are objections or contraindications to operations of this sort, artificial noses, held in position by spectacles, offer a very creditable substitute for Nature's handiwork.

Rhinoscopy.

Rhinoscopy as now practised owes its existence to the discovery of laryngoscopy, for posterior rhinoscopy employs practically the same instruments and means as does the sister art. Anterior rhinoscopy was no doubt practised in the surgery of very early times, but its importance, considered alone, has been greatly enhanced by the ability to view also the naso-pharynx.

Only a few simple instruments are really necessary for the practice of rhinoscopy. Of prime importance is some good source of illumination. This may be a simple oil lamp or a gas or an electric light with complicated fixtures. A student lamp with a metallic chimney in which is adjusted a plano-convex lens for condensing the rays of light, if that is necessary or desirable, is a very good light.

A good gas-light in suitable position with reference to that of the patient will do very well. Such a light, so attached to a bracket that it will move in all planes, with the chimney and lens for condensing, constitutes a very excellent source of illumination.

A concave forehead reflector with a central perforation, having a ball and socket on the rim, adjusted either by a band or a spectacle frame, a nasal speculum and a nasal retractor for anterior rhinoscopy, a small-sized laryngoscopic mirror, and a tongue-depressor for posterior rhinoscopy, are all the instruments needed.

In anterior rhinoscopy an ear-speculum of small size and a little larger than usual may be employed. Thudicum's speculum, a bivalve instrument, is very useful (Fig. 256). Self-retaining wire dilators are of

great convenience and cover the minimum amount of the surfaces to be examined. Those known as Fränkel's and some varieties invented and used by Prosser James are the best. Special rhinoscopic mirrors are not necessary; the small sizes of laryngoscopic mirrors are generally used with the handle bent to an angle of about 105°.

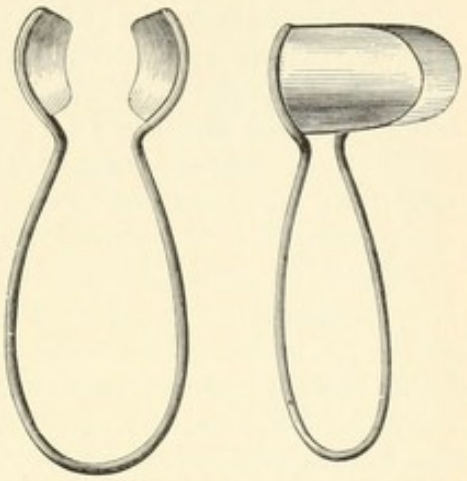


FIG. 256.—Thudicum's nasal speculum.

Anterior Rhinoscopy.—For the practice of anterior rhinoscopy the patient is seated directly in front of the surgeon in an upright position, the head thrown slightly backward. The light is placed so as to come over the right shoulder of the patient. The rays are focussed upon the forehead mirror, and thence thrown into the nasal fossa, which it is thus possible to explore completely from roof to floor and from septum to side. The middle and inferior turbinated bodies, the middle and inferior meatus, come plainly into view; the superior turbinated body is rarely or never seen. If the nostril is unusually spacious, it may be possible to see the posterior wall of the pharynx.

Not all portions of the nasal mucous membrane are of the same color. The middle turbinated body is of a pale color, the septum is darker, and the inferior body the deepest red of all.

Cocain should ordinarily be applied in a first examination. After tolerance has been established it may be less necessary. The lower turbinated body has much erectile tissue, which on irritation is apt to become distended and occlude the passage. Application of cocain prevents this, and reduces the abnormal sensitiveness of inflamed parts of the surface.

Posterior Rhinoscopy.—In posterior rhinoscopy the position of the patient and of the light are the same as in anterior rhinoscopy, but here the light is thrown into the mouth and concentrated upon a mirror at the back of the throat, so that the observer does not get a direct view of the parts he is examining, as before, but an image only. The mouth must be opened widely, and the tongue well depressed on the floor of the mouth. The mirror is warmed to prevent condensation of vapor upon it, and, introduced at the corner of the mouth, is carried up behind the velum, and should be brought to a standstill midway between that and the posterior pharyngeal wall.

Certain difficulties present themselves here in some cases. The hard palate may be prolonged so far backward that there is scant room between it and the pharyngeal wall, and this may be so pronounced that it is not possible to obtain an image at all. Adenoid vegetations may present themselves in the way. These have to be removed before the examination is practicable. A long soft palate may hang so low as to obscure the image. In this case it must be held aside by a retractor or palate hook; or a ligature may be passed around it and fastened to a tooth, thus giving freedom to the surgeon's hand. A tape may also

be passed through the nostrils and brought out of the mouth, lifting the palate out of the way. The tape is generally carried over and tied behind the ears. Another obstacle to examination is that the patient as soon as he opens his mouth begins oral respiration, and the entering current of air carries the uvula tightly against the pharygneal wall. This can quickly be corrected if the patient will, even with the mouth open, acquire the ability to breathe through the nose. He may be directed to place his hand tightly over the widely-open mouth. He will then be forced to nasal respiration. Removing the hand, he can easily continue the same mode of breathing.

The rays of light from the reflector must fall upon the mirror in the fauces in such a manner that they will be reflected from it upon the posterior nares. The mirror will thus receive the "rhinoscopic image." Only rarely, however, will a complete image be reflected upon it. The mirror is held so as to examine first one side, and then the other, and the mind combines the two halves so as to make the perfect picture.

At first the observer will be able to make out little, but patience and care will soon make the different parts stand out clearly (Fig. 257).

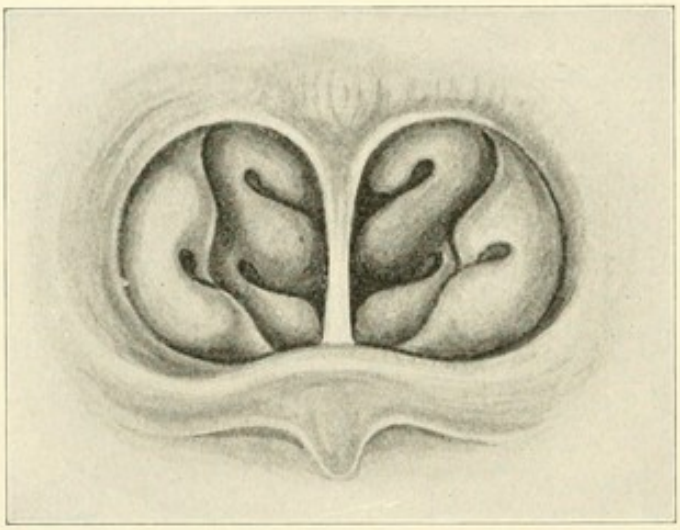


FIG. 257.—Representation of posterior rhinoscopic image.

When the mirror is finally adjusted at the proper angle, about 130 degrees with the horizon, first the posterior surface of the uvula, then that of the velum, come into view. The velum arches up in the field of vision so as to always obscure a part of the lower posterior nares. The septum nasi is most prominent, and soon asserts itself as the landmark to which the other parts are instinctively referred. It is narrow, glistening, and pale below, but widens out into the pharyngeal vault, deepening in color as it increases in width, though the darker color is partly due to the fact that above it is less brilliantly illuminated. On either side are two somewhat oval spaces, much darker in color than the septum, since they are hollow or receding—the choanæ or posterior nares.

Stretching across from the external side of each are three bulbous structures, the turbinated bodies. The middle one is the most prominent, really overshadowing the other two. The superior turbinated

bodies are small, of triangular shape, pointing downward and inward, and, indeed, are sometimes scarcely visible, being overlapped by the middle ones. The inferior turbinated bodies fill in the lower outer angle of the space external to the septum and overlie the lower part of the middle body. Owing to the arch of the velum, their lower part is rarely visible, though here, as elsewhere, there is great variety in the configuration of the parts. This shape of the velum prevents the inferior meatus from appearing in the rhinoscopic image. The middle one comes out distinctly as a depression between the middle and inferior bodies toward the outer boundary of the space. The superior meatus looks like a line above the middle turbinated body. The orifice of the Eustachian tube presents on each side opposite the upper part of the inferior turbinated body. It is a depression situated on a smooth rounded projection, and lies in a different plane from the parts just described. It is scarcely necessary to say that for the successful practice of rhinoscopy a thorough knowledge of the normal parts is indispensable.

A great variety of instruments and also of medicaments are employed in the treatment of diseases of the nasal passages. Most of these have been discussed in the treatment of nasal diseases, and mention has also been made of the different methods both of cleansing and of treatment; the student is referred to complete works on rhinal therapeutics for more detailed information.

The douche, both in the profession and among the laity, is the most widely known of any method both for cleansing and for treating the nasal passages.

The simplest arrangement is that of a reservoir of some sort, a cup, a bottle, or a small fountain syringe, to which is attached rubber tubing ending in a nose-piece. The nose-piece is passed into one nostril, the patient bending slightly over a basin. He must resist the inclination to swallow as the liquid strikes the pharynx, so that it will not pass into the Eustachian orifice, and immediately the stream will pass into the posterior nares of the other nostril.

Many surgeons prefer, instead of the douche, a coarse spray. There are many varieties of nasal spray-producers, of which Leffert's is one of the best (Fig. 258).

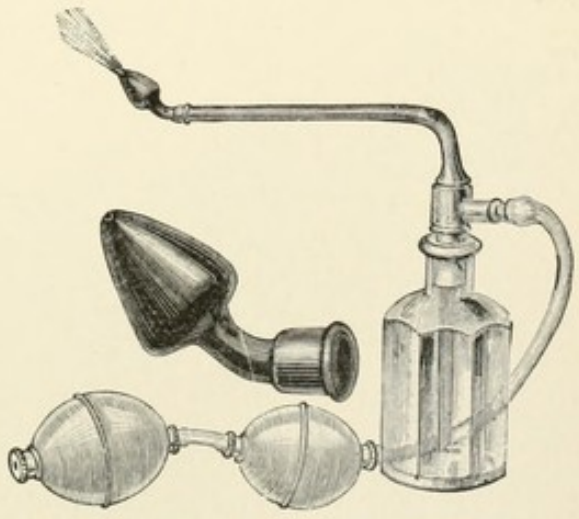


FIG. 258.—Leffert's nasal spray apparatus.

Syringes are useful for removing crusts and inspissated secretions. A common bulb-syringe, fitted with suitable nasal tubes, may be used, although syringes especially for the nose are manufactured. For the anterior nares a straight hard tube is used or the aurist's syringe, but for the posterior nares a tube curved at the end so as to enter and fit into the posterior opening is necessary.

Compressed air-atomizers of complicated structure are a desideratum in the treatment of obstinate chronic cases, especially those of syphilitic origin.

Insufflators are of common use, and apply a powder instead of a liquid to the nasal mucous membrane.

Bougies of soluble materials are often used in treatment of the nasal passages. Dilators, either solid or hollow, of soft or hard material, are a necessary part of the outfit of those who treat diseases of the nasal passages.

The medicaments used resolve themselves into astringents, stimulants, cleansing solutions, antiseptics, and caustics, and their name is legion, though they are the same as are used to accomplish the same results in other parts of the body.

II. DISEASES AND INJURIES OF THE ACCESSORY SINUSES OF THE NOSE.

The Antrum of Highmore or the Maxillary Sinus.—**Injuries.**—"This cavity hollowed out of the body of the maxillary bone" is more open to injury than any other accessory sinus of the nose, both from its exposed position at the most prominent portion of the face, and because its walls are very thin and yield readily to pressure or violence. A blow upon the cheek may fracture the walls of the antrum, or it may be penetrated by a weapon or by bullets, in which case the fracture is compound.

If the fracture is simple without depression, the pain and soreness may quickly subside, giving no marked symptom of inflammation and without permanent injury. If the fracture is comminuted, depression is likely to occur. The bone may be restored to position by operative interference either through the nose or the mouth. It is rarely possible for fractures of the walls of the sinus to occur without setting up inflammation of the mucous membrane lining the cavity, followed by abscess as a rule.

Foreign bodies in the antrum are usually either bullets or insects. To these, as occurring rarely, may be added the crusts formed by an ozena of the antrum, spicula of bone, portions of broken instruments, drainage-tubes, bits of gauze, etc. from former operations.

Diseases.—Inflammation may be either acute or chronic.

Simple acute inflammation without abscess is, no doubt, a frequent occurrence as a complication of severe coryza. The symptoms are negative, however, unless the process, instead of ending in steady resolution, goes on to the acute purulent form. In this case the ostium maxillare is temporarily closed from the congestion and inflammation of the mucous membrane in the narrow orifice. Other causes are—traumatism, as previously mentioned; the presence of polypi in the nose, closing the ostium maxillare (or of polypi within the antrum, effecting the same thing); or, more frequently than anything else, dental caries, particularly that form in which an alveolar abscess infects the antrum by extension from the root of a tooth that projects up into the floor of the antrum. It has been observed in the case of infants from injuries received during labor.

Symptoms.—There may be no physical signs of acute purulent inflammation of the antrum, but in severe cases they are usually present in a more or less pronounced degree. If there is no outlet for the pent-up pus, then the objective symptoms are most marked and the subjective most painful.

The abscess, even though it is surrounded by bony walls, produces marked distortion. It may crowd the teeth downward until they project abnormally in the mouth; it may flatten the normally convex hard palate; it may push up the floor of the orbit until the eyeball bulges forward; it may crowd the adjoining nasal wall until it closes the nostril or may cause marked enlargement of the cheek over the malar bone.

With such signs fluctuation is generally present, because the bone is much thinned, and eventually, unless the pressure is relieved by surgical interference, the abscess will burst at the point of least resistance, either into the nostril or the mouth, or very rarely through the cheek or the floor of the orbit. Crepitation is frequently detected over a thinned portion of bone. If, however, the ostium maxillare is patent, pus will be discharged into the middle meatus of the nostril from beneath the turbinated bone on one side. This may be continuous or intermittent, and may increase or decrease in amount according to the position of the head. When this is the case, it is frequently observed that the color of the discharge is ozenic. When pus is confined within the antrum there are tenderness on pressure, pain radiating in various directions, and a feeling of distention and distress in the head generally. The soft parts of the face may be greatly swollen. There may be also constitutional symptoms, such as accompany the accumulation of purulent matter in other parts of the body, rigors, sweats, fever, and severe headache.

Diagnosis is made by the discharge of pus into the middle meatus if the opening into the nostril is patulous—by the physical signs and constitutional symptoms if it is occluded.

Some authors advocate transillumination by means of a small electric lamp placed in the mouth as a means of differential diagnosis. It will be seen, however, that this would be little more than confirmatory of other symptoms. The patient is placed in a dark room, and the lessened illumination of the diseased side of the face gives evidence of opacity in the antrum. Such opacity might, however, be due to thickened bony walls, to tumors or cysts, or to greater thickness of the overlying tissues on the one side. Should abscess of the antrum be bilateral—a condition not unknown—transillumination would be of no value unless it could be demonstrated that the illumination of the face was less than in the case of a large number of other people. Possibly the Röntgen rays may, at no distant time, become available in clearing a diagnosis in such conditions. Foreign bodies, cysts, and tumors in the antrum may present some difficulties to the diagnostician, but the evidences of acute inflammation under these conditions is, as a rule, absent, and the cachexia of malignant growths is wanting in abscess.

When pus appears persistently in the nostril of an adult, it may be from any one of the sinuses. If all signs of its source are absent, the

patient may be directed to bend the head low, when the discharge will be increased if it is from the antrum of Highmore. On resuming the erect position it will, if wiped away, not return at once. If it comes from the other sinuses, removal will not stop the flow. In children foreign bodies in the nose most commonly produce a unilateral discharge, and from anatomical considerations young persons seldom suffer from antrum-disease. If, after all attempts to settle the question of abscess of the maxillary sinus, doubt still remains, an exploratory incision may be made, preferably through the canine fossa, or the inferior meatus, where the bone is so thin that moderate force will effect an entrance.

Treatment.—In acute inflammation of the maxillary sinus without the formation of abscess antiseptic and detergent washes in the nasal chamber, with hot applications, are generally all that is necessary both to cure the existing condition and to prevent further trouble. On the first indication of the accumulation of pus, here, as elsewhere, free evacuation is the rule. If a carious tooth can be profitably spared here, through its socket is the ideal opening, both for ease of access and thoroughness of drainage, and such a route was formerly the only one attempted, even if a sound tooth were sacrificed. Now, however, if no decayed tooth present itself for vicarious extraction, an opening is made, either with probe or trocar, at the lower part of the canine fossa or near the floor of the nostril in the inferior meatus, or in both places, by which drainage is more rapid and irrigation more thorough. If it is suspected that the purulent inflammation is caused by a foreign body or by necrosed bone, thorough search for such must be made with a probe, even to the breaking down of septa of bone. The removal of such foreign material may make it necessary to enlarge the opening.

Chronic inflammation of the antrum of Highmore may persist for years. It may run a rather steady course, or a chronic condition, with discharges comparatively slight in amount and at rather long intervals, may with some regularity give way to more acute exacerbations, during which both the frequency and the amount of the discharge are noticeably increased. In either case there is evidence of accumulated secretion in the fact that lying down or bending the head to one side or low down will increase the amount of the discharge. Pain is not generally a marked symptom, though headache is common, and there is a depression of spirits and a generally lowered tone to the system.

Constant discharge of pus over the Schneiderian membrane is believed by some to cause nasal polypi, and these, on the other hand, by occluding the opening into the antrum, may bring on acute inflammation, though by some authors a form of chronic inflammation is described in which the outlet is occluded.

Diagnosis must rest upon the unilateral discharge, usually fetid, from the nose; and since it is possible for a discharge from the frontal sinus through the fronto-nasal canal and the ostium maxillare to reach the antrum, and also from the ethmoidal cells through the hiatus semilunaris to reach the same place, it is plain that an absolute diagnosis without confirmatory symptoms is sometimes impossible, for these discharges would reach the nasal cavity from the antrum, appearing under

the middle turbinated bone, and, nevertheless, the mucous membrane of the antrum be wholly free from the inflammatory process.

Treatment.—Under the conditions last sketched treatment of the antrum of Highmore would be utterly futile. If, however, the discharge really has its origin in the sinus, and will not yield, as it frequently does, simply to intranasal douching with antiseptic and astringent lotions, then the antrum must be opened, cleansed, and drained. The choice as to openings is to be made as in the case of acute inflammation. Antiseptic solutions, as boric acid, are then used to cleanse the antrum. After exploration and removal of foreign substances or necrosed bone a drainage-tube (either Myles' or Bosworth's, according to circumstances) is inserted, and the antrum should be thoroughly washed after each meal. When there is no further evidences of pus, the drainage-tube is withdrawn and the opening heals very quickly, although so long as it persists the flushing of the antrum must be maintained because of the liability to infection from food.

Sometimes, after the operation has been most thorough, evidences of chronic inflammation again make their appearance and the operation must be repeated.

Foreign Growths.—Cysts have been known to exist within the antrum of Highmore, also serous accumulations and extravasations of blood. Tumors, both benign and malignant, are not relatively uncommon, as hematomata, fibromata, bony tumors, myxomata, and both sarcomata and carcinomata. (According to the table of Weber, based on 307 cases analyzed by him, carcinoma is by far the most common, and sarcoma next.)

Symptoms appear rather insidiously, and may be confined to local pain and distress, with the addition of cachexia and involvement of glands in malignant disease, or there may be evidence of involvement of contiguous structures.

Extirpation, if the age and health of the patient permit, is the only course, and even then the trouble may be too extensive to be checked.

Frontal Sinus.—Injuries.—This cavity communicates with the nasal cavity through the fronto-nasal canal, a relatively long and narrow opening. It is subject to simple, compound, and comminuted fractures. The first is usually the result of direct violence, as a fall or a blow upon the forehead, while the last is the result of gunshot wounds, stabs, falls, blows, explosions, etc.

In simple fracture commonly only the anterior wall is broken, and in that case the most frequent and serious symptom is emphysema of the face and forehead because of the escape of air from the nose into these tissues. The posterior wall of the sinus may be fractured, with consequent access to the brain. If the outer wall is depressed, it must be elevated to avoid disfigurement of the face. If the dura mater is exposed, an operation may be necessary.

In compound and comminuted fracture all pieces of bone or fragments of other tissue must be removed from the sinus, and also all foreign bodies, as bullets or splinters. Jagged points of bone must be removed, and the parts restored as nearly as possible to their normal position. Plastic operations may be necessary to secure this end.

It is said that the frontal sinus is the most liable to invasion by

insects, as flies, centipedes, etc. Strict antisepsis must be maintained whatever the operation, and particularly if there is likely to be any involvement of the brain.

Diseases.—*Inflammation* may either be acute or chronic. The *acute form* is frequently caused by an extension of inflammation from the Schneiderian membrane. It is also the result of such injuries as were described in the previous section. It may also result from tertiary syphilis, and whatever the cause, there may or may not be abscess. From the frequency with which it is involved in acute coryza it would seem at first thought that it is affected more frequently than the other accessory sinuses of the nose, but this probably is not the case. The canal to this sinus is so narrow that it is easily occluded by the swelling of its mucosa. Secretions are thus retained, and consequent symptoms appear earlier and are more marked than in the case of other sinuses, where some outlet is generally preserved, even when the mucous membrane is considerably congested or inflamed.

Symptoms.—A sense of fulness in the forehead, intense headache and pain in the frontal region, are the usual symptoms of inflammation of the frontal sinus without abscess. If an abscess form, all these are aggravated, constitutional symptoms appear, and local signs are marked. There are chills, fever, and, if there is pressure upon the brain or invasion of it by the products of inflammation, there may be delirium. There are local pain and tenderness on pressure, bulging and distention of the parts, even to exophthalmos. If the pent-up pus finds access to the cranial cavity and implicates the brain, there is delirium. Over the affected part the skin often becomes intensely red, simulating erysipelas. If the inflammation is of syphilitic or tubercular origin, there are very likely both local and constitutional manifestations of its presence in the system. The eyes usually share in the affection to some extent, photophobia, conjunctivitis, and lachrymation being common.

Absorption of the bone takes place if the pressure is great, and consequently, if there is spontaneous evacuation, the pus finds vent at the point of least resistance.

Fluctuation and crepitation are often very noticeable before this occurs.

Treatment.—In simple acute inflammation without abscess pain may be controlled by opium, with the usual treatment of an acute coryza, and leeching if there is fear of abscess. When there is evidence of the accumulation of pus, free evacuation is the only rule. An attempt may be made to reach it through the nasal outlet. If this fail, as it is apt to do, an external incision is to be made, even though it leave a scar. The cavity is washed out with disinfectant solutions and a drainage-tube inserted. If syphilis is the cause of the abscess, necrosed bone will probably be found; this must be carefully and completely removed and specific treatment must be begun.

Chronic inflammation of the frontal sinus is generally, if not always, purulent. It may be the result of repeated attacks of acute inflammation, or it may be the outcome of a single acute attack of unusual severity. Chronic inflammation of the Schneiderian membrane may involve that of the frontal sinus; also abnormal nasal conditions, as hypertrophy, a deviated septum, nasal polypi (by causing partial ob-

struction of the fronto-nasal canal), will produce a chronic inflammation of the mucosa lining the frontal sinus. Syphilis and tuberculosis, foreign bodies and tumors, are all causative factors in producing chronic purulent inflammation of this sinus.

Symptoms.—All of the symptoms and local signs of acute inflammation may be present in the chronic form, but are generally less severe, pain being rather dull and constant, with occasional remission, alternating with exacerbations. Pus is generally to be seen in the nose, but may be so small in amount as almost to escape notice. If this is the case—that is, if the discharge is not marked and constant—there is frequently an unusually large discharge, followed by a temporary quieting of all the symptoms. It is sometimes impossible to differentiate with certainty between a discharge of pus in the nose, coming from the frontal sinus, and that coming from the other accessory sinuses, and, as we have seen, it may really come from the maxillary sinus when the inflammation is in the frontal sinus. If it originates in the maxillary sinus, bending the head and wiping away the pus will stop its coming for a time; if it is from the frontal sinus, its flow will be continuous. If, on examination with a probe of the ethmoidal sinuses, there is no evidence of exposure of bone by the absorption of its mucous covering, then ethmoidal disease may safely be excluded. If the disease give evidence of having its seat well forward, sphenoidal disease may be set aside. However, all the sinuses may be involved at once, or any two or three of them. For instance, purulent inflammation originating in the frontal sinus may set up the same trouble in the antrum of Highmore, and it may finally reach the ethmoidal cells by extension from the pituitary membrane.

Treatment.—Two possible routes for evacuation present themselves—one through the natural passage, and one by external incision through the frontal bone. The difficulties are threefold in respect to the former: the opening to the passage may not be found by the probe in the hand of the surgeon, since we must find it by touch alone, illumination being out of the question; secondly, if by chance the probe engages in the proper orifice, it may be impossible to clear the passage to the sinus; lastly, there is great danger to other contiguous localities should the probe slip. So that, in spite of possible deformity, an external incision is the safer. It may be made above or below the end of the eyebrow, but preferably below, because the scar is there less noticeable. The contents of the sinus are evacuated, a probe is passed downward into the nose, and a drainage-tube inserted into the passage, through which the sinus is washed out daily. The wound is closed and dressed as in other situations. Complications and sequelæ must be met as they occur.

Mucocele and cysts have been frequently reported as found in the frontal sinus.

Foreign bodies, as bullets, splinters, and insects, have already been referred to, and in addition concretions similar to rhinoliths may form in the frontal sinus.

Tumors, both benign and malignant, are of not infrequent occurrence.

Polypi and osteomata are the most common types of the former. Both carcinomata and sarcomata are found, the latter being the more

common. Great deformity and destruction of parts from pressure are the usual sequelæ, with local and reflex symptoms of great variety and intensity as the disease develops.

Whether or not extirpation is to be attempted must be determined in each case by its own peculiar character.

Ethmoidal Sinuses.—It is by analogy rather than by demonstration that we arrive at conclusions regarding ethmoiditis. Owing to its position and the thinness of its mucosa and limiting walls it is, of all the sinuses, the most prone to acute inflammation with or without abscess, or to chronic inflammation with absorption of the mucosa and the underlying bone. But none of these are capable of demonstration. It is only when the probe strikes bare bone that we are absolutely certain of disease in this locality.

The *cause* of ethmoiditis must be chiefly in the extension of inflammation from the nasal fossæ. Diphtheritic membranes have been formed in the ethmoidal cells, and ozena probably often arises here.

The *symptoms* are, in the main, those of acute rhinitis or of frontal disease. By exclusion ethmoiditis may probably be diagnosed.

Treatment.—If the probe finds exposed bone or if by exclusion ethmoidal inflammation has been diagnosed, then the curette affords the only means of relief after removal of all polypi, hypertrophied tissue, and spurs of bone or correction of deviated septum in the nasal passages.

Sphenoidal Sinus.—**Sphenoiditis** is even more obscure and doubtful in its manifestations than ethmoidal inflammation, and is usually a complication or a sequel of the latter disease. The sphenoid sinus lies in close relation to so many important structures that it may well be implicated in lesions affecting them; on the other hand, its own injury or partial destruction would immediately be felt by the nerves and blood-vessels in its neighborhood. If it is distended with an accumulation of pus, reflex and remote symptoms are caused from the pressure.

Diagnosis is reached by exclusion. Operations may be through the mouth, the orbit (after enucleation of the eye), and the nose.

III. NEUROSES OF THE NASAL PASSAGES.

The olfactory nerve is the only one concerned in the special sense of smell, and hence any abnormalities as to smell must be due to disease of this nerve. The fifth nerve is the nerve for common sensation and touch. Either of these may be affected separately or both together.

Anosmia is the absence of smell, and strictly the term should be used to express entire abolition of the sensation. A rather loose use of it, however, permits us to speak of the impaired sensation as partial anosmia. It may be temporary or permanent, because its causes naturally fall generally into two great groups—those in which the nerve itself is injured or destroyed, and those in which obstruction in the nasal cavity prevents the exercise of its function.

Sometimes no cause can be found to account for the condition, and then it is said to be idiopathic, the real cause being constitutional or an

overlooked traumatism. It is believed that there may be inflammation or rupture of either the olfactory bulb or the nerve before it reaches the opening into the ethmoid plate or in passing through that opening, or that there may be a hemorrhage into the tissues of the bulb or the nerve within the cranium. Tumors on the distended lateral ventricles pressing upon the nerve or its roots, particularly the external root, may prevent its functional activity or even destroy the nerve. Blows upon any part of the head, since the olfactory bulbs lie on the floor of the cranium, may sever the connection with the brain. Atrophy and degeneration of the nerve are not unknown. Besides lesions within the cranium, the nerve may suffer injury within the nasal cavity. Anosmia may be caused by long-continued hyper-stimulation from powerful odors. Well-credited instances are recorded where ether has been the causative factor in producing anosmia.

Douches have been known to produce it, probably because the lotions used were too strong. Prolonged rhinitis is no doubt the commonest cause of temporary anosmia. Paralysis of the fifth nerve is said, finally, to produce it. In the main, injuries to the bulb, the nerve, or its terminal filaments will result in permanent anosmia, though of course there may be cases of temporary anosmia where the cause lies in the lesion of the nerve itself.

On the other hand, where obstruction produces the symptom it is far more apt to be only temporary, and is generally only partial.

One has only to recall the common causes of obstruction to enumerate the causes of obstructive anosmia—nasal polypi, tumors, hypertrophic rhinitis, deviated septum, crusts of inspissated mucus, acute coryza, cicatricial contraction, etc. Generally with the removal of the obstruction the power of smell is regained. Any cause also which produces dryness of the surface of the mucous membrane will interfere with smell, as moisture is essential to its exercise. Paralysis of the dilator muscles of the nose may cause temporary or permanent anosmia according to the duration of the paralysis.

Frequently anosmia is unilateral, and may thus exist without the knowledge of the patient. Plugging the other nostril is necessary then to verify the condition.

Anosmia may also be due to congenital causes, either congenital occlusion of the nasal fossæ or congenital absence of the olfactory tract.

Anosmia is frequently observed in connection with hysteria, and is then accompanied with the suspension of other sensations, as taste, all of which are believed to be of central origin.

Dr. William Ode has conducted researches to establish the fact that diminution or absence of pigment in the olfactory region impairs the sense of smell. This may be a coincidence and not a cause.

Taste is closely connected with smell. Our appreciation of flavors is really due in large measure to smell, and when this sense is dulled or absent its loss may first be noticed by the fact that well-known flavors are not recognized by the sense of taste.

Further, when the olfactory nerve is unimpaired and the anosmia is due to obstruction, the odoriferous particles may reach the nerve at times through the posterior nares.

Diagnosis rests in the obstructive cases upon examination, otherwise upon the statement of the patient, since it is a subjective symptom.

Prognosis depends upon the cause. Cases due to obstruction have the best hope of recovery; next in order are those due to rhinitis, which are almost hopeless if the rhinitis is long continued. Anosmia due to lesions in the nerve itself seldom improve.

Treatment.—Removal of the obstruction by any of the methods already detailed is usually sufficient for cases that are due to obstruction. For those due to rhinitis the treatment for that disease is all that can be given. When the nerve is diseased little can be done except to maintain generally good nutrition of the nervous system. Galvanism has been tried, but the strongest current that can be used in this locality is too weak to be of any service. Strychnin locally applied with a brush is advocated, but the danger of poisoning by this method must not be overlooked. It is better given as a tonic. If the disease is of central origin, treatment is useless. Stimulation by snuff or strong odor may be tried.

Hyperosmia or Hyperesthesia of the Olfactory Nerve.—The sense of smell may become abnormally acute. Such a condition may exist apart from disease, or it may be developed with disease or as a result of disease. Certain people have a peculiar susceptibility to certain smells, and betray no special acuteness in respect to others; others possess an unusual sensitiveness in smell while in certain states of health—as, for instance, hysterical people not infrequently lay claim to extreme sensitiveness in the perception of odors or at least of particular odors.

Closely connected with hyperosmia, and perhaps at times not to be distinguished from it, is the condition known as parosmia—a perverted or altered appreciation in regard to smell. Of such a sort is the odor so often definitely perceived by epileptics just as the seizure is felt. Probably the perception of odors by hysterical patients at times borders closely upon parosmia. Insane people often complain of odors, usually disagreeable ones. This may be imagination or it may be due to structural changes in the nerve within the cranial cavity. Tumors within the bulbs or pressing upon them or degenerations of various sorts are known certainly to cause parosmia. Such odors are usually disagreeable in themselves; but, whatever their character, if they persist they become unpleasant. Olfactory derangements, such as these last described, must result in anosmia when the obstruction is complete. Certain people seem also to have dull or perverted appreciation of odor even when the condition is far from being anosmia. Some are uncertain or indifferent as to odors, or odors widely different may seem to them just the same. Such olfactory abnormalities are not unlike color-blindness in the optic nerve.

Reflex Neuroses.—Of late years much attention has been given in medical literature to the "sensitive reflex area" in the nose, which either by pathological conditions within the nose or by irritants from without, is so stimulated as to produce effects in remote parts of the body. Its location is at the posterior end of the middle and inferior turbinated bones, and somewhat upon the septum opposite these parts.

The normal intent evidently of such an area is to protect the air-

passages against the intrusion of unsuitable substances. It is only when the sensitiveness of this area exceeds the normal that the remote effects of neuralgia, photophobic nausea, etc. are felt from its stimulation. On the other hand, atrophy of the mucosa in this region destroys the reflex sensitiveness. Cocain, locally applied, destroys temporarily all manifestations of reflex irritability.

Some of the conclusions based upon the existence of this area have "proved too much," and a conservative attitude may well be maintained until their importance and influence are established by further investigation and experiment.

The fifth nerve may become paralyzed, leading to loss of sensation in the Schneiderian membrane, or it may become hyperesthetic and lead to violent and prolonged sneezing, which is usually unimportant, but may lead to hemorrhage.

IV. THE LARYNX.

Laryngoscopy is the inspection of the interior of the larynx. The discovery that this portion of the body can be brought into view for study and treatment is of comparatively recent date, and marked a decided advance in the methods of treating throat-diseases.

Mirrors have long been employed for inspecting such parts of the teeth as the dentist cannot readily see. Manuel Garcia, a singing-master of London, employed such a mirror to make investigations as to the structure of the larynx. His researches and experiments, however, went no farther than to establish the fact that phonation depends upon the true vocal cords. But just as Garcia had employed the instrument of the dentist to establish new facts regarding his own profession, so Czermak of Pesth, taking up his investigations where Garcia had stopped, added a new specialty to medical surgery by the use of artificial light reflected from a concave mirror upon the mirror in the throat to produce an image of the larynx.

Laryngoscopic mirrors are made in sizes varying from three-eighths of an inch to an inch and an eighth in diameter. They must be attached to a firm, slender handle at an angle of 135°. Those of about an inch are used for adults; smaller ones are employed for children and for adults with unusually narrow fauces.

Any convenient light, direct or reflected, may be used for illumination, and here sunlight is really the best, although a gas-light or electric or oil light serves excellently well if carefully adjusted at the proper angle and falling over the right shoulder of the patient.

Concentrators are not necessary if the light itself is really brilliant.

The head reflecting mirror has a central perforation, and is mounted on the head by a band or a spectacle frame and should move freely in all planes. It need not be more than three or four inches in diameter.

Instead of the head-mirror, one attached to the lamp- or gas-fixture may be used, as in Tobold's laryngoscope (Fig. 259), and for many purposes this is simpler and easier to adjust, but the practitioner should be master of both methods, that his services may be available away from his office.

When the light is adjusted the patient opens his mouth as widely as possible, extends his tongue, and keeps it in that position by holding it

with a handkerchief in his hand. The surgeon, having previously warmed the laryngoscopic mirror, takes it in his hand much as he would hold a pen, the handle pointing downward and outward. With the reflecting surface outward he carries it back over the dorsum of the tongue until it strikes the uvula. This is pushed backward by the mirror, the lower edge of which should touch the pharynx, and all of it be plainly in view, its surface at an angle of 90° with the line of vision. Practice only makes these manœuvers both quick and firm enough to prevent gagging on the part of the patient, and they should be supplemented by most intimate knowledge of the regional anatomy of the parts and of their normal appearance. Cocain may be applied if there is hypersensitiveness of the parts. Study of the normal throat in living subjects and of the larynx removed from the cadaver, both

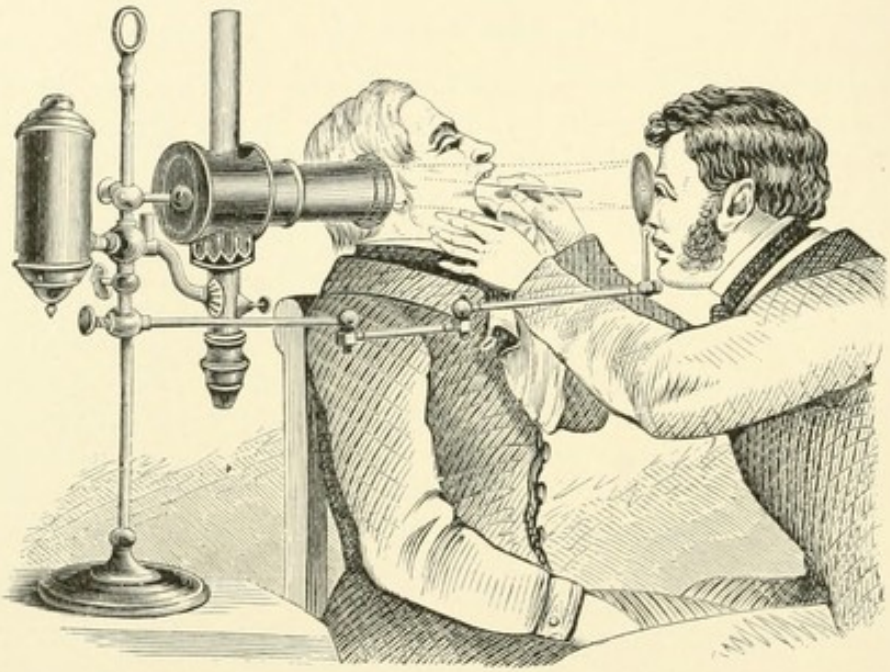


FIG. 259.—Tobold's large laryngoscope and student's lamp.

directly and with the laryngoscopic mirror, is the only method of preparation for such work.

An artificial light gives to the parts of the larynx a deeper color than normal.

A little care is necessary on the part of the beginner in the laryngoscopic art to appreciate the correct relations of the image presented to him, for he sees in a nearly vertical plane what he has been accustomed to think of as a horizontal plane, and with the anterior and posterior portions seemingly reversed. This reversal in a normal throat should be of no moment whatever. With neoplasms or other disease invading the larynx a moment's reflection will assure the observer of its real position.

In the normal larynx the mucous membrane is of about the same color as in other parts of the body. Where the cartilage, which in this region is fibro-cartilage, shows through, it gives a yellow tinge to the overlying mucous membrane. On the other hand, it appears a deeper

red than in most of its extent when it overlies glandular tissue. Also the parts best illuminated, those that are farthest forward in the laryngoscopic image, "the high lights," will appear the lightest in tone, while those that are deepest will assume a darker hue.

Repeated examinations will acquaint the observer with the normal appearance as a whole as seen either by sunlight or artificial light, and he will be quick to observe any departure from this condition as indicative of disease.

No one position of the throat-mirror will suffice to reveal all portions that become visible in the successive positions, and the instrument must be moved slightly to present the best possible views.

The first thing to be noted in the laryngoscopic image is the epiglottis. Behind and above this is visible a portion of the base of the tongue. At the lowest part of the arch of the epiglottis on each side are the lingual fossæ, separated by the middle glosso-epiglottic ligament and bounded externally by lateral ligaments of the same name. A view of the lingual face of the epiglottis shows these three ligaments or folds of mucous membrane passing from above downward, connecting the tongue with the epiglottis. On the laryngeal face of the epiglottis is seen the cushion of the epiglottis, a rounded portion some-

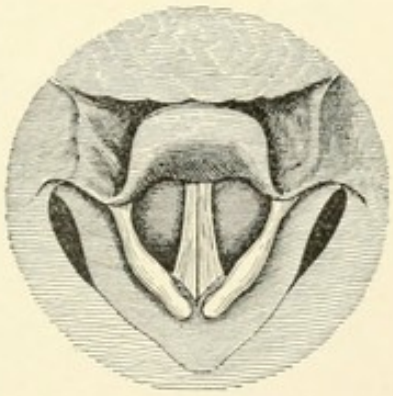


FIG. 260.—The laryngeal image during phonation.

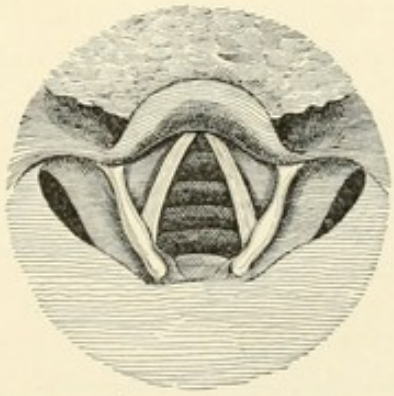


FIG. 261.—The laryngeal image during inspiration.

what higher than the rest; at about the center of the face we also see the posterior portion of the anterior palatine folds, and also the posterior palatine folds, the ligaments attaching the tongue to the hyoid bone, and those connecting the epiglottis to the same bone and the posterior and lateral portions of the tonsils. All the parts so far mentioned are really exterior to the larynx proper, but incidentally come into view as the mirror is placed in position for inspection of the larynx, and are not visible by direct inspection.

Within the larynx are to be inspected the parts at the level of the vocal cords and a variable portion of the walls of the larynx and trachea below that plane.

Most distinctively in the center of the laryngoscopic image are seen two white glistening bands, the true vocal cords. They may serve as landmarks from which other parts are located on either side. During the act of phonation they are approximated closely, and it is then impossible to view the parts below (Fig. 260). During inspiration the

vocal cords are widely separated, and it is during this interval that the parts in the lower part of the larynx and upper part of the trachea must be inspected (Fig. 261). The rima glottidis is thus seen to vary in extent from a mere line in phonation to an opening of relatively large dimensions during respiration.

Immediately external to the true vocal cords on either side are to be seen the ventricular bands or false vocal cords, the entrance to the ventricular looking like a dark band next to the true vocal cords. External to the ventricular bands and somewhat posterior to them are the arytenoid cartilages. They nearly meet behind the vocal cords when the latter are approximated, but are shorter and farther apart during inspiration. Between the posterior ends of the arytenoid cartilages lies the arytenoid commissure.

Forming the lateral walls of the larynx and merging into the arytenoid commissure are the aryepiglottic folds, ridges of mucous membrane that arise from the lateral border of the base of the epiglottis. Lying upon the arytenoid cartilages can sometimes be made out the cartilages of Santorini. The "staff of Wrisberg" is also observed, and the vocal processes during respiration. On either side of the aryepiglottic folds are seen, darkly shaded in the image, the laryngopharyngeal sinuses.

During inspiration the infraglottic portions of the larynx are inspected, showing the mucous surfaces of the cartilages forming the larynx, the cartilaginous ring of the trachea, and, in exceptional cases, its bifurcation into the bronchial tubes.

Such is the normal appearance of the human larynx. The surgeon will find in studying lesions of the larynx alterations in either its mucous membranes or its shape, injuries or neoplasms.

Injuries of the Larynx.—These are produced by the operation of internal or external causes, the former chiefly by foreign bodies within the larynx, by burns or scalds; the latter in a great variety of ways, accidental or intentional.

Internal injuries may also result from intra-laryngeal operations unskilfully performed, also from substances vomited, especially in the case of the insane and of patients under anesthesia.

Internal injuries caused by the entrance of foreign bodies into the larynx are very common, and vary greatly in the severity of the lesion and the urgency of the symptoms, since the number of different objects that may find their way into the larynx is wellnigh innumerable. To attempt to make a list of the objects that have entered or may be found in that cavity is useless, for any object that may be placed in the mouth, thoughtlessly or otherwise, may slip past the fauces and find lodgement in the larynx. The student can enumerate them for himself, placing as most common those objects which children especially are apt to have in their hands, as toys, or can most easily obtain from their surroundings.

The closing of the passage may be so complete as to prove fatal almost immediately, or the object may be such as to remain concealed in the mucous membrane and excite an extreme or only a slight degree of congestion or inflammation. Objects may reach the interior of the larynx also from without, as bullets or the detached fragments of sharp-pointed weapons or instruments. Internal wounds may be

punctured, lacerated, or contused. The foreign bodies may be quite accessible, or may be so deeply buried in the tissues, either from the mode of entrance or from subsequent swelling of the parts, as to make it almost impossible to locate them. Even when there is no real wound of the laryngeal mucous membrane there may be spasm of the glottis, and respiration be so interfered with that the results are fatal. Symptoms of pronounced character may be wanting, and from such a negative condition there are symptoms of varying severity up to those of great intensity. Pain, cough, laryngeal and pharyngeal neuroses, spitting of blood, extravasation of blood into underlying connective tissue, and severe inflammation of mucous membrane are the usual symptoms in cases of this sort.

On evidence of laryngeal irritation, whether the history of the entrance of a foreign body can be obtained or not, a laryngoscopic examination should be made. If the foreign body is visible, it is generally easily removed. If it is concealed by tumefaction of the tissues, measures must be taken to reduce the swelling by the use of astringents and local sedatives. In cases where its presence is undoubted, but it is too low to be demonstrated, tracheotomy may be performed, and this operation may be necessary if the bleeding has been so considerable as to cause an obstruction in itself.

Burns and *scalds* of the larynx usually are accompanied by similar lesions of the tongue, mouth, throat, pharynx, esophagus, and even of the nasal passages. Burns are produced by the inhalation of steam, hot air, and smoke during fires. Scalds are due to hot and caustic fluids, swallowed usually without design.

When it is intended to swallow such fluids, they quickly pass the epiglottis ; when not, the instinctive effort to arrest deglutition throws them back upon the larynx, which often then suffers the most of any of the structures exposed to the action of the fluid. Acute laryngitis of an intensely severe type immediately follows, and usually implicates not the mucous membrane alone, but the underlying tissues, the extent of such involvement depending upon the degree of heat and the concentration of the fluid. Edema of the larynx is an almost constant attendant of such lesions, and constitutes one of the chief dangers.

Burns and scalds produced by hot water, air, and steam assert themselves at once, while the destructive effects of many caustics are less prompt. Pain of an agonizing character is the most distinctive symptom.

If life be not at once sacrificed, sloughing of necrosed tissue will be followed by cicatricial contraction, which in itself may later present problems of no small difficulty to the surgeon.

If suffocation is imminent, tracheotomy should be immediately performed, and morphin injected subcutaneously to relieve the intense suffering. Cooling and soothing washes may be used both upon the larynx and accompanying lesions of the mouth, nose, and throat ; but the outlook is very bad at best in severe cases of this sort. Such cases are commonly the attempts of the insane or of the sane would-be suicides, and the condition is concealed as long as possible, thus losing the advantage of prompt assistance. Too much stress cannot be laid upon the imminent danger of edema of the larynx, whatever the cause

or nature or severity of the injury. It has been known to occur even when the offending substance entered the larynx during the act of vomiting.

If the outlook is fairly favorable for recovery, it is altered for the worse if at any time suppuration supervene.

External injuries of the larynx are caused in many ways, either intentionally or accidentally. In battle the larynx seems to sustain relatively few injuries, and blows, whether accidental or designed and however aimed, seem more often to fall upon the back or side of the neck than upon the front part. Attempts at homicide or suicide afford the largest number of external injuries of the larynx. They are contused, punctured, lacerated, incised, and gunshot wounds. Contused wounds from accident or design, and incised wounds made with the intent to take life, greatly exceed all others in number. From this cause, as well as clinically, fractures of the larynx may be regarded as a species of contused wound, since, although injury may be very slight, it may be so considerable as to fracture a cartilage, generally the cricoid or the thyroid (without interruption to the continuity of the integument). Rupture of muscles and ligaments or of the vocal cords, dislocation of other cartilages, fracture of the hyoid bone, and injuries to the trachea similar to those of the larynx may all be associated with fracture of the larynx. Kicks from animals, falls, blows with the fist or weapons, may be the cause of such injuries. The greater number of them, however, are produced by attempts at strangulation by the hands of an assailant or by homicidal or suicidal attempts with rope or strap or improvised cord.

Extravasations of blood into the tissues beneath the integument are usually associated with injuries to the larynx.

Punctured wounds, even in battle, are rare. In civil life they result from accident, generally by falling upon sharp-pointed sticks or portions of machinery.

The same may be said of lacerated wounds. Their cause, aside from gunshot wounds, is the crushing force of some jagged instrument, as broken glass or crockery or the cog-wheels or other portions of machinery.

Incised wounds of the larynx outnumber all other varieties put together, because a "cut-throat" seems to the ordinary murderer or suicide to offer so ready a means of putting an end to life. Yet the fact that the case so often falls into the surgeon's hands before it reaches the undertaker's shows that a miscalculation is made somewhere. A much neater piece of work from a chirurgical point of view would be the severance of the large vessels of the neck, and much more certain and effective from the standpoint of the original operator if he were not too ignorant to appreciate what he is missing in every sense of the word. The would-be suicide stretches back his throat and makes a gash from left to right generally, and if the knife goes in deeply enough he may injure all structures from integument to pharynx; he may sever the epiglottis at any place between its free border and its attachment at the angle of the thyroid cartilages; he may cut the vocal cords or any of the cartilages of the larynx, gash the thyroid gland and tongue, injure the hyoid bone, or he may cut low down, and, ex-

pending the force of his blows on the trachea, the larynx may escape almost or wholly uninjured. The gash is generally a long one, and retracts greatly, and yet with such injuries as those mentioned it is not necessarily fatal. The sterno-cleido-mastoid muscles are advanced and lie over the large blood-vessels of the neck, so that the latter escape. There may be considerable hemorrhage from smaller vessels, and if this find its way into the trachea, it may cause suffocation. If there is much hacking of the cartilages, portions may fall into or over the trachea in such a way as to obstruct respiration completely.

Gunshot wounds of the larynx, either from bullets or bits of shell, are uncommon except in the army during battles. The relative infrequency of such injuries in military service is a matter of remark. They make up the greater number of lacerated wounds, although they may cause a contused wound, depending somewhat upon the force of the missile. The comparative immunity of the larynx from injury when it is apparently not less exposed than other parts of the body is no doubt largely due to the resiliency of its cartilages, so that a ball striking it is deflected.

Symptoms.—The symptoms of injuries to the larynx from external causes are usually self-evident, the only exception being in some contused wounds. In such cases the bruise will be suggestive. If, in addition, there are pain and tenderness on pressure or in deglutition, dyspnea, cough, bloody expectoration, retraction of muscles, nervous manifestations, swelling of the integument, the symptoms are certainly characteristic and make the diagnosis very clear. Laryngoscopic examination may reveal tumefied and reddened or lacerated tissues or ruptured structures.

In punctured wounds, besides the external appearances, emphysema is common, and threatened suffocation the rule from the emphysema and the presence of blood in the larynx and trachea.

Incised Wounds.—Most prominent and important of all the symptoms is the wound itself, and the other symptoms depend largely upon its extent. If it is small, the hemorrhage may be less than when it is large, but more dangerous from the fact that in such a case it is more apt to find its way into the trachea and cause suffocation. In any case, even if the large vessels are not implicated, hemorrhage is apt to be an important symptom and an important factor in the prognosis, for the blood-supply is large here, and, either from the primary or the secondary hemorrhage, suffocation is imminent.

Fragments of tissue also may occlude the trachea dangerously or fatally.

The patient is weak from loss of blood, may suffer extreme thirst, and lose his voice from injury to the vocal cords or from gaping of the wound. If the pharynx is involved, swallowing may be difficult or impossible. There may be distressing cough from the blood in the trachea, and the mental and physical distress which always attends dyspnea is present. Emphysema is common. Fluids swallowed may escape through the incision. There is great pain, usually with great tenderness of surrounding parts.

Gunshot wounds may be attended by any or all of the symptoms

characteristic of other wounds, and, in addition, are most apt to be followed by neuroses of one sort or another.

In all wounds of the larynx a secondary hemorrhage which may quickly cause suffocation is to be feared after the closure of the external wound.

Diagnosis is based upon the wound and resultant symptoms.

Prognosis must be guarded, although it is not wholly unfavorable. Sometimes with small contused or gunshot wounds the shock is greater than with large incised wounds, and, on the whole, the latter, even though extensive, promise the best as to recovery.

If the patient survive both primary and secondary hemorrhages, the system may finally yield to the shock and depletion, or suppuration may supervene at a later date in the wound itself or in the air-passages. Pneumonia is a frequent result of the entrance of blood and other extraneous substances into the air-passages.

So much of injured tissue may eventually slough as will bring about a fatal issue by causing septic infection or by reopening the wound.

Finally, after the healing of the wound, gaps and fissures may remain; the function of the parts may never be fully restored; and cicatricial contraction may go on to such an extent as to endanger life by stenosis. If there is not cicatricial contraction, the cartilages may be enlarged and distorted by the healing process until the function is greatly impaired.

Treatment.—In most severe cases of injury to the larynx after removal of extraneous substances from the trachea, tracheotomy is the first step in treatment, because suffocation is imminent, either immediately or when tumefaction of the tissues shall have begun, or when secondary hemorrhage shall have set in after recovery from syncope. Even in wounds of comparatively slight importance the surgeon will save himself all possibility of unpleasant future complications if tracheotomy be performed as a prophylactic measure in a course of treatment that, under favorable circumstances, is certain to be long and tedious.

The next step is the stopping of hemorrhage. If large vessels—either of the thyroids, for instance—have been severed, they should be ligatured; compression and the application of cold may be of service, or the local application of astringents.

Hemostatics may be given internally. If hemorrhage prove obstinate, it may be necessary to ligature the carotid. The strength of the patient must be maintained by prompt stimulation either hypodermically or per rectum.

With these preliminaries disposed of, the surgeon must as speedily as possible give his attention to the condition of the wound itself. He must study it that he may determine his method of procedure before the tissues are distorted by swelling, and also that he may remove any fragments that cannot be saved, lest they in some way occlude the air-passages. If the tongue is severed, the parts should be sutured to prevent the posterior portion from falling back upon the larynx.

It is seldom of any avail to attempt to suture the cartilages, not

even portions of the epiglottis uniting kindly. If the wound is laterally extensive, some sutures may be placed through the soft parts at its extremities. If the wound were entirely closed, there would be great danger from suffocation from secondary hemorrhage, and emphysema is much less easily controlled if the wound is sutured in its entire extent.

If the wound is not extensive, sutures may be entirely dispensed with. The edges of the wound are coapted and held in position by strips of adhesive plaster. The position of the patient is important. He must be so placed in a semi-reclining position that the head inclines enough to favor close juxtaposition of the edges of the wound without their overlapping. The head is then held immovable by bandages skilfully applied over the head and fastened to a band under the arms or around the waist. Rather loose antiseptic dressings should be placed over the wound, and frequently inspected that exudations may be promptly wiped away. If suppuration occur, its treatment is the same as in other wounds.

Unless the pharynx has been wounded also, there is generally little difficulty in feeding the patient. If, however, for any reason, the wound is distended in taking food, the surgeon must be equal to the emergency by placing tubes in throat or nostrils or by providing for rectal alimentation.

There is generally a tendency to cough from the presence of blood or other liquids or excessive secretions due to the irritation. This must be repressed by the administration of codeine or opium.

Sometimes, especially if there is no tearing open of the wound, there may be little cicatrization. Occasionally fistulous openings remain, which always must be covered, both for appearances and to preserve the function of phonation, or a plastic operation may be done to fill the breach.

If stenosis of the trachea or larynx result from cicatricial contraction, it is best corrected by gradual dilation, though persistent efforts in this direction are sometimes wholly fruitless.

Foreign Bodies in the Air-passages.—No accident is more common than the entrance of some substance into the air-passages. It may occur during the act of swallowing, when for some reason the epiglottis has failed to close normally, or if something is being held in the mouth, a careless habit in which no one should indulge, and to which children are especially prone, a sudden inspiration may carry it into the larynx, where it may remain or pass on into the trachea. During dental operations or those upon the mouth and throat foreign substances like a fragment of tooth, the cork or bit of wood which has been used as a gag to keep the teeth apart, bits of sponge, or fluid may find their way into the windpipe. Emesis, especially during anesthesia, may provide the substance that enters the air-tube. Artificial teeth have an uncomfortable habit of traveling backward, especially during sleep. A bronchial gland or large masses of mucus or quantities of blood may be coughed up and occlude the trachea or larynx from below. Foreign bodies may enter by perforating the external wall, as bullets in gunshot wounds. They may also work their way in from the interior parts of the body by pene-

trating the tracheal wall, as, for instance, from the esophagus. Foreign bodies may also enter the air-passages through wounds previously sustained.

In most cases reflex cough or spasm is at once excited; the substance is expelled almost before it has found lodgement, and the affair is forgotten. In others vigorous slapping upon the back, or at most inversion of the patient with slapping, brings to a happy termination the slight struggle for breath and the choking sensation.

In others the foreign body is not expelled, and the annoyance and discomfort from its presence are slight and transient. In others distressing symptoms occur at intervals. In still others severe laryngitis, even of a suppurative form, asserts itself with more or less rapidity. In others there is immediate distressing dyspnea and the services of the surgeon are in urgent demand. In still others the occlusion is so complete that a fatal termination is immediate, and that under circumstances most painful and agonizing.

Organic materials are apt to undergo changes, even decomposition. Seeds, for instance, may increase in size from absorption of moisture if long retained in the air-passages. Inorganic substances may become almost encysted, so covered are they with secretions and calcareous deposits. Those of smooth outline and small size may remain indefinitely without serious discomfort, but never without danger from possible change of position.

Symptoms.—Symptoms may be almost or wholly negative, or they may remain in abeyance until the irritation has induced a laryngitis which is obstinately prolonged. Generally, however, there is spasm of the glottis, spasmodic cough, pain, and change of color, the face becoming at first crimson and then purple. The eyes may protrude, and the countenance express the utmost anxiety and distress. The patient throws himself about and tears at his throat. This may be followed by unconsciousness, from which he may recover or which merges into death, or the spasm may pass and an almost or a quite normal state be regained. Only one paroxysm may ensue, or the first may be succeeded by others at regular or irregular intervals. Even when the initial symptoms are comparatively slight a change of location of the intruding body may suddenly precipitate secondary spasms of great severity. There may be dysphagia from pressure on the esophagus. Local pain usually indicates where the foreign body has lodged, cough is common if it is in the trachea or bronchus, and hoarseness or aphonia will follow its lodgement in the larynx.

Severe lesions of the lungs may either be simulated or actually exist as a result of the introduction of foreign bodies into the air-passages, according to the nature and location of the offending matter.

Diagnosis.—With a history of the intrusion of a foreign body into the air-passages diagnosis is a matter of no difficulty. Where such a history is not forthcoming and laryngoscopic examination reveals nothing, the diagnosis is exceedingly difficult. If the body is of hard material, the probe may reveal its presence, but not necessarily. Auscultation will assist to some extent. If a tube be largely but not wholly occluded, a sonorous râle will be betrayed. If it is wholly occluded, respiratory murmur will be wanting. Unilateral bronchitis should

always suggest the presence of a foreign body in the lower air-passages. Difficult respiration will suggest that rather than disease.

Prognosis.—This is always grave. Even if the comfort of the patient is not seriously interfered with, there is always danger in change of location and in the possibility of the lighting up of an acute inflammation or in the supervention of edema. The substance may be expelled spontaneously, but if its presence is unquestionable, no risks should be taken; it should be removed. After spontaneous expulsion recovery is usually complete, but death has resulted from the inflammation set up before its expulsion.

Treatment.—If the symptoms are not imperative, slapping upon the back and inversion are naturally first tried.

Removal by the natural orifice is desirable if possible. If the object can be located by the laryngoscope, it may then generally be removed by the finger or by slender forceps suitably curved. Cusco's laryngeal forceps are a most excellent instrument. Flexible forceps may be bent at the desired angle (Fig. 262).

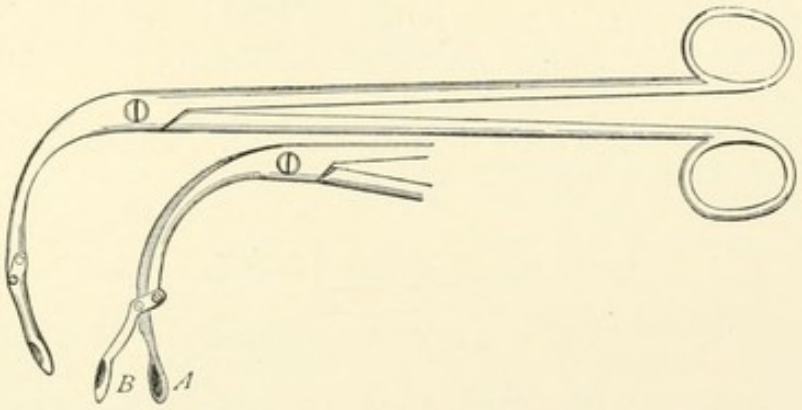


FIG. 262.—Cusco's laryngeal forceps.

Substances of irregular, jagged shape must be very carefully manipulated in order not to tear the tissues during their removal, and such as can be so treated should be crushed, as nutshells, and removed piecemeal or coughed up.

If none of these expedients succeed, tracheotomy must be performed, and sometimes it should be done as a precautionary measure, lest in efforts to remove the object through the larynx it assume such position as to occlude the larynx or trachea completely.

Whether the operation should be above the thyroid gland, through it, or below it depends upon the shape, position, and size of the object, and upon the shape of the neck to be operated upon. Unless it is absolutely certain that the foreign body lies high, the low operation is to be chosen, for there is more space here than above the glands for operating, and the gland is so very vascular as to make it desirable to avoid wounding it if possible. However, if the incision must go through the gland, the isthmus should be ligatured twice and cut between the ligatures. The edges of the wound must be retracted, and an improvised retractor will serve very well, though good instruments are made for the purpose (Fig. 263). The incision should be an inch or an inch and a quarter in length. Ordinarily, if the object is

in the trachea or bronchial tubes, it at once presents itself at the opening, is spontaneously expelled, or can be easily removed by the surgeon. Slapping upon the back and inversion will remove more obstinately retained objects. The surgeon may blow or force air into the opening, and the expiration of this condensed air will usually force out the object. Search may have to be made for it. It is rare, indeed, that tracheotomy does not succeed; if not at first, then after the inflamma-

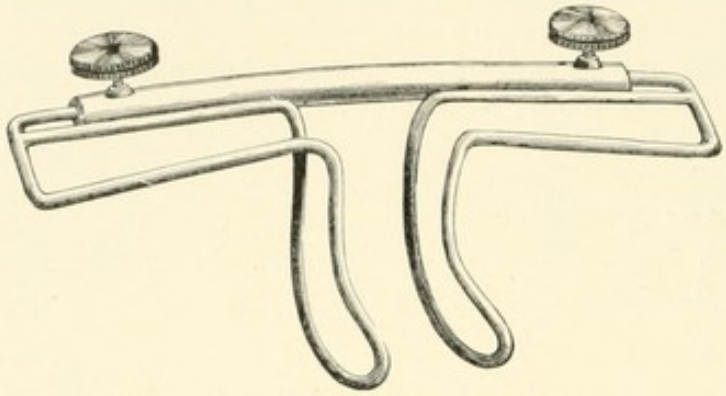


FIG. 263.—Minor's trachea-retractors.

tion of the tissues has had time to subside. The ingenuity of the surgeon will usually overcome all difficulties.

Diseases of the Larynx.

Laryngitis.—Catarrhal.—Acute laryngitis usually involves the whole larynx, but it is not uncommon to find the disease limited to one or several parts, constituting the circumscribed variety. Thus the vocal cords alone might suffer, but commonly a cause sufficient to affect them would implicate also the contiguous portions of the mucous membrane. It may be primary or secondary—*i. e.* it may be due to extension from the trachea, naso-pharynx, mouth, or tongue. The commonest cause when it is primary is exposure to cold or dampness. Other causes are overstrain of the larynx in talking or singing, inhalation of irritating vapors, dust, or smoke, and traumatism either from internal or external injuries.

It is also caused by certain drugs, as iodin and mercury, and by constitutional diseases in which the system suffers greatly, as the exanthemata, gout, rheumatism, pyemia, and erysipelas.

On laryngoscopic examination the mucous membrane appears red and swollen, with patches of mucus here and there, which at first sight may look like pus. These patches appear particularly upon the vocal cords. In simple acute catarrhal laryngitis the secretion is not pus. The microscope is therefore useful to settle the diagnosis. Inflammation is bilateral. The congested membrane tends to occlude the passage and so interfere with respiration.

The ordinary form of laryngitis is not a protracted disease, two weeks being rather an extreme limit and it may last only a few hours. The circumscribed form may be only temporary or may merge into the chronic form of laryngitis.

The *symptoms* vary from scarcely perceptible uneasiness to extreme pain, cough, hoarseness or aphonia, difficult deglutition, dyspnea, and fever.

If only the larynx is invaded, none of these symptoms, as a rule, are severe, but many times other portions of the respiratory tract are also inflamed, and the aggregate symptoms produce a disease of great severity.

Diagnosis may be determined with tolerable accuracy from the symptoms. If they are at all persistent, a laryngoscopic examination should be made to exclude other graver diseases whose early symptoms do not differ noticeably from those of acute catarrhal laryngitis.

Prognosis.—The prognosis in simple, uncomplicated acute laryngitis is good. There is no danger of extension to other parts of the respiratory tract. Repeated attacks at frequent intervals may predispose to the habit or lead to chronic laryngitis. When the disease accompanies a constitutional dyscrasia, it is then a local manifestation of a constitutional disorder, and the prognosis depends upon that of the disease. When due to traumatism it depends upon the severity and extent of the lesion caused by the traumatic injury. A circumscribed laryngitis has, on the whole, a less hopeful prognosis than the diffused form.

Treatment.—Mild purgative hepatic stimulation and restricted diet constitute a sufficient constitutional treatment for most cases, since many recover without any medical treatment whatever. External applications of cold or leeches just above the sternum may serve to diminish the inflammation. Mercuric chlorid is an excellent drug in this affection. Inhalations of steam charged with astringent and healing solutions, as balsam of tolu, balsam of Peru, oil of pine, oil of tar, tincture of benzoin, etc., are excellent local remedies. Applications of astringents with brush or swab are apt to be made with some rudeness and consequent injury to the mucous membrane. They should be made with the hand-atomizer instead, as rough treatment may bring on an edema.

Internal remedies, such as are found in the form of troches, are of benefit, not because of their local healing powers, but because of their constitutional stimulation of the secretory function. Aconite may be used for the fever.

The large majority of cases of laryngitis that come under the physician's care are those of the public speakers and singers whose voices, having failed temporarily from over-use or strain, must nevertheless be put into good condition as soon as possible. Rest and confinement to the house, absolute discontinuance of the use of the voice even in conversation, and faithful continuance of the treatment outlined above, will effect the speedy cure hoped for.

Bosworth believes that many cases of so-called acute laryngitis are really the lighting up of an exciting chronic inflammation, a sequence of repeated attacks of acute rhinitis or of naso-pharyngeal catarrhal inflammation. Accordingly, he would treat such inflammations as an antecedent measure and also while treating the laryngitis proper. He advocates the rather free use of cocain in this connection.

Acute Infantile Laryngitis.—In children the mucous mem-

brane, both above and below the glottis, is more vascular and sensitive than is the case with adults, and also more richly supplied with glandular tissue. It is of smaller caliber also, so that tumefaction of the mucous membrane more readily leads to stenosis.

Inflammation above the glottis is similar to that of adults, except that there is a greater intensity of symptoms, as might be expected from the anatomical differences just noted.

Quiet, warmth, restricted diet, and the same line of treatment as indicated for adults, modified to suit the age of the little patient and the severity of the symptoms, is all that is needed, for, though at times alarming, the inflammation above the glottis, if it extend no farther, is rarely dangerous.

Below the glottis, however, inflammation takes on a more serious aspect. Here lymph-glands are numerous, far more so relatively than in adults, and in some there is a special tendency to enlargement of those structures. Exposure to cold aggravates this tendency, and we have the quickly supervening phenomena of "croup." In some adults there lingers, long after the period of childhood is passed, a croupous tendency, only explicable by the fact that subglottic lymphatic tissue is relatively abundant, especially sensitive, and subjective to inflammatory changes. Dr. Francke H. Bosworth maintains that in children who are subject to attacks of "croup" there is a chronic inflammation of this lymphatic tissue, and that when there is exposure to cold or damp it takes only a brief time for this chronic inflammation to change to an acute form of great severity. The tissues become greatly swollen and tend to occlude the upper air-passages, hence respiration is greatly interfered with.

Symptoms.—Paroxysmal attacks come on usually at night, in which a severe, high-pitched barking cough and a peculiar stridulous inspiration are the characteristic features. There may be aphonia, and yet the "croupy" cough due to the irritation of the swollen, turgid membrane just beneath the glottis may be present. There are fever, flushed face, restlessness, pain, and distress in the throat, at which the child clutches during the spasms.

During the day there may be almost entire remission of the symptoms, but the voice becomes hoarse toward night, and there is an occasional barking cough which is suggestive of the paroxysm that will occur during the night.

The presence of accumulated mucus, still further filling up the clearly narrowed lumen of the larynx, probably explains the nocturnal exacerbation of the symptoms. As the disease progresses secretion is more abundant than at first, and the raising and expectoration of this mucus seems temporarily to mitigate the symptom. Suffocation, though always seemingly impending, rarely occurs, and when the disease is fatal there are complications from bronchitis or pneumonia as a rule.

The disease runs its course in from three or four days to two weeks. In the cold damp days of spring and autumn, especially when children are allowed to play out of doors, have wet feet, or wear damp clothing, recurrent attacks may be expected.

A laryngoscopic examination, though difficult in the case of children,

should be insisted upon. The disease must be differentiated from membranous croup and diphtheria. In the early stages it is at times difficult. In diphtheria there is a membrane in the fauces and generally marked constitutional symptoms. In membranous croup the progress of the disease is slower and dyspnea is not so marked at first. Constitutional symptoms are also less marked.

Treatment.—As a prophylactic measure a child who betrays a predisposition to this disorder should not be exposed to extremes of temperature nor to sudden changes, nor be allowed to remain in damp clothing, nor to breathe damp air. The feet should be kept warm and dry. Attention should be given to the general health, and a plain, nourishing diet should be the only one tolerated.

The bowels should be made to move freely. Calomel or hydrargyrum cum creta, as in other forms of laryngitis, seems of especial benefit.

To control spasms antispasmodics may be administered internally, and hot water should be freely used externally in the forms of fomentations upon the throat, and as baths into which the child should be placed at intervals of four hours.

Inhalations of chloroform or of amyl nitrite or of ether may be necessary when prompt action is desirable during a severe spasm. Astringent sprays, applied with the atomizer, should be used at intervals, especially during the day, when the child is more tractable owing to the absence of the paroxysms.

Inhalations of steam impregnated with healing and sedative drugs have a good effect, and for a like reason the atmosphere of the room should be kept moist.

Sometimes emesis is of avail in relieving the larynx, but it is not necessary to administer emetics for this purpose. Tickling the fauces will accomplish the same result and not charge the stomach with drugs. Cough-medicines and sleeping-potions should be avoided if possible, so that the stomach may not be overtaxed. Muriate of ammonia favors secretion, and may be given with that end in view. If respiration is seen to become more difficult, a soft catheter may be inserted. If suffocation seems imminent, intubation or tracheotomy is indicated, but is rarely necessary in an uncomplicated case of even severe subglottic laryngitis.

Chronic Laryngitis.—**Chronic Catarrhal Laryngitis.**—Cases arise which cannot be traced to extension from other structures or to acute attacks of laryngitis. Such may be called primary or idiopathic. Most cases of chronic catarrhal laryngitis are secondary in their etiology, coming from extension of inflammation from the nose or naso-pharynx. Many forms of rhinitis compel the patient to breathe through the mouth, and the air, being damp, cold, and unpurified by not passing through the nasal chambers, acts as an irritant to the laryngeal mucous membrane. Possibly exposure to dust and impure air, improper use of the voice in speaking or singing, or the continuous use of alcohol and tobacco may cause a primary chronic catarrhal laryngitis, and in such cases as cannot be traced to the extension from the upper tract the cause must be found in such conditions or in a dyscrasia. This disease is more common in males than in females, in adults than in

children. The mucous membrane is thickened, with dilated blood-vessels and hyperplasia of tissue. Sometimes the muciparous glands seem to be chiefly involved, though it is doubtful if inflammation of chronic character in mucous membrane is ever confined to them alone. When they are largely involved secretion is excessive and accompanied by desquamation of epithelial elements. Erosions are the exception.

Symptoms.—Noticeable among the symptoms is the altered quality of voice. At first or in mild cases this betrays itself only on prolonged use of the voice or in the effort to sing. When singing is attempted the patient is unable to sing either clearly or to reach the higher notes with the accustomed ease, if at all. Later, hoarseness is continually present. The voice has a more strident quality in the morning, becomes clearer as the nocturnal secretion of mucus is raised, but if much used may give out entirely, and the patient then suffers from temporary aphonia, and there are pain and an "aching" sensation if, forgetting his temporary disability, he attempts to make himself heard. There is some cough and a general feeling of uneasiness and discomfort which the patient attempts to relieve by "clearing the throat." In ordinary chronic catarrhal laryngitis there is no pain, or only transient pain, and little secretion, unless an acute attack supervenes upon the chronic condition or there is accompanying bronchitis.

Diagnosis.—Since the disorder usually comes on gradually and asserts itself somewhat strongly at times, only to be followed by apparent improvement, and finally to settle down into a well-marked chronic disease, the patient is generally able to diagnose his own condition fairly well. With the symptoms detailed and a laryngoscopic examination the diagnosis is clear.

Prognosis.—This is good as to life; as to continuance, it is dependent upon the cause. If due to extension from the nose, or naso-pharynx, no cure can be expected until the morbid condition in these localities is corrected, and treatment should be directed to that end. If the disease is idiopathic, both topical applications and constitutional remedies are needed; certainly the latter when it is suspected that the cause is some fault in the constitution.

It is a disease of indefinite duration, and rarely if ever is spontaneously cured. If not directly causative of neoplasms, it certainly paves the way for their development and furnishes a favorable soil for their incipient growth.

Treatment.—Nasal respiration should be restored and nasal affections corrected by the treatment therapeutic and surgical detailed under the Surgery of the Nose and Naso-pharynx. Pure air, careful exercise, frequent baths, moderate and restricted use of the voice, careful attention to the general health, and rigid avoidance of everything that is known to aggravate the disease, are of great importance in this affection.

In addition, local treatment should be employed. Astringent sprays are useful applied with an atomizer, either a hand bulb-instrument or the one with compressed air. One remedy will sometimes succeed when another fails, and, again, better results are obtained by alternating one with another. Silver nitrate, a half-grain or more to the ounce; zinc sulphate, five grains to the once; ferric chloride, three grains to

the ounce, Monsel's solution, 15♏ to the ounce; copper sulphate five grains to the ounce; alum, ten grains to the ounce,—are all good. Tannic acid is sometimes used, also jaborandi, to promote secretion.

Instead of sprays, or along with sprays, inhalation of drugs may be practised. To accomplish this hot water is impregnated with the drug —preferably an alkaline—and the steam inhaled for several minutes. Opium may be added to either the spray or inhalation if there is much pain. Cocain should be applied if the membrane is hypersensitive.

Most surgeons treat the larynx and trachea as they do the nasal cavities by means of compressed-air apparatus, using a variety of astringent and antiseptic solutions according to the demands of each particular case.

Subglottic chronic catarrhal laryngitis bears the same relation to the ordinary chronic form that the infantile subglottic acute laryngitis bears to the ordinary acute form. It is altogether a graver affection.

Chronic subglottic laryngitis is almost invariably the result of repeated acute attacks. It tends to produce stenosis of the larynx, and its gravity is proportionate to the amount of occlusion. Gradual loss of voice, increasing dyspnea and cough, are its most distinctive symptoms.

Diagnosis is to be made by laryngoscopic examination, when the tissues below the vocal cords are seen to be much hypertrophied and of a pale grayish color with diminished secretion. Only perichondritis is likely to be confused with this. In perichondritis pain is more acute.

Prognosis is doubtful, depending upon the cause. It is not very favorable as to complete recovery, but it may be possible to hold it sufficiently in check to avoid the necessity of tracheotomy.

Treatment.—If excess of lymphatic tissue is plainly the cause, absorbents must be used (iodid of potassium or iodid of iron) in large doses.

In many cases surgical interference is necessary. Excessive tissue may be cut away or the galvano-cautery may be developed. Dilatation by hollow tubes is the most rational and the most generally successful method, though absorption goes on slowly under pressure of this sort.

Laryngitis sicca is the term applied to a peculiar form of chronic laryngitis in which secretion is deficient and crusts form and adhere to the mucous membrane, as in atrophic rhinitis.

The *cause* is obscure. Since in most cases it is accompanied by atrophic rhinitis, both diseases are due either to one and the same original cause or the laryngitis, as maintained by some, is an extension from the rhinitis. This, however, is usually difficult of demonstration, and it seems more reasonable to conclude that the same cause is in operation in the system to produce both. The crusts vary in color according to whether they are composed of inspissated mucus alone or of mucus mixed with pus and blood from below the glottis. Sometimes they are annular, being formed on the trachea—sometimes of irregular shape, especially if found in a ventricle.

Erosions are common from the attachment of crusts. A considerable quantity collects beneath the crusts and slight hemorrhages are not uncommon.

Symptoms.—Morning cough in the effort to expel the crusts that have formed during the night, together with the naturally attendant conditions, dyspnea, fetid breath, and aphonia, constitute a marked group of symptoms.

Irritation of the throat is sometimes excessive, and is made the worse by attempts to clear it.

Laryngoscopy makes positive the diagnosis.

Treatment.—Removal of crusts, cleansing of the underlying surface, and stimulation of the membrane are the indications.

To effect removal the crusts are first softened with some solution from the atomizer, and then gently removed with swab or brush or fine instrument. After this is done all pus should be removed and all bleeding stopped. Silver nitrate is one of the best substances for application to the membrane. Any of the astringents mentioned in the Treatment of Chronic Catarrhal Laryngitis may be employed.

Chorditis tuberosa (**trachoma of the larynx**; **Singer's node**) is a variety of chronic laryngitis first recognized and described by Tuerch. It consists of a small white tumor upon one or both vocal cords, more commonly, it is said, upon the left one, situated at the junction of the anterior and middle thirds of the cord. It is due to an extreme effort to reach the highest notes in singing where there is already a condition of chronic laryngitis. It does not increase in size after its first appearance. It produces hoarseness even in conversation, and makes the use of the voice in singing an impossibility. It is readily seen on laryngoscopic examination.

It may be removed by the application of silver nitrate or by the use of the galvanic cautery. In any case the use of the voice should be interdicted, even in conversation, and both the chronic laryngitis and the general health should be treated.

Diphtheritic laryngitis, as a rule, results from extension of the disease from the fauces. It belongs more properly to the domain of the general practitioner of medicine, and becomes of interest from a surgical point of view only when intubation or tracheotomy is to be performed. The operation will be described in its proper connection, for it is called for in a variety of crises, not in diphtheria only.

Edema of the larynx by an earlier nomenclature was known as **edema of the glottis,** but, as it is the larynx chiefly, and not the rima glottidis that is involved, the modern requirement of making the name of the disease describe both its position and character brings about a rejection of the older term. It may be either acute or chronic. By the term is meant an infiltration of the submucous connective tissue of the larynx or of the epiglottis on either or both surfaces. It may be a true edema, a "hydrops" resulting from venous congestion. The constituents of the infiltrating fluid may be serum, lymph, pus, or blood in any combination, and it may accumulate slowly or be practically instantaneous in its manifestations, especially when due to traumatism.

When the lesion is of inflammatory origin, the inflammation is very acute, and extends deeply below the mucous surface into the cellular connective tissue—really a cellulitis or phlegmonous laryngitis.

Exposure to cold and moisture is the commonest cause, though it may possibly be due to over-use of the voice, but probably in that case

there is a preceding laryngitis of mild type of which the patient is unaware. It may follow the passage of foreign bodies into the larynx, especially if the intruder is of such a character as to lacerate the tissues. It often occurs after extremely cold or hot or caustic liquids have been swallowed. It accompanies or follows many acute systemic disorders, in many cases hindering coalescence. Slight exposure to drafts or cold, especially damp cold, is then the exciting cause in a system already debilitated by disease, as scarlet fever, typhoid, erysipelas, gout, measles, diphtheria, croup, quinsy, nephritis, pneumonia, bronchitis, or affections of the tongue and throat. Septicemia is said to furnish conditions especially favorable to its development. Clumsy operations upon the larynx or the inevitable contusion and laceration attending the removal of neoplasms may cause it. Men are more prone to edema of the larynx than women, because of their greater exposure to cold and dampness.

The non-inflammatory form of edema is due to causes not within the larynx itself; the cause is to be sought for in conditions predisposing to dropsy in other parts of the body. Whatever prevents normal venous return, as renal, cardiac, and hepatic disorders, may cause it, especially if there is a morbid condition of the mucous membrane, as relaxation or chronic inflammation.

The epiglottis, especially the posterior surface, the epiglottic folds, and the ventricular bands are the portions most commonly infiltrated, the vocal cords and the subglottic portions suffering only rarely. The swellings are tense, hard, with some fluctuation under the touch of the finger, and in severe cases portions of the enlarged masses may be seen on depressing the tongue.

Symptoms.—At times the edema comes on so suddenly that death ensues before relief can be summoned. In such cases there may be spasms of the constrictors of the glottis or paralysis of its dilators, or the condition may have been present for some time, and some untoward movement of the parts, as a cough or hasty inspiration, may have increased it or so changed the position of some portion of tissue as to occlude the opening.

In the edema of venous congestion the suddenness of the onset is more marked, and the premonitory symptoms less so than in the phlegmonous type.

In the phlegmonous variety there are no pyrexia, discomfort, and increasing distress in the throat, and the symptoms are all developed within twenty-four hours.

Pyrexia is absent in the serous edema of venous congestion, and pain is not so marked as in the inflammatory form. In both there are increasing dyspnea, stridulous breathing, dysphagia, and restlessness. The face is anxious. Sleep is impossible from the fear of suffocation. In acute edema all these symptoms manifest themselves in intense paroxysms when the disease is fairly present. The patient may die in the first paroxysm or the paroxysms may increase in severity, with cyanosis, protruding eyeballs and tongue, and rapid pulse, until a fatal issue is reached.

In chronic edema the symptoms steadily increase in severity. The paroxysms are followed by temporary relief, but gradually grow more

severe and frequent. Excitement may renew the paroxysms when they have apparently been quieted.

The *diagnosis* indicated by the symptoms is confirmed by the laryngoscope.

Prognosis.—Suffocation is the one great danger. As has been said, it may occur instantaneously at the first or any succeeding paroxysm. Or apnea may come on gradually from the insufficient oxidation of the blood. Unrelieved, an acute case will increase in the severity of its symptoms, go on from bad to worse, and terminate fatally, ending in coma, generally in three or four days.

Chronic edema is not the less dangerous because its development is slower. Since its causes are likely to be of long duration, if not incurable, there is slight hope of recovery from chronic edema. What would be a trifling edema in other parts of the body is here sufficient to threaten life, and it is often necessary to resort to tracheotomy as a means of relief and to take away the element of danger while the general condition is under treatment.

Deuteropathic cases, provided means are taken to relieve immediate danger, must depend upon the disease accompanying or causing them. Edema below the glottis is less favorable than that above.

Treatment.—Depletion of the infiltrated tissue by any and all means is here the indication. Free puncture and incision or scarification by a laryngeal knife or by ordinary lancet or curved bistoury covered with thread or court-plaster almost to the point affords immediate outlet to the accumulated fluid. This may be repeated in six or eight hours if necessary. The laryngoscope should be used if possible; if not, the knife must be guided by the finger. The cuts must be as far away from the median line as possible, so as not to complicate an already bad condition by the entrance of fluid into the air-passages. Gargling with warm water or inhalation of steam causes relaxation or dilatation of blood-vessels, so that hemorrhage is more free. If this fails to give relief, tracheotomy should be performed at once. In severe cases it is used as a precautionary measure, for edema is so treacherous a disease that suffocative apnea has often been known to take place after the departure of the surgeon and before he could be recalled. The surgeon must also bear in mind the fact that congestion of the brain or lungs may occur, and even after a fair degree of respiration has been restored the patient may die from suboxidation. In country practice, where the surgeon can see his patient only at long intervals, these are considerations not to be neglected. Tracheotomy rather than laryngotomy is to be performed, as better meeting the possible complications.

Intubation is practically out of the question in these cases, for, if the difficulties of insertion are happily overcome, retention is almost impossible because of the swelling and distortion. In moderate cases a catheter might possibly be retained. Spontaneous subsidence is not unknown. In edema from nervous congestion and in chronic edema from any cause, in addition to the above line of treatment the cause must be treated and systemic depletion of the infiltrated tissues be resorted to by catharsis, diaphoresis, and diuresis.

Edema of the larynx from causes that produce anasarca is practically incurable, so that the treatment can only be palliative.

Abscess of the Larynx.—This affection may be intra-laryngeal or peri-laryngeal. It may be primary or secondary, but is usually the latter, being commonly secondary to perichondritis, phlegmonous laryngitis, or acute diseases, among which are enteric fever, typhus fever, the exanthemata, small-pox, diphtheria, pyemia, tuberculosis, syphilis, and glanders. Traumatism, especially that due to the entrance of foreign bodies, is a cause, and when this is so the location of the abscess is determined by the place of the injury. When due to systemic diseases it shows a preference for the cartilages in the following order: the inferior surface of the epiglottis, the internal surface of an arytenoid cartilage, and the ventricular bands.

The abscess may "point" externally or internally; only rarely does an internal abscess point externally. The external may find an outlet on the cutaneous surface, even by a somewhat extended fistulous track, although when it is a retro-pharyngeal abscess it naturally "points" into the pharynx.

Symptoms.—There are pain, aphonia or dysphonia, dysphagia, dyspnea, and cough. When peri-laryngeal on the anterior or lateral aspect of the larynx, a tumefaction is often visible on inspection and palpation, with pain, tenderness, and fluctuation on pressure. When it is retro-pharyngeal deglutition may become impossible from the pain that the attempt induces. Dyspnea may be extreme and suffocation imminent, either from the large size and amount of occlusion or from the contraction and paralysis of muscles in neurotic patients.

Diagnosis of the intra-laryngeal variety is by the laryngoscope. A tumor presents, red and angry at the base, with a yellowish apex, though the accompanying inflammation of the mucous membrane may tend to conceal the abscess; it must then be diagnosed by circumscribed sensitiveness of the membrane. Peri-laryngeal abscess is diagnosed by the physical signs.

Prognosis is favorable unless it is a sequel or complication of exhausting diseases, and then it depends upon them. Precautionary tracheotomy will remove danger of suffocation, and if the system recovers only slowly, the opening should be maintained for a short time, as under such circumstances there may be a succession of laryngeal abscesses. After one abscess, and especially after several, stenosis may result, but it is rare.

Treatment.—Spontaneous discharge with immediate relief is not unknown, but should not be waited for. Once diagnosed, an intra-laryngeal abscess should be incised, either with the laryngeal knife or a curved bistoury protected to within a short distance of the end. If, for any reason, the surgeon cannot reach it, tracheotomy presents the only safe course. Peri-laryngeal abscesses are opened at the most prominent point.

Chondritis and Perichondritis.—Chondritis is invariably secondary to perichondritis, and the latter is almost as invariably a secondary disease, although a primary form due to protracted exposure to cold and moisture, especially when the voice is much used at the same time, is not unknown. Perichondritis is essentially also an acute disorder. Other causes than cold are—traumatism, typhoid fever (which seems especially prone to bring on acute inflammation of the perichondrium),

the exanthemata, diphtheria, pneumonia, erysipelas, tuberculosis, malignant disease, and syphilis. Men are more subject than women, adults than children, probably from the greater frequency of the exposure. Between twenty-five and forty is the period most apt to suffer from this disease.

The pathological changes are inflammation, with occasionally great tumefaction. If there is pus, the perichondrium separates from the cartilage, and the latter then undergoes necrosis; as a rule, and somewhat tardily, sloughs are removed. Usually one cartilage only is involved, especially at first, but they may all be affected together or successively. The arytenoid cartilages are liable to become separated from their attachment and be discharged *en masse*, though the affection is apt to be unilateral.

The cricoid is affected most frequently on the posterior portion, causing destructive and painful deglutition.

Perichondritis of the thyroid is usually unilateral on the inner surface, though no part is wholly exempt from possible implication.

Perichondritis of the epiglottis is invariably a secondary affection, and generally occurs in syphilis, advanced stages of tuberculosis, and carcinoma, and is then an ulcerative form of the disease.

Symptoms.—These vary with the location and intensity of the affection, but there are present the usual signs of suppurative disease and chills, or occasionally marked rigors and fever (100°–102° F.), general pains in the muscles and bones, loss of appetite, and occasionally slight nausea.

The symptoms of acute laryngitis quickly assert themselves, accompanied by an acute sensation or a localized soreness not common to simple laryngitis. There is sometimes pain during phonation and deglutition, and it is said to be more severe when the abscess is caused by syphilis than when caused by other diseases.

Hoarseness is followed by loss of voice, respiration becomes difficult and stridulous, and apnea threatens. Cough is not a very common symptom until the abscess begins to discharge pus or fragments of necrosed cartilage.

Diagnosis.—The laryngoscope, in addition to subjective symptoms, is all-important here when the interior aspect of the cartilages is involved, and physical signs, together with subjective symptoms, are sufficient when the external surfaces are affected.

A cricoid perichondritis produces irregular tumefaction beneath the vocal cords, usually at the back, but sometimes laterally, and pushes up toward the surface of this space, tending to occlude it.

Upon the arytenoid cartilage the perichondritis limits movement, and may make an ankylosis between the cricoid and itself, and is usually unilateral, tending to press backward toward the esophagus.

The symptoms of chills, fever, and general malaise, with sore throat, may at first confuse the diagnosis, since phlegmonous laryngitis and croupous laryngitis begin somewhat similarly.

In both of these diseases, however, the fever runs higher than in perichondritis—up to 104° F. at times—while in perichondritis it rarely reaches 102° F. In croupous diseases the peculiar cough is present and the tumefaction is more nearly annular. In phlegmonous laryngitis the

inflammation and tumefaction are uniform, and may be almost wholly above the larynx. New growths are without acute inflammation.

Prognosis.—Those cases of perichondritis that are caused by exposure to cold and dampness or by traumatism are of favorable prognosis. Those caused by tuberculosis or malignant disease or other progressive disorders, and in which all the cartilages are successively involved, rarely recover.

When perichondritis is caused by the more acute diseases, complete recovery may occur with resolution of the disease. But quite likely, as has been seen, extensive necrosis of cartilage may ensue, with consequent deformity, stricture, and stenosis—conditions that must be met as they arise.

Treatment.—At first measures must be taken to check inflammation and promote absorption. Leiter's coils and ice applied externally, together with the swallowing of ice, are all of great value here. Among absorbents, mercury or iodin may be applied as an ointment, and solution of iodin may be applied internally.

The bowels must be kept open, and the cause may be treated if it is acute or systemic disease. Tonics and stimulants are often indicated. Severe pain may be relieved by injections of morphin or by the application of cocain to the laryngeal mucous membrane. Syphilis should receive specific treatment.

Laryngotomy should be performed if obstruction threatens, and is better than tracheotomy for the removal later of the necrosed portions of cartilage.

In many cases bougies or other dilators have to be used for a long time to overcome stenosis, and in others tracheal tubes have to be permanently worn. Plastic operations are not successful.

Ulcers of the Larynx.—Ulceration of the larynx may simply affect the mucous membrane or it may be the result of the breaking down of tumors, either benign or malignant, or of those of tubercular or syphilitic origin.

A chronic inflammation of the laryngeal mucous membrane predisposes to ulceration, as in other mucous surfaces, but the process is not at all distinctive. The ulcers may be slight erosions due to traumatism or to desquamation of epithelium in a condition of low vitality, or they may have considerable depth if the cause and condition of the membrane both persist. Such ulcers often exist quite commonly upon the vocal cords without the knowledge of the patient, and are regarded simply as a manifestation of the chronic process under circumstances more or less tending to aggravate it. Stimulation of the surfaces and edges with nitrate of silver, with general treatment of the chronic laryngitis, is the treatment. Rest and non-use of the voice often effect a cure without therapeutic interference.

Tuberculosis of the Larynx.—Without doubt, in the majority of cases tuberculosis of the larynx is secondary to pulmonary disease, yet there is no reason why its first area of invasion may not be there, since the tubercle bacillus may find primary lodgement in any part of the body. In fact, we may go farther, and declare that a process of reasoning, unsupported by clinical facts, might lead us to the conclusion that the larynx from its anatomical position is particularly exposed to

primary invasion by the tubercle bacillus. But, clinically, it is found that in many cases pulmonary tuberculosis goes on to the fatal end without invasion of the larynx at all, or it occurs very late in the history of the disease; and further that laryngeal tuberculosis unaccompanied by pulmonary lesions is so rare as to be practically unrecognized. When laryngeal tuberculosis has been believed to exist alone, it has been followed so promptly by signs of the disease in the lungs that the conclusion was almost inevitable that it was present before or simultaneously with the affection in the larynx. In any event, the existence of the disease in the larynx affords the strongest probability of its speedy migration to the lungs, though of course this is not a demonstrable certainty.

Since the sputum charged with the bacillus is constantly passing over the mucous membrane of the larynx, it needs only the presence of an erosion to effect inoculation, and no doubt such is the clinical history of the great majority of cases of tuberculous disease of the larynx. The generally lowered tone of health and the tendency to "catch cold" lead to a condition of the mucous membrane especially favorable for the development of micro-organisms.

The disease is most common in male adults between twenty and forty years of age.

Pathology.—If the larynx come under observation during the incipient stages, it is seen to be anemic and paler than normal. Later there is thickening of the mucous membrane from tubercular infiltration.

Tuberculosis of the larynx generally shows first at the arytenoid cartilage or commissure, and later the aryepiglottic folds. It invades the ventricular and the vocal bands and the epiglottis in the order named, but all parts are subject to it. At first it may be unilateral, but as the disease advances both sides are involved, particularly in the lymph-glands, with great deformity. As the tumefaction progresses small yellowish points appear studding the mucosa, but the integrity of the epithelium is not at first impaired. Later, each of these yellowish points becomes the seat of ulceration. These diminutive ulcers by increasing in size coalesce, and ulcers of larger and larger size are formed until the membrane is almost one continuous ulcer. It is of a grayish-yellow color, not depressed, not differing markedly in color from the anemic infiltrated mucous membrane at its edges. Secretion is somewhat scant and of a thick, ropy consistency, with a relatively large amount of mucus compared with pus, and charged with the tubercle bacillus. Infiltration is always extensive, and prevents the loss of tissue which is really going on from the surface of the ulcer from becoming prominently manifest. Though beginning in the mucosa, the infiltration deepens, and perichondritis with consequent chondritis is not uncommon. Necrosis occurs as in perichondritis due to other causes; the arytenoid cartilages also may be discharged entire or in part; on the other hand, there may be ankylosis of the crico-arytenoid joint. Edema may really be present, but more frequently the excessive tubercular infiltration simulates the edematous condition.

Symptoms.—One of the earliest symptoms, and the one which perhaps first draws attention to the disease, is loss of voice. Infiltration

at the commissure prevents approximation of the vocal cords, and the voice is wholly gone at once. In others, where the disease commences elsewhere or is only slight, there is hoarseness, followed by a weak voice which gradually merges into aphonia. When the tubercular infiltration is higher the voice may not be lost, but this is rare.

There is excessive sensitiveness of the parts, and pain is early, severe, and lasting, particularly when the epiglottis is invaded. Food passing over renders deglutition almost impossible, and an already grave condition is rendered more so by the diminished nourishment. When destruction of tissue has gone to a considerable extent the case is complicated by the passage of food into the larynx or posterior nares. Cough is an ordinary concomitant of the pulmonary lesion, but is increased and is much more painful after the involvement of the larynx.

Dyspnea is not especially characteristic of the disease, though it may be present. Hemorrhage in large amount never comes from the larynx. The laity are apt to feel that laryngeal disease is especially serious, and the patient frequently betrays his anxiety in his face.

Diagnosis.—The almost invariable existence of pronounced pulmonary tuberculosis renders the probability exceedingly strong that ulceration in the larynx would be of the same origin. However, ulcers of syphilitic origin may exist along with tubercular disease, so that a differential diagnosis must be made. Tuberculosis of the larynx is also to be differentiated from malignant disease.

Syphilitic ulcers are round in shape, excavated, and have an areola of reddish color. There are usually other indications of the disease in the system.

In malignant disease the ulceration is unilateral, irregular in outline, and nodular; there are profuse ulceration and much destruction of tissue, and the characteristic cachexia is usually present. Microscopical examination of the sputum is employed to establish a doubtful diagnosis.

Prognosis.—This is exceedingly grave as to life, inasmuch as it usually complicates an existing condition already serious in itself.

If the disease were actually primary and seen in its early stages, it might no doubt be wholly arrested, but practically this never happens. Its course may be checked and the patient rendered more comfortable. According to the statistics of Bosworth, it shortens life on the average one year. The average duration of pulmonary tuberculosis being three years, a patient will probably live one year and six months after the appearance of the disease in the larynx.

Treatment.—Assuming that constitutional treatment, both medicinal and dietetic, would already be in progress, we need here consider only the local measures suitable for tuberculous ulceration in a locality so easily accessible as the larynx.

Cleansing should be thorough. This is accomplished by an alkaline spray thrown upon the part, as Dobell's solution, or boric-acid solution, or a solution of peroxid of hydrogen. Astringents may then be applied, as nitrate of silver, sulphate of zinc, or tannin in glycerin.

Pain, which is always persistent and often severe, may be controlled by solutions containing morphin. Cocain should be used with care, as absorption takes place rapidly; deglutition will be easier and nutri-

tion will be better maintained if its application be made before food is taken.

Iodoform or aristol or boric acid should be dusted on the parts after the cleansing. The odor of iodoform is so extremely disagreeable that europhen in solution may take its place.

Lactic acid is a time-honored remedy. Menthol in olive oil is mentioned by some authors.

Medicated inhalations often afford marked relief to the parts, but their curative qualities are very small.

Regular treatment, as indicated above, should be given two or three times a week.

Tracheotomy may be necessary if there is an edematous infiltration. It has even been advocated as a curative measure, its value being the rest afforded to the larynx and in the greater amount of oxygen thereby furnished to the system. At best, it may render the patient more comfortable and possibly somewhat prolong his life, but is certain to impress him with the progressive and hopeless character of the disease.

Syphilis of the Larynx.—Syphilitic disease of the larynx occurs both in the secondary and tertiary stages, and in general it may be said its manifestations in either stage are identical with those in the nasal or buccal mucous membrane, modified only by the anatomical situation. Following the cutaneous eruptions of the secondary stage is at times an erythema of the mucous membrane of the larynx. Mucous patches are somewhat common manifestations of the secondary stage, but are frequently the first evidence of the disease in the larynx. They may appear on the vocal cords, the epiglottis, the arytenoids, and the ventricular bands, and may be few or many, the symptoms depending upon the location. Ulceration is a late manifestation of the secondary stage, but is a constant lesion in the tertiary. It is symmetrical and bilateral, and is either superficial or deep. The superficial ulcers may almost be said to mark the border-line between the secondary and tertiary stages, while deep, destructive ulcerations are the inevitable result of the unchecked progress of the disease in the tertiary stage.

Gummata characterize the tertiary stage, and their natural termination is ulceration.

The superficial ulcer, but slightly depressed below the surface, is rounded or ovoid in form, has no areola, and secretes a yellowish pus. The amount of necrotic tissue is relatively small.

The deep ulcer results from the breaking down of the gummy tumor. It is, as a rule, a rapid process, and the amount of necrotic tissue discharged is relatively large. It generally invades the perichondrium, setting up a perichondritis with chrondritis, resulting in necrosis of cartilage. The arytenoid cartilages are apt to be first attacked, and may be wholly destroyed. The cricoid, the thyroid, and lastly, the epiglottis, are attacked in the order named. In the fibro-cartilage of the epiglottis the process of destruction is more like constant erosion than is the case with true cartilaginous structures, where a sequestrum is formed which may slough as soon as fully detached, or may remain *in situ* indefinitely or until destruction of all surrounding tissue sets it free.

Symptoms.—Impairment of voice in all degrees is a marked symptom, depending for its extent upon the location of the lesions. Dysphagia is another symptom, particularly if the posterior portion of the cricoid is involved or the epiglottis much eroded.

Superficial ulcer gives only slight symptoms, pain being often wholly absent. In contrast with the negative signs of superficial ulcers deep ulceration is often exceedingly painful, especially when the perichondrium is involved. Dyspnea may be present, especially if a gummy tumor obstruct the air-passage. After it has broken down in ulceration this symptom is relieved.

Diagnosis presents few difficulties, particularly if the existence of the disease in the system is known. Mucous patches show a grayish area slightly raised above the general level of the membrane. The bright-yellow pus of the superficial ulcer is characteristic. A gummy tumor is smooth and rounded.

The deep ulcer has a sharply-defined edge, is crater-like, and has a dark-red areola, much secretion, and necrosed tissue.

It must be differentiated from tubercular disease and malignant disease.

In tuberculosis the ulcer is irregular, of a grayish color like the surrounding membrane, has little secretion, and may be accompanied by pyrexia. Microscopical examination will show also the tubercle bacillus. Malignant disease is irregular, nodular, and unilateral. Microscopic examination of a bit of the tissue will show the cell-arrangements peculiar either to sarcoma or carcinoma.

Prognosis.—Taken in the earliest stages, laryngeal syphilis yields readily to constitutional treatment, combined with such local treatment as would be given for the comfort of the patient in ordinary catarrhal laryngitis.

Treatment.—For all manifestations of syphilitic disease before the appearance of the superficial ulcer constitutional treatment alone usually suffices. With the appearance of this ulcer cleansing and antiseptic remedies should be topically employed. The treatment of a gummy tumor is constitutional only, its absorption before ulceration begins being the thing to be desired. Deep ulceration must be treated locally by cleansing, astringent, and antiseptic solutions, and iodid of potassium is to be pushed internally.

Resulting cicatricial stenosis must be treated, as that condition is elsewhere, by dilatation or division.

Tumors of the Larynx.—Morbid growths in the larynx are common, and of these the greater number are benign. They may appear either externally or internally, but more frequently they are internal, occasionally both. The symptoms are such as naturally give great alarm to the patient and his friends, but danger to life is relatively slight.

Benign Tumors.—All or nearly all varieties of benign tumors have been found in the larynx, and, in the order of frequency, are papilloma, fibroma, osteoma, myxoma, adenoma, lipoma, angeioma, enchondroma, and those of mixed character. Some of them undergo degeneration, fatty, colloid, and amyloid.

Papillomata outnumber all other kinds of neoplasms put together,

and, while most morbid growths are single, these are occasionally multiple.

Men suffer more frequently than women from this disease, and during the more active period of life, from thirty to fifty. It appears so early in infancy that it may be assumed to be congenital, nor is advanced old age free from it.

The favorite sites of neoplastic growths are the anterior parts of the larynx, notably the vocal cords, though they appear anywhere on the laryngeal surface.

The size varies from that of a millet-seed to a growth large enough to protrude from the larynx and threaten life from asphyxia.

Etiology.—The cause is obscure, and it is rare indeed that a definite one can be found for any particular case.

Acute and chronic laryngitis, especially under exposure to cold and to irritating vapors, over-use of the voice, the deuteropathic laryngitis of acute and constitutional diseases, and traumatism have all been assigned as causes of benign tumors in the larynx. But such diseases do not produce tumors in the majority of cases, and, on the other hand, tumors develop when no morbid process can be assigned, and are surrounded by perfectly healthy tissue, just as a "wart" develops on the cutaneous surface of the hand.

Symptoms.—All varieties of benign tumors produce the same symptoms, according to size and location. Since most of these tumors are either upon the vocal cords or near enough to them to modify their function, phonation is either altered or lost. Before or in place of complete aphonia there may be either a weak or a hoarse voice, and the earliest indication of the presence of a laryngeal tumor may be a certain, almost indefinable, alteration in the quality and tone of the voice, such alterations being more pronounced or being replaced by aphonia as the disease progresses.

If there are growths on the two sides, so that the chink of the glottis is divided, double voice or diphthonia may result.

Position rather than size determines the alteration in the voice. A small tumor seated on the weak bands may impair their function greatly, when one many times the size situated at some distance will affect the voice little or none at all.

Respiration, especially during inspiration, may be interfered with, and dyspnea may become pronounced with the enlargement of the growth.

Dysphagia is not common unless the morbid growth occupies the posterior part of the larynx. Cough is seldom present, as nerves are rarely injured, and pain is uncommon for the same reason.

Hemorrhage is either absent or slight. The growth itself may not be felt, and its presence may be unnoticed except for interference with phonation, or it may give a feeling of discomfort and uneasiness.

Diagnosis is made by the laryngoscope, and the practitioner needs to be thoroughly acquainted with the external and histological characters of the different varieties of tumor, as well as the probable site, size, and mobility. In children, the use of the laryngoscope being sometimes non-practicable, the *tactus eruditus* alone must give the desired information. Even when the laryngoscope is used, a snare or

probe may be needed to bring a growth into full view. When possible a portion may be removed for microscopical examination, but this is not always desirable.

Papillomata may be single, but are often multiple, either sessile or pedunculated, and usually found at the anterior part of the vocal cords. The surface is wart-like, and the interior on section shows the same formation in its central papilla covered with multiplied epithelial layers. They vary in color, through shades of pink, from white to red. Their appearance when they are multiple has been compared to that of mulberries. They are common in childhood and adolescence—a diagnostic point between them and epitheliomata which occur in middle life.

Fibromata, situated most commonly also on the vocal cords, are single, smooth, hard, rounded, pedunculated, and have a surrounding areola.

Cystomata are caused by the retention of a secretion in a mucous gland from an obstructed duct. As it fills it projects above the surface and may attain the size of a small marble. It occurs most frequently on the epiglottis, is round, smooth, semi-transparent, movable, compressible, and pink in color.

Myxomata are probably due to the myxomatous degeneration of the mucous membranes or of other tumors, and are found most frequently upon the vocal cords. In situation and external character they so much resemble papillomata as to suggest the idea that they are a degeneration of that common form of laryngeal tumor.

Angeiomata are rare, and are usually seated upon the vocal cords, but may be found anywhere. They vary in size from that of a pea to a hazelnut, and are of a deep-red color.

Adenomata are so rare that their occurrence is denied by some specialists in throat diseases, but there can be no doubt of their occasional existence.

Lipomata are supposed to be external neoplasms as a rule, though Bruns reports one of intra-laryngeal origin.

Enchondromata are more commonly seen upon the posterior portions of the larynx, selecting as favorite sites the cricoid, the thyroid, and the epiglottis in the order named. These tumors are always hard, large, and sessile, projecting inward. Their contour is irregular, and when the mucous membrane is eroded they are seen to be hyaline in structure. They may be very small, or so large as to fill the laryngeal cavity, giving rise to extreme dyspnea. Few tumors are composed of one histological substance, but, as in other parts of the body, are of mixed type.

Prolapse of the ventricle may be mistaken for neoplastic growth. It can be diagnosed by noting the absence of the ventricle and by replacing the membrane temporarily with an instrument.

Prognosis.—Per se, tumors of this sort do not menace life. By occlusion, if they are allowed to attain a large size, they may cause suffocation; but the increase in size is always slow, and if there are any reasons why the growth cannot be removed, the operation of tracheotomy can be performed. As a rule, also, prognosis as to recovery of voice is good if this has been impaired or lost, though in rare cases it may never be restored.

When a growth has been removed by the external operation, cicatrization of the thyroid cartilage may so distort the parts that the normal voice is lost.

Occasionally benign growths undergo transformation into malignant tumors, especially when they are subjected to some constant irritation or when repeated clumsy attempts at operation are made, but the proportion of such degenerative alterations is exceedingly small.

Sometimes spontaneous expulsion, or still more rarely spontaneous absorption, takes place.

Treatment.—Treatment is wholly surgical, and two methods of removal are recognized, the intra-laryngeal and the extra-laryngeal. With the laryngoscope and the variety of laryngeal instruments now at the surgeon's command it is rare indeed that intra-laryngeal operation will not be abundantly successful. Not all intra-laryngeal growths demand immediate operative interference. If the symptoms and the inconvenience are slight and the growth does not enlarge, it is optional whether the operation is performed or not. Such a growth may remain stationary for an indefinite period, and then begin to enlarge, and this indicates prompt removal.

Operation through the natural passages is by cauterization, incision, abscission, excision, crushing, écrasement, and avulsion.

Cauterization is effected by chemical or electrical agency. When the former is selected, as it may be in the case of small, easily accessible papillomata, a variety of caustics has each its advocates, as nitric acid, nitrate of silver, zinc chlorid, caustic potash, mercuric nitrate, London paste, Vienna paste, or chromic acid. A tiny crystal of chromic acid is fused on the end of a curved laryngeal probe and applied to the neoplasm. A concentrated solution may be applied by means of a bit of sponge or cotton held firmly in catch-forceps. The greatest care must be used in such operations not to drop foreign substances into the respiratory passages, and also to accustom both patient and surgeon to the necessarily delicate manipulations. Preliminary attempts may be made with the simple instruments not carrying any caustic whatever, for in the actual operation the greatest care must be exercised to touch no portion of the laryngeal surface except the papilloma.

Similar precautionary measures may be taken when the galvano-cautery is used. Various cautery points are made for laryngeal treatment, and may require wrapping down almost to the point to protect all tissue but that under operation, for traumatic laryngitis or edema of the larynx may follow clumsy manipulations. The point must be carefully adjusted before the current is turned on, and the current should be turned off before the instrument is removed. Cauterization by the galvano-cautery is really one of the least desirable of all methods of treatment unless in the hands of a most skilful operator.

Incision is employed for cysts only, and a curved knife is used.

Abscission and excision, practically one and the same operation on growths of slightly different shape, are done by knives of various curve properly protected nearly to the end, by scissors, or by the guillotine.

Crushing is accomplished by forceps, and is not primarily a removal, but a destruction of the vitality of the neoplasm, with the expectation that it will eventually slough.

Écrasement is detachment by means of the snare, and is applicable only to growths of small size, but has the advantage of only slight hemorrhage if done slowly.

Evulsion is the method adapted to the greater number of new

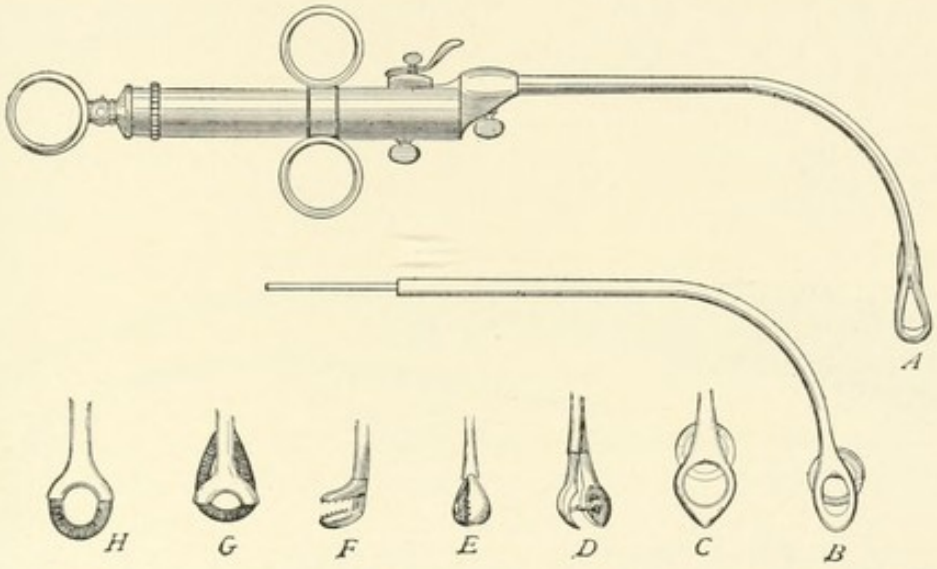


FIG. 264.—Störck's forceps: *A*, wire écraseur; *B* and *C*, guillotines; *D*, *E*, and *F*, forceps; *G*, guillotine, half closed; *H*, the same, open.

growths. The growth is grasped by forceps and torn away either *en masse* or piecemeal. Soft growths, either pedunculated or sessile, come away very readily, but those of harder consistency, as fibromata, often are removable with great difficulty. If hemorrhage is so great

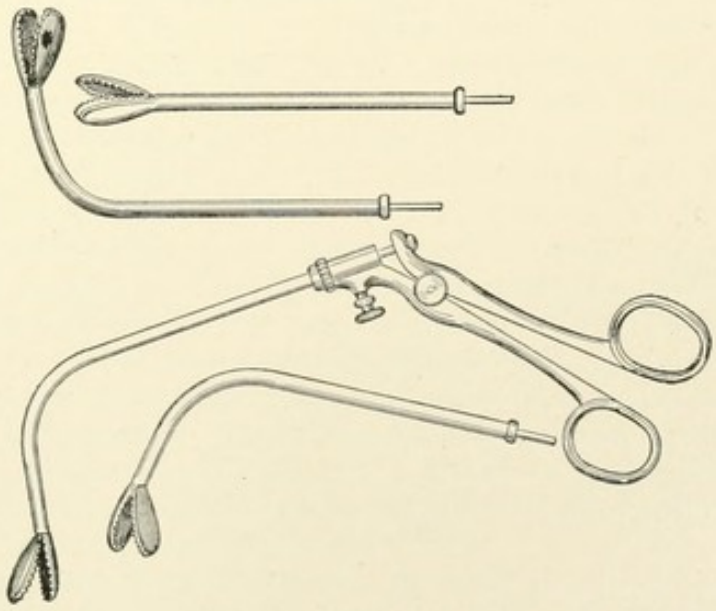


FIG. 265.—Gottstein's forceps.

as to obscure the field in the case of a growth removed in fragments, several sittings may be necessary. A finger in the larynx sometimes easily detaches foreign growths.

What form of instruments to use is a question of some nicety, and

different surgeons have devised instruments adapted to their own particular manner of operating. Mackenzie of London perfected a forceps bent at right angles and intended to operate in the entire circumference of the larynx. He has also invented tube-forceps, less generally used than the other, and of a less wide range of usefulness.

Störck's instrument (Fig. 264) is bent to the quadrant of a circle, and may be adjusted to a universal handle.

Gottstein has an instrument (Fig. 265) with one curve nearly at right angles in the distal end, and another at the junction of the handle and the instrument proper, but most operators use it awkwardly.

Many find Shrötter's instruments (Fig. 266) very useful on account

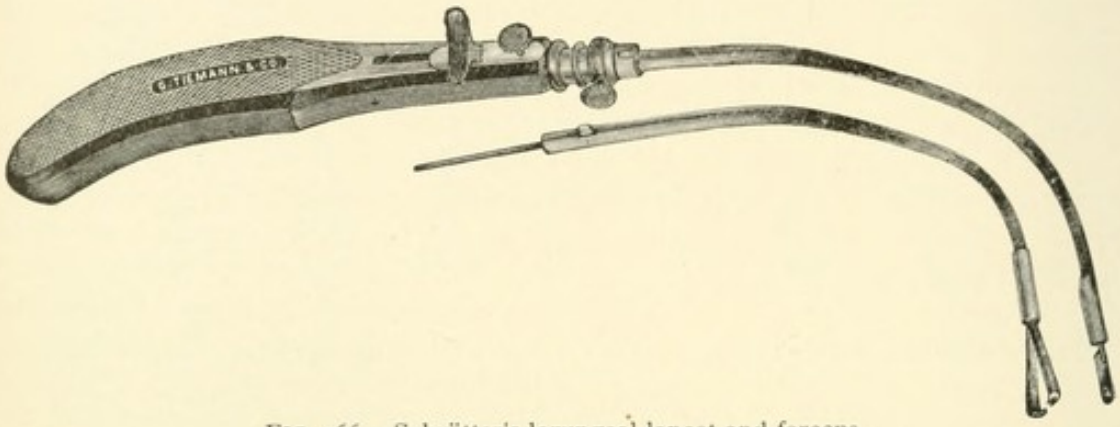


FIG. 266.—Schrötter's laryngeal lancet and forceps.

of the handles being bent horizontally out of the operator's line of vision.

The *extra-laryngeal* operation is to be performed when the growth is so large or so situated as to make thorough eradication through the mouth either doubtful or impossible.

A preliminary tracheotomy may be done and the method through the mouth again attempted, or the tracheotomy may be performed only with a view to removal. Where entrance shall be made must depend upon the individual case. It may be through the median line of the thyroid, or through the crico-thyroid ligament, or through both cricoid and thyroid, or the trachea may be opened, or the section made partly in the trachea and partly in the larynx. Section may be between the hyoid bone and the larynx, but this reaches little surface that is not equally accessible by the mouth; a lateral section has been proposed.

The cricoid, having a comparatively small blood-supply, is prone to necrosis, and, as has been said, cicatrization after operation upon the thyroid cartilage is apt to distort the vocal cords and impair the voice. All considerations must be duly weighed before commencing the operation.

After having entered upon so important an operation the surgeon will see to it that extirpation is so radical that repullulation is inevitably forestalled. Thorough cauterization of the parts upon which ablation has been practised will secure this. If hemorrhage after thyrotomy is large, the operation may have to be done in two stages, and it is best to leave in a tracheotomy-tube if possible, as resolution is more rapid when perfect rest to the parts is thus secured.

Cocain should be used before commencing internal operation upon the throat. The case should be treated immediately with caustics if there is any appearance of remaining fragments or if recurrence threatens.

It is only practice upon the cadaver that will give the requisite rapidity and delicacy of manipulation.

Malignant Tumors.—Tumors of malignant character are either sarcomata or carcinomata, the proportion of the latter to the former being 612 to 1 (Bosworth).

1. *Sarcoma.*—All or nearly all varieties of sarcoma have been reported as found in the larynx. Sarcomata are not excessively large, about the size of a walnut being the limit. They extend by involving adjacent tissue, and not by the lymphatics. The disease occurs most frequently in adult males between the ages of twenty-five and sixty, with the majority of cases in old age. The disease is usually primary, with no evidence of hereditary predisposition, though a very few cases have been reported as secondary.

No cause is known, but possibly persistent laryngitis may have something to do with it, though an otherwise healthy larynx may be the seat of sarcoma.

Symptoms in the early stages may be nearly negative, or at least may not differ from those of the non-malignant tumor. Pain may be more marked, but in some cases is wholly absent. As the disease advances cough may assert itself, and the sputa may alter in character, containing some blood and eroded fragments.

Diagnosis.—Diagnosis is made by the microscope. Yet to the practised eye certain distinguishing characteristics will declare the malignancy of the growth, for it does not exactly resemble any of the benign tumors. Occasionally it resembles a papilloma, but it is situated more posteriorly. There is an abnormal-looking mucous membrane immediately surrounding the growth, either pale or too vascular, and sometimes there is superficial ulceration. There is a thick deposit of muco-pus upon the irregularly-shaped mass.

Sarcoma is distinguished from carcinoma by the fact that the lymphatic glands are not involved.

Prognosis.—Let alone, the disease is fatal, and may be quickly so, for at times, especially in the later stages, the tumor grows very rapidly, filling the larynx, death resulting from suffocation. If the growth is wholly removed, the prognosis becomes favorable.

Treatment.—Extirpation is the only safe procedure, and here radical treatment is surgical. In so grave a disorder, where the removal of every particle of the growth is essential and where repeated manipulations result only in evil, the operation through the mouth does not sufficiently promise certain success. Thyrotomy must be the rule here. Sometimes there must be resection of a portion of the larynx, or even laryngectomy. If the disease is confined to the epiglottis, that may be removed entire.

2. *Carcinoma.*—Of all the cases of cancer, only a very small percentage are located in the larynx. Here it is usually primary, but has been known to be secondary by extension from neighboring organs. It is not circumscribed, but spreads rapidly into contiguous tissues, and

hence, though generally unilateral to begin with, it becomes bilateral by extension.

Intrinsic carcinoma hovers about the vocal bands, while the extrinsic variety more frequently selects the epiglottis as its site. Lymphatic glands are not always involved, especially in intrinsic carcinoma, the extrinsic variety being more apt to extend to the lymphatics.

It occurs at all ages, but is most frequent in the last part of the so-called middle life and in old age from fifty to seventy, and occurs in males far more frequently than in females.

The *cause* is obscure, but acute, and especially chronic, laryngitis, traumatism, the contraction of cicatrices, over-use of the voice, the irritation of benign growths, and especially clumsy attempts at their removal, have all been assigned as causes.

Symptoms.—The symptoms are essentially the same as of malign growths in the early stages.

The glands are early involved. There is generally some ulceration, a more abundant secretion than normal, and thus the breath becomes fetid and offensive and the sputa charged with abnormal constituents and tinged with blood. Although it is rare, the ulceration may eat through small arteries and hemorrhage ensue.

Pain is not constant, but is usually more marked than with benign tumors or sarcoma, and a peculiar feature is that it radiates up behind the ears and over the neck, particularly in extrinsic carcinoma.

Salivation may be excessive. Cough in the ulcerative stage is usually present.

Sometimes dyspnea is so extreme as to threaten suffocation. After a time these extreme symptoms remit, the reason being the removal of tissue by the ulcerative process.

Diagnosis.—The true character of carcinoma of the larynx may be overlooked at first, from the fact that it is deep within the tissues before its presence is known. Careful study of the subjective symptoms and superficial appearance of the tumor, particularly in the ulcerative stage, the fetid breath, and the pain running up toward the ears, will be enough to suggest cancer.

The final diagnosis is by the microscope, and fragments should be removed from a suspected tumor for that purpose. Its nodular, ragged, irregular, and greater extent serves to distinguish it from sarcoma. Cachexia is characteristic also, but less so than with cancer in other parts of the body, and it does not appear early as a rule. By microscopic examination it can be differentiated from tuberculosis, and by specific treatment from syphilis.

Prognosis.—It is a fatal disease. Removal may lengthen life, but will not save it.

Treatment.—Since the patient becomes, from the fetor, very offensive to himself and his attendants, it is best to use sprays of antiseptic and deodorizing material, as carbolic solutions, peroxid of hydrogen, permanganate of potash, etc.

Pain is to be relieved by the use of morphin.

If dyspnea is extreme, tracheotomy is to be performed.

Whether actual attempts at surgical extirpation shall be made

depends upon the strength and wish of the patient and the position and extent of the growth.

If it is external, operation is useless. If it is intrinsic and unilateral, a half section of the larynx may eradicate it, or if of limited extent and bilateral, laryngectomy may be justifiable.

Neuroses of the Larynx.

Neuroses of the larynx are either sensory, paralytic, or spasmodic.

Sensory neuroses, in comparison with the paralytic disorders of the larynx, seem relatively unimportant, and are usually transitory or mere concomitants of disease of the larynx.

During certain diseases, notably tuberculosis and carcinoma, there is hyperesthesia of the mucous surface of the larynx; this occurs more transiently and to a lesser degree in acute than in chronic laryngitis.

After certain diseases, as diphtheria, and sometimes after syphilis, there is anesthesia of the mucous surface. This is a concomitant also of some purely nervous diseases involving the superior laryngeal nerve.

In neurotic individuals paresthesia is not uncommon. It may be due to some disease or it may be purely or nearly imaginary. Examination often reveals unsuspected disease, and sometimes no cause can be found.

Neuralgia of the larynx, though very rare, may be a part of neurasthenia or the result of a generally anemic or depleted condition, and is then, as a rule, accompanied by neuralgia in other parts of the body. It may also occur independently of the disease elsewhere. It is usually most painful. Sensory neuroses, except as symptoms of surgical diseases of the larynx, possess little interest for the surgeon, and fall more properly within the domain of the medical practitioner.

Paralysis.—Functional paralysis occurs chiefly in hysterical subjects, and requires the same treatment which that disorder receives whatever its manifestations.

By paralysis is meant an organic affection of the nerve supplying the larynx. It may be due to a lesion in the nerve itself anywhere in its course or to mechanical interference with its function, as when there is pressure upon it from tumors or infiltrations. Ankylosis of an articulation may put an end to the function of the part, but is not a true paralysis, since the nerve is wholly unaffected. Paralysis may be partial or complete.

Paralysis of the Superior Laryngeal Nerve.—Sensation for the mucous membrane of the entire larynx is provided by this nerve, and it supplies motor fibers also to the crico-thyroid muscle and partly to the arytenoids. Hence a complete paralysis of this nerve would produce anesthesia of the laryngeal mucous membrane and motor paralysis of the crico-thyroid and arytenoideus muscle. Tension of the cords would be interfered with, and there would be lack of approximation of the arytenoid cartilages. This affection may be unilateral or bilateral, the former condition being due more frequently to local disease or injury, the latter to cerebral disease or extensive local injury.

The commonest cause of paralysis of this nerve is diphtheria. It is then accompanied by complete anesthesia, and by anesthesia and

paralysis of neighboring parts, as in the pharynx when the muscles of deglutition are involved. Other exhausting diseases, as typhoid fever, have been known to produce this condition.

Diagnosis is based upon the history of the case, with a study of the action of the laryngeal muscles by means of the laryngoscope, together with the fact that anesthesia of the mucous membrane is also present.

If paralysis is bilateral, only the vocal processes touch during phonation, making an elliptical opening in front and a triangular posteriorly. If it is unilateral, the laryngoscopic image is less distinctive, for it then resembles merely a relaxed condition of the cord (Bosworth).

Prognosis is good, though complete recovery is slow.

Treatment.—The diet must be nutritious. Electricity, the faradic form, is of good service. Strychnin is the best drug for this condition, but general tonics are usually needed. If the origin of the disease is syphilitic, specific treatment is necessary. If it is of central origin, nothing can be done unless the central lesion is due to syphilis.

Recurrent Laryngeal Paralysis.—This nerve supplies with motion all muscles of the larynx except the crico-thyroid, and hence when it is paralyzed there is complete absence of motion in all parts of the larynx, for the crico-thyroid muscles act to no effect alone, if indeed they act at all. Long-continued paralysis of these nerves leads to degeneration of the nerve itself, and consequently to degeneration and atrophy of the muscles which they innervate, and not infrequently to ankylosis of the cartilages of the larynx from long-continued disuse.

Etiology.—The commonest cause of paralysis of this nerve is pressure upon it at some part of its course. The course of the right and left recurrent laryngeal nerves respectively is not the same on both sides of the body, it being on the left side, as it winds around the arch of the aorta, more exposed to pressure from aneurysmal tumor of that vessel. Statistics, however, do not seem to show that aneurysm is accountable for the relatively larger number of paralyses of the left recurrent laryngeal nerve, but to such a cause must be added also its greater exposure on that side.

Lesions existing anywhere in the course of the nerve will cause paralysis.

Any disease of the brain where this nerve in its beginning is involved or pressed upon will cause paralysis. During its course it may be pressed upon by aneurysm, enlarged lymphatic glands, mediastinal tumors, pleuritic or cardiac effusion, cancer of the esophagus, or enlargement of the thyroid gland. Causes affecting the peripheral terminations are less frequent probably than any other. They are inflammation of the laryngeal mucous membrane, usually involving that of the pharynx as well, and inflammation of the muscles of the larynx, especially with great effusion into their substance. Rheumatism of these muscles is believed to cause it, also anemia, syphilis, poisoning by drugs, blood-poisoning by diphtheria, typhoid fever, and the exanthemata.

The paralysis due to pressure on the recurrent laryngeal nerve of one side sometimes is accompanied by paralysis of the nerve of the other side, and this has never been satisfactorily explained. The suggestion has been made that the irritation of the one affected leads to central changes felt by the other.

Ziemssen reports a case where there was bilateral paralysis, that on the left side being due to aneurysm of the aorta, the other to aneurysm of the subclavian artery.

Symptoms.—At the onset of the affection in unilateral paralysis the voice is weak, but with time it nearly recovers its normal strength.

In bilateral paralysis phonation is completely lost, and there is rapid loss of air through the glottis when the attempt to speak is made. Dyspnea is common. Laryngeal paralysis is really a symptom, as a rule, of some grave disease, and the concomitant symptoms of that disease are present as well.

Diagnosis.—Objective symptoms in laryngeal paralysis will suggest the disorder, especially in connection with the history. Diagnosis, however, is verified by the laryngoscope.

The vocal cords occupy the cadaveric position of Ziemssen between extreme abduction and adduction. In unilateral paralysis the cord on the affected side is in the cadaveric position; the other passes the median line a little, as if to compensate as much as possible for the disability of its fellow. The arytenoid cartilage also goes a little past the normal position. These deviations from the normal give to the rima glottidis an apparent deflection toward the paralyzed side.

In many cases of recurrent laryngeal paralysis the *cause* is perfectly apparent, for the paralysis, as has been said, is but a symptom of a grave disorder. On the other hand, the laryngeal paralysis may be the first indication of a serious systemic affection, and it then becomes the duty of the surgeon to trace backward, as it were, until he finds the seat of the obscure disease—it may be in the central nervous system, in tumors or aneurysm within the chest, or in tumors or enlarged glands in the cervical region.

Prognosis.—If the cause is some acute disease or even poisonous drug, the outlook is more encouraging than for pressure on the nerve-trunk, and least of all is it hopeful when the trouble originates in the brain, for this is usually incurable.

Treatment.—Remove the cause if possible. If the peripheral nerves only are affected because of some local inflammation, local measures are indicated, as the use of astringents.

Electricity may be of use if the trouble lies primarily in the muscles or if it can be made to assist absorption of a tumor, as is sometimes the case. General hygienic and therapeutic measures are to be carried out as for superior laryngeal paralysis.

Paralysis of the Abductors.—When the posterior crico-arytenoids are paralyzed, the vocal cords are brought into approximation, as in phonation. Much theorizing has been done as to the cause of this paralysis, but, since it is a frequent accompaniment of diseases having their origin in brain lesions, particularly locomotor ataxia, it is highly probable that many cases are of central origin. Still others may be produced by pressure on the nerve-trunk or by peripheral lesions. In bilateral paralysis during the inspiratory act the vocal cords are drawn close together, symptoms of dyspnea become very urgent, and the vocal cords cannot be drawn far apart under any circumstances. During expiration the cords are forced up in a vaulted manner, separating as

they rise, so that the column of air has free exit. The abductor muscles from protracted non-use may undergo degeneration and atrophy.

Unilateral paralysis is apt to be due to pressure; disease of the bilateral variety is likely to have a central origin. Local irritation or injury has been known to produce it, but such a cause is more likely to be followed by bilateral paralysis.

Dyspnea is not urgent if it exists at all, and the laryngoscope reveals pathological conditions on one side only. It may remain unilateral indefinitely or may merge into bilateral paralysis. Tracheotomy is never a necessity for unilateral paralysis of the abductors.

Symptoms.—The one distinctive symptom is inspiratory dyspnea, with at times great inspiratory stridor, not particularly noticeable at first, but increasing in severity and frequency of the attacks as time goes on. Other symptoms are those of the disease that produces the paralysis, and whatever concomitant symptoms it may produce in other nerves or in other parts of the body.

On laryngoscopical examination the cords are seen to approach each other very closely and to be lifted apart during expiration; they assume a normal position during phonation, for the voice is not affected, except that it suffers interruption in utterance from the stridulous inspiration.

Prognosis depends upon the cause. It is good if the cause is merely local, not bad if due to pressure of a benign tumor, and very bad if due to pressure of malignant growth, aneurysm, or to central nervous affections.

Increasing unrelieved dyspnea is always of grave import, but tracheotomy may come to the rescue for this condition.

Treatment.—Tracheotomy is to be performed when the dyspnea demands it. Otherwise treatment is the same as for paralysis of the superior laryngeal nerve.

Paralysis of the Adductors.—In this disease, when bilateral, the lateral crico-arytenoids are drawn far back against the wall of the larynx, leaving the rima glottidis as wide as possible. In unilateral disease one muscle retreats to the laryngeal wall. It is probably not of central origin, but generally of local causation, although diphtheria, lead-poisoning, and occasionally typhoid fever may produce it.

Bilateral adductor paralysis is so rare as to raise a question as to whether it really exists, or whether the so-called cases were not hysterical semblances of such a condition.

In unilateral paralysis the cord on the unimpaired side passes the median line, somewhat toward the immovable fellow of the opposite side, and its arytenoid passes in front of the other, these positions making an oblique rima glottidis.

Aphonia is the *symptom.* Laryngoscopic examination makes clear the diagnosis.

The *prognosis* is excellent.

Treatment.—Local treatment for the local condition and absolute discontinuance of all attempts to use the voice are absolute requirements. General tonics and the best hygienic living are indicated. Electricity, preferably the faradic current, and strychnin are also valuable.

Aphonia is a symptom easily counterfeited by dishonest persons,

and either hysteria or dissimulation may call it to their aid. The distinguishing characteristic is this, that whereas paralysis of the adductors is rarely or never bilateral, hysterical aphonia is always so, and dissimulation is simply silence with perfectly normal laryngeal muscles. In either case anesthesia or surprising the patient when he is "off guard" will clear up the doubtful features of the case.

Paralysis of the Internal Tensors.—No form of laryngeal paralysis is more common, because of the frequency of chronic laryngitis and straining of the voice from over-use. When included in some local inflammation the thyroid muscle fails to contract as it should. The voice, though still audible, loses its modulatory power, is weak and unable to make the higher notes heard, and is hardly under the control of the patient. It is usually unilateral, giving the "Indian-bow" image of the glottis in the laryngoscope during phonation, but it may be bilateral when the image is an ellipse. Paralysis of the arytenoideus often accompanies tensor paralysis, and then in the laryngoscopic image the vocal processes are approximated, shortening in front the "Indian bow" or elliptical opening in the glottis during phonation, and showing posterior to the vocal process a half ellipse, its point toward the front, its base posteriorly.

If paralysis of the arytenoideus occur alone, the vocal cords during phonation are properly approximated in front of the vocal processes, leaving behind them a triangular opening. Complete restoration is the rule in these cases, and local treatment with tonics, strychnin, and possibly electricity constitutes efficient treatment.

Spasm of the Glottis.—Certain diseases, as croup or diphtheria, may create or closely simulate this condition, but here is considered only that form of *laryngismus stridulus* which is simply of nervous origin. It may be due to spasmodic contraction of the muscles, which coapt the vocal bands, the ventricular bands, or of those which close the glottis. Both adults and children are subject to it, but particularly infants of delicate health—the scrofulous, anemic, rickety, those who are in their first dentition, who are suffering from gastro-intestinal ailments, from whooping-cough, or in whom enlarged glands press upon the laryngeal nerves, or in whom the meninges are irritated by caries of cervical vertebræ.

In adults the immediate cause is a reflex nervous excitability from a variety of causes, as food or drink "going the wrong way" into the larynx, the entrance of foreign bodies into the air-passages, etc.

Quite frequently there is some existing disease of the larynx that favors the occurrence of such accidents, as tuberculosis, syphilis, or tumors, either benign or malignant, either internal or external, pressing upon one of the nerves. Severe affections of the pharynx and esophagus, causing painful deglutition, predispose to spasm of the glottis, because then food and drink are apt to get into the larynx.

Some diseases of central origin, as epilepsy and locomotor ataxia, afford frequent examples of it, and a condition of generally uneven nervous poise is said to be predisposed toward it.

Symptoms.—The symptom of distinctive character is the paroxysmal stridulous inspiration which occurs at intervals and lasts a few seconds. The intervals between the spasmodic attacks may be hours or days,

but if the system is in a condition predisposing to the occurrence of spasm, they usually increase in severity and frequency, particularly in the case of children, and also with them the attack usually comes on at night. With adults the disease is rarely, if ever, fatal. In the case of children eclampsia and death often follow severe attacks, and may occur after convalescence has apparently become established.

Diagnosis.—In the case of children croup would first suggest itself, but the absence of fever and cough and the natural tones of the voice would suffice to exclude croup. The generally ill-nourished condition of the little patient, inflamed gums, the whooping-cough that is present, or gastro-intestinal troubles will afford data for the cause of laryngismus stridulus. If laryngoscopic examination is attempted, the placing of the instrument is apt to excite spasm, and then the contracted muscles are seen in the case of adults, and may even be provoked to establish the diagnosis.

Bilateral paralysis of the abductors may cause spasm, but is more chronic, less severe, lasts longer, and a study of the laryngoscopic image will show total absence of action in the abduction, the glottis is less rigid, and there is a marked absence of the convulsive movements that attend spasm of the glottis.

Prognosis.—Because of its reflex origin it is not fatal in adults. When it seems as if suffocation were imminent, relaxation allows of inspiration, probably because of the sedative effects of carbonic acid which is in excess in the system, but tracheotomy may be desirable to ensure comfort. In children the prognosis is unfavorable, the degree of danger depending upon the cause and severity of the attack.

Treatment.—The causative disease must be treated, sedatives given for the excessively neurotic condition, and the general health brought to the highest possible point by tonics, nutritious diet, exercise, cold baths, massage, and whatever other measures may be possible.

With children the immediate convulsion demands fresh air, ammonia to the nose, hot water to the feet, cold to the head, flagellation, holding of the nose, loosening of clothing, examination to see if there is an impacted glottis and perhaps a hasty tracheotomy.

If the spasms tend to repeat themselves, preparations should be made by the attendants for rapid treatment. In addition to the measures mentioned, morphin may be used, preferably hypodermically, amyl nitrite may be kept at hand for instant inhalation.

During the interval between the attacks the cause should be removed as rapidly as possible, and the system built up by dietary and hygienic measures.

V. STRICTURE AND STENOSIS OF THE LARYNX AND TRACHEA.

Stenosis of the larynx and of the trachea are so frequently associated clinically, and the causes producing the affection in the one are so nearly identical with the causes in the case of the other, that it is not less scientific than convenient to treat of the two together. Either or both structures may be the seat of stenosis, and there may be one or more points of constriction, though usually in such a case the multiple points of constriction have the same causes, or causes operating at

widely different times may be chargeable with the clinical condition. The cause of stricture may be wholly external to the organ (compression-stenosis) or within its cavity, or it may be in the walls of it (*occlusion-stenosis*).

Compression-stenosis may be caused by aneurysmal tumors, enlarged thyroids, thymus, or lymphatic glands, cicatricial tissue, cervical abscess, a foreign body, and by a diseased cervical vertebra, sternum, or clavicle. In this kind of stricture the integrity and character of the walls of the organ are unimpaired, but they undergo involution from the pressure.

Occlusion-stenosis is caused by cicatricial connective tissue, by warping or distention of the tube itself, usually from congenital malformations, by tumors, foreign bodies, edema, inflammation of mucous and submucous tissue, submucous hemorrhage, paralysis of dilator muscles or spasm of constricting muscles of the larynx, by adhesion of the vocal bands, ventricular bands, or arytenoid cartilages, or by the presence of false membranes.

Injuries, especially gunshot wounds and cuts inflicted with suicidal intent, are productive, in the process of healing, of connective tissue which ultimately contracts, producing stenosis.

Stenosis varies between extreme limits. It may be a scarcely appreciable diminution in the caliber of the organ or a complete obliteration of it. It is commonest and most important at the glottis, for here the lumen is narrowed, and to all other causes operating in other parts of the canal is added the contraction of the laryngeal process.

Under long-existing pressure degenerative changes may take place in the tracheal walls. The cartilaginous rings may atrophy or become wholly absorbed, so that perforation occurs.

According to the cause stricture is permanent or temporary.

Symptoms.—Whatever the cause and wherever the lesion, the symptoms are practically the same. The chief symptom is dyspnea on exertion. It may take months or years to develop, but when due to false membrane it may reach its height in a few hours. In any case, if unrelieved, the stridor increases and the stenosis threatens suffocation. The face is pale, livid, drawn, and anxious, and the pulse becomes weak and fluttering. Sensations of tightness and discomfort are felt in the chest. Cough is not always present, but when it is it is hard and metallic. The voice weakens as the disease progresses, though in chronic cases it may not be observed at first. In acute cases, where false membrane is present, deglutition may be difficult or impossible.

Physical examination reveals an altered respiratory murmur. It is harsh and strident, and in extreme cases may be heard across the room, and on auscultation seems to pervade the entire chest. When the larynx is the seat of the constriction, it descends during inspiration—a symptom wholly absent when the constriction is in the trachea.

Diagnosis depends upon the symptoms, the history of the case, and laryngoscopic examination. It must not be overlooked that a slowly-developing stenosis is a far different thing, so far as prognosis and treatment are concerned, from the rapidly-developing stenosis due to recent cuts or gunshot wounds, to edema, or to the false membranes of croup, diphtheria, and scarlet fever, or to the paralysis or spasm of

the glottis resulting from those diseases. The laryngoscope is most important in both classes of cases in order to determine where tracheotomy shall be performed if symptoms become urgent.

Prognosis depends upon the cause. It is unfavorable in aneurysm, mediastinal tumors, malignant tumor, external or internal, in some forms of hypertrophy of the thyroid gland, and in many acute cases where false membrane is formed.

It is favorable when there is occlusion by benign tumors, especially in those so high that they may be reached through the mouth. The prognosis is more favorable in all cases when it is so high that tracheotomy can be performed below the obstruction.

Stenosis from paralysis or spasm of the laryngeal muscles may be hopeful under long-continued treatment if a tracheotomy be performed to ensure comfort and safety to the patient.

Treatment.—Foreign bodies must be removed either through the mouth or external incision. Benign tumors can be removed by the methods described; malign tumors are sometimes removable.

Compression can be relieved only by treatment of the cause. Tracheotomy must often be performed for false membrane or for the resulting spasm or paralysis of acute diseases. Adhesions must be carefully separated. The case may even call for laryngectomy. But the treatment applicable to the greater number of cases is dilatation, because the large majority of chronic cases are those resulting from the contraction of cicatricial tissue after syphilitic ulceration. Dilatation is generally a slow process, requiring a year or two of persistent treatment, and tracheotomy, with the wearing of a cannula, is preliminary to its successful carrying out. The common way is to place in the canal a bougie as large as will enter the stricture and let it remain for a few minutes. Gradually larger ones are borne for a longer time. Various ingenious contrivances for inserting and retaining them have been made, and patients readily learn to use these instruments themselves. Metal dilators, of two or three blades for more rapid work, are sometimes used, but because they irritate the parts are little to be recommended.

VI. MALFORMATIONS OF THE LARYNX AND TRACHEA.

In the examination of the trachea and larynx of infants that have breathed but a short time or not at all a double trachea is sometimes found, as if the bronchial tubes had extended themselves up to the larynx. Sometimes the trachea is divided in part of its course by a septum; it may contain diverticula; it may be dilated in some parts and constricted in others; it may open into the esophagus, or it may be entirely absent.

A more common congenital fault is an external opening through the integument—a fistula. This is supposed to be due to non-closure in fetal development of the third or fourth branchial fissure, in which case it is most commonly unilateral near the sterno-cleido-mastoid muscle, or it may be accounted for by non-union of the third or fourth branchial arch, when the fistula then opens in the middle line. Sometimes there are bilateral fistulæ, one near each sterno-mastoid muscle, though only

a few such cases have been reported. The opening upon the integument is usually very small, though often internally it may be seen by laryngoscopic examination. Occasionally the track between the internal and external openings is very circuitous. Sometimes there is no external opening, and the internal opening may manifest itself by an emphysematous condition of the cervical cellular tissue. That such a condition is not constant is explained by the supposition that the opening is stopped by secretion. From the integumentary opening a drop or two of muco-pus exudes from day to day, and air on forced expiration.

Treatment is by caustics, electrolysis, or plastic operation.

Tumors of the Trachea.—All sorts of tumors, benign and malignant, have been found in the trachea. Their characters do not vary from such growths in the larynx, and are more common toward the laryngeal extremity and upon the membranous than the cartilaginous portion. They occur most frequently in adult males. They are usually secondary, and quite frequently are associated with similar growths in the contiguous structures, the larynx, esophagus, and bronchial tubes.

Sometimes, in tracheotomy, the cannula injures the tissues, or there is a subsequent attrition of the mucous membrane, and on the site of such injuries fungoid excrescences appear. Also after the wound from such an operation has cicatrized there appear similar vegetoid growths upon the scar. The symptoms are the same as for growths not caused by operation.

As compared with similar growths in the larynx, sarcoma of the trachea is relatively common. Carcinoma is generally secondary.

Symptoms.—These are substantially the same as for laryngeal neoplasms—dyspnea, loss of voice, harsh cough, and pain—when the growth is a carcinoma. It is said that carrying the head forward lessens, and lying down increases, the intensity of the symptoms.

Diagnosis is made from the symptoms and by the exclusion of laryngeal disease by laryngoscopic examination or by inspection through an external incision. It is not, however, impossible to view the trachea well toward its bifurcation if laryngeal tumors do not obscure the field. Involution of the trachea from external pressure must not be taken for neoplastic growths.

Prognosis for benign tumor is good, for malignant very bad.

Treatment.—Unless situated very high in the trachea, treatment through the mouth is impracticable. Tracheotomy is performed, and the growth removed by the instrument suited to the case. After removal the site of the growth is cauterized. In most cases if, after tracheotomy, a carcinoma is discovered, it were better not to attempt removal, but to insert a cannula, and make the patient as comfortable as possible by sedative drugs. The presence of carcinoma in other parts and cachexia would prevent any doubt as to the character of the growth, even before tracheotomy.

Tracheocele is a hernia of a portion of the mucous membrane of the trachea between the rings of the trachea or through fistula. It may be the size of a pea or as large as an egg. It is filled with air and enlarges on forced expiration. It may be almost or wholly negative as

to symptoms, or may cause dyspnea, weakened voice, or the voice may be temporarily lost. Pressure will usually remove it temporarily, and may do so permanently, though occasionally radical treatment must be employed to effect a cure.

VII. BRONCHIAL TUBES.

Injuries to the bronchial tubes are of external origin, and are discussed more properly under the general Surgery of the Chest.

Tumors are generally malign, and, as a rule, are secondary to the disease in the lungs, and, on the whole, rare.

Stenosis of the bronchial tubes is not rare, and is caused by substances within the lumen, changes in the walls themselves, or by pressure outside of the tubes. A small foreign substance, as a pea or bean, may find its way into the bronchial tubes. Chronic inflammation may thicken the walls, but, of all agencies producing alterations in the substance of the bronchial walls themselves, infiltration from chronic syphilis is the most common. Syphilitic granulomatous deposits occasionally diminish the lumen of the bronchial tube.

Mediastinal tumors, carcinoma of the lungs and lymphatic glands, more frequently than anything else, cause stenosis of bronchial tubes.

Symptoms are not especially distinctive, and are apt to be masked by those of the disease that causes the stenosis. Dyspnea, cough, and stridor are the chief symptoms.

Treatment.—If syphilis is the cause, administration of iodid of potassium must be pushed. Nothing can be done for carcinoma except to relieve pain. Unless there is a definite history, a small foreign body could not be diagnosed; it could not well be removed, but might be coughed up.

Tracheotomy.—The term "tracheotomy" is used, with less than the customary professional accuracy, to indicate any operation that is performed to admit air to the lungs when for any reason respiration through the natural channels is impeded by certain operations above the trachea. It includes laryngotomy, crico-thyroid laryngotomy, thyroid laryngotomy, laryngo-tracheotomy, and tracheotomy proper. The two operations inexactly indicated by the word are usually spoken of as the high and the low operation. By the "high operation" is meant incision above the thyroid gland through the crico-thyroid membrane and the first ring of the trachea—strictly a crico-tracheotomy or a laryngo-tracheotomy. The "low operation" is below the thyroid gland, and is through the fourth and fifth rings of the trachea, and on down to within an inch of the sternum—a tracheotomy proper. Sometimes incision through the thyroid gland cannot be avoided, and, since it lies on the second and third rings of the trachea, this is also, correctly speaking, a tracheotomy. Occasionally in opening into the larynx the thyroid cartilage alone is incised, constituting a thyroidotomy, a thyro-laryngotomy, or a laryngotomy, any of the three terms correctly describing the location of the incision.

In cases of croup and diphtheria, and when time and little hemorrhage are the desiderata, the high operation is chosen by most surgeons. Where the operation may proceed in a leisurely manner and

where permanency of opening is desired, the low operation is selected. Generally, since it is a highly vascular structure, the thyroid gland is avoided. If for any reason it is desirable to make the incision at that portion of the trachea, the second and third rings, where its isthmus lies, then two ligatures should be passed around it, one on each side of the median line, and securely tied.

The reasons for performing tracheotomy are numerous and generally imperative. It is done as a precautionary measure to secure free respiration and to prevent the entrance of blood into the air-passages when a long and bloody operation is to be done in the mouth or pharynx or naso-pharynx. It is done when a foreign body is in the larynx, sometimes to give access to air and sometimes to effect the removal of the foreign body; in syphilitic and tubercular ulceration and in malignant stenosis of the larynx, to afford rest to that organ; in certain paralytic and spasmodic affections of the laryngeal muscles threatening suffocative dyspnea; in croup, diphtheria, and acute inflammations of the larynx that greatly diminish the lumen; and in edema of the glottis. So frequently has it been mentioned in discussion of diseases of the larynx and trachea that the student is already familiar with the indications for its employment.

Sometimes the necessity for tracheotomy is so urgent that the surgeon has opportunity for choice neither of instruments nor site. A sharp penknife may be used, and the shape of the neck, and even the attitude of the patient, may determine the location of the operation. If, as is often the case with children, the neck is fat and short, the high operation or that through the thyroid gland will be the only possible one. If the neck is long and thin, the incision may be made close to the sternum, always in the median line if possible, for there hemorrhage is least and the tissues most easily separated. If, in the hasty operation with a life at stake, a plexus of veins or an artery is found crossing the middle line, the risk must be taken with confidence in stopping the hemorrhage after the immediate danger is past. If the more leisurely operation is possible, such vessels may be pushed aside or divided between two ligatures.

Operation.—Unless the patient is already unconscious, an anesthetic should be given or cocain injected locally. A firm pillow or sand-bag is placed under the back of the neck and shoulder so as to stretch the trachea and make it more prominent. An incision is made in the middle line, beginning at the level of the cricoid cartilage and proceeding downward for a distance of five to seven centimeters. The skin, subcutaneous tissue, and platysma are divided; the remaining muscles in front of the trachea can be separated by the handle of the knife. The left hand of the operator now steadies the trachea while the remaining tissues are dissected through and the rings of the trachea exposed. All hemorrhage having been arrested, a sharp hook or tenaculum is now inserted into the trachea to bring it forward and hold it steady while it is being opened. The rings of the trachea are easily felt by the point of the finger, and cannot be mistaken for anything else. A sharp-pointed knife is the best for making the opening, and it should be pushed through the wall of the trachea with a sharp, quick thrust, as this prevents the mucous membrane from being stripped off and carried

before the point of the knife. Two or three rings are divided or the cricoid cartilage and one ring. As soon as the windpipe is opened air rushes in, and blood, air, mucus, and perhaps false membrane are driven out with each expiration.

If the operator is acting in an emergency and has no tubes at hand, all he has to do is to pass a silk thread through the edge of the tracheal wound and the skin on either side. The thread can be secured to a piece of elastic passing behind the neck. Thus the tracheal wound can be kept wide open.

Tubes made of aluminum are the lightest, and in that respect the best. Those made of hard rubber or silver are also used. They are

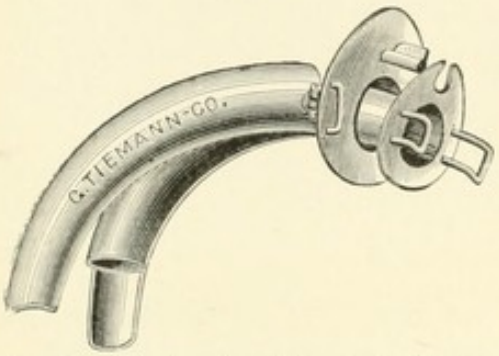


FIG. 267.—Gendron's split cannula, silver.

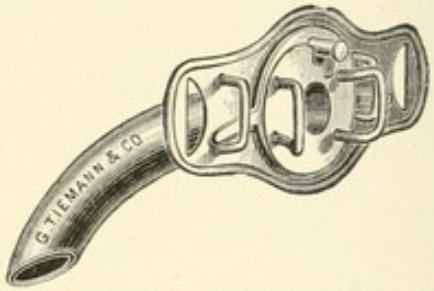


FIG. 268.—Little's aluminum trachea-tube.

graduated to suit the size of the windpipe, and are made double to allow of the inner tube being withdrawn and cleansed (Figs. 267, 268, 269). Selecting the largest tube which the trachea can conveniently receive, the tracheal wound is held open either by the silk threads already mentioned or by the handle of the knife held transversely, and the tube slipped into position.

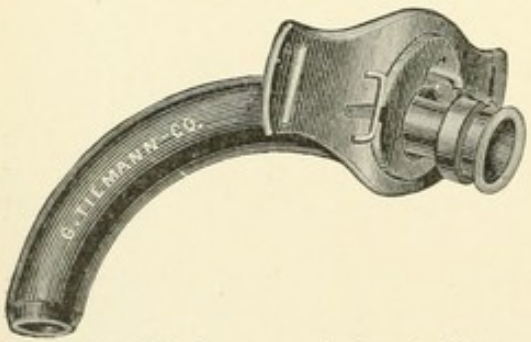


FIG. 269.—Trachea-cannula, hard rubber.

The after-treatment requires the utmost care. The air of the room should be kept moist and maintained at a temperature of about 80° F. A few folds of sterilized gauze should lie loosely over the front of the neck to filter the air as it enters the tube. The tube is to be kept clear of mucus by passing a damp feather through it from time to time, and once or twice a day the inner portion should be taken out, thoroughly cleansed, and returned. In cases of diphtheria five to ten days is a sufficient time to retain it. If the operation has been resorted to for the removal of a foreign body, one or two days will suffice. In cancer of the larynx or other permanent obstruction the tube must be retained permanently.

Intubation of the Larynx.—Thanks to Dr. O'Dwyer of New York, we have a device which can be employed without a cutting operation, and which in a large proportion of cases answers all the purposes of tracheotomy.

Intubation of the larynx is indicated in diphtheria and croup, in some cases of dyspnea caused by burns and scalds, and in pressure upon the larynx from tumors. The instruments necessary for the operation are made in sets, and consist of tubes of sizes suitable for patients from early infancy up to twelve years of age (Fig. 270). The proper tube for each case is found by consulting the scale *B*, which indicates the length of the tube and the age for which it is suitable. No 1 is proper for a child up to eighteen months old; No. 2, between eighteen months and three years; No. 3, for the fourth year; No. 4 from five to seven years; and No. 5, from eight to twelve years. When the tube is to be inserted a silk thread is passed through a small hole near the anterior angle of its upper opening. Should the tube be placed in a wrong position, it can be withdrawn by means of this thread. The obturator is next screwed into the introducing handle and slipped into the tube. The nurse holds the child upright on her lap with its arms controlled by a sheet. An assistant controls the little patient's head, and at the

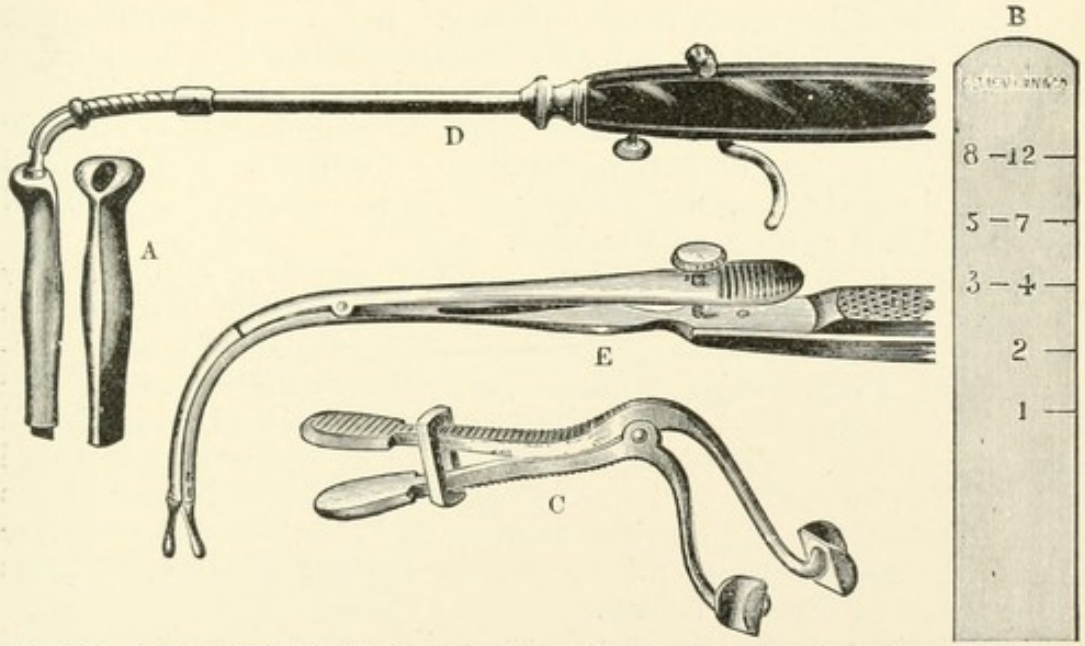


FIG. 270.—O'Dwyer's intubation instruments: *A*, tube; *B*, scale; *C*, mouth-gag; *D*, introducer; *E*, tube-extractor.

proper moment inclines it backward. The operator, seated in front, inserts the gag (*C*) and opens the mouth as widely as possible. The introducer is taken in the right hand with the silk thread looped around the little finger. The index finger of the left hand is passed in to the epiglottis. The epiglottis is raised, leaving the glottis uncovered and ready to receive the tube. At the same instant the tube is passed back to the end of the left finger, and by it is guided into the glottis. This is the only difficult part of the operation. The end of the tube must be kept exactly in the middle line; it must keep in close contact with the under surface of the epiglottis, now held upright by the finger; the finger must guide it to the opening, and then move to one side to let the tube pass; the other end of the handle is now sharply raised, and the left finger feels that the posterior wall of the larynx is behind the tube. The tube is then pushed on to its position, and by a move-

ment of the sliding thumb-piece on the handle quickly disconnected and the handle and finger withdrawn from the mouth. If breathing goes on satisfactorily through the tube, the thread is withdrawn, the index finger again being used to press upon the upper end of the tube and prevent its withdrawal while the thread is pulled out.

The removal of the tube after it has served its purpose requires a little skill. The patient is held as before. The operator, taking the extractor (*E*) in his right hand, introduces his left index finger, and, guided by it, the end of the closed extractor is inserted into the opening in the tube; by the aid of the thumb-piece the blades are sprung apart and the tube withdrawn.

Skill in the use of these instruments can be secured by practice on the cadaver, and it is a duty which the student owes himself and his patients to obtain this dexterity before attempting the operation on the living.

Laryngectomy.—When the larynx is the seat of a sarcoma or a carcinoma which does not involve the neighboring tissues or glands, the operation of laryngectomy is indicated. It has also been resorted to for the relief of stenosis and of lupous, syphilitic, and tuberculous diseases. Some very satisfactory cases have been reported.

Operation.—If there is sufficient time, a preliminary tracheotomy should be made one or two weeks before the major operation, and when practicable the tracheal opening should be high up, so that it will be included in the subsequent incision.

First Step: The Incision.—This should extend from a little below the chin to within an inch of the sternum, keeping exactly in the middle line throughout. The superficial tissues are divided and the deep muscles separated until the larynx proper, as well as the membranes above and below it, is exposed. The isthmus of the thyroid gland is divided between ligatures. Divided vessels are secured by forceps and afterward ligated. The larynx is next freed from the muscles and other tissues which are attached to it, provided they are free from disease; otherwise the dissection must go beyond the growth, so that the diseased parts can be removed with the larynx.

Second Step: Removal of the Larynx.—The esophagus is separated from the first ring of the trachea and from the posterior surface of the cricoid cartilage. The esophagus ends at the upper border of the cricoid cartilage, and is divided here when the larynx is removed. The patient is breathing through the tracheal cannula, and it is of great importance that no blood be allowed to enter by the side of the instrument. Michael's device for this purpose is very simple. He perforates a cylindrical piece of sea-sponge, moistens it, and then runs the cannula through it. The sponge is now allowed to dry, and is surrounded by a water-tight membrane which is secured tightly by tying it to the cannula at the top and bottom. It is then covered with a solution of gutta-percha. After its insertion the sponge is moistened with an antiseptic lotion injected into it by a hypodermic syringe. The larynx is now separated from the trachea, and to further guard against the intake of blood the divided end of the trachea is plugged as far down as the cannula. The upper and lateral attachments of the larynx are now quickly divided and the larynx lifted out of its position. A careful

search is made for diseased tissue, and if any remain it is thoroughly removed. The tracheal tube is left in its former position or it may be inserted into the upper end of the trachea.

Third Step: Care of the Wound.—It is best not to close the wound, but to allow it to heal by granulation, which it does with great rapidity. Packing with strips of iodoform gauze and careful tamponade of the tracheal tube are all that is required. The esophagus having of necessity been opened, the packing must be so arranged that should the patient vomit the whole of the dressing need not be removed. At the end of two days the patient is fed by introducing the end of a stomach-tube into the esophageal opening, and this will have to be continued for about three weeks, when the tube can be passed by the mouth.

Much improvement to the patient's condition is obtained by the use of an artificial larynx made of light metal. Indeed, ingenuity has gone so far that the new larynx is provided with vocal cords, by means of which the patient can speak so as to be heard and understood at a reasonable distance. The successful cases in this operation are 25 or 30 per cent.

Unilateral laryngectomy, by which is meant the removal of a lateral half of the larynx, is performed exactly on the same principles as the complete operation. It is less hazardous, but, on account of the limited space, more difficult of performance.

VIII. THE CHEST.

Wounds occur chiefly as stabs or as bullet-wounds, and their most serious aspect is the internal hemorrhage which they produce. Wounds of the heart have already been considered. When one of the great vessels is opened, the result is generally speedy death. A wound of the lung is recognized by the patient expectorating blood. Collapse of the lung on one side or the entrance of air into the wound would indicate that the pleura was perforated. Paralysis of the diaphragm points to division of the phrenic nerve. Sudden collapse and death would indicate the severance of a large vessel or a wound of the heart. Profuse external hemorrhage is probably due to a wound of an intercostal or the internal mammary artery.

Treatment.—A wound of the chest should not be probed, for no additional information can be gained thereby, and a clot may be broken up which was doing good service in arresting hemorrhage. The intercostal arteries are not difficult to reach, and can be ligated. The internal mammary lies about half an inch from the edge of the sternum, and can be secured by passing a curved needle around it carrying a ligature. In most cases patients who survive the immediate effect of a wound will have to be treated on the expectant plan and kept at rest.

Effusions into the Pleural Cavity.—One or both pleural cavities may be more or less filled with collections of blood, serum, or pus. Blood as an effusion is, as a rule, the result of a stab-wound or a traumatism sufficient to fracture a rib and drive the fragments into the lung, thus producing hemorrhage. When the collection of blood is moderately large, coagulation takes place and the serum is separated from the

clot. In the course of three or four days the serum is absorbed. If, however, septic germs gain an entrance, suppuration is the result and the serous effusion becomes a collection of pus (empyema).

Much more frequently the cause both of serous and purulent collections in the pleural cavity is pleurisy, and when the ordinary resources of medical treatment prove unavailing, the surgeon is called upon to relieve the condition by operation.

The signs of a collection of fluid in the pleural cavity are the same whether the fluid be blood, serum, or pus. The symptoms are different; if the signs of an effusion come on within a few hours or even a day or two after traumatism, the effusion must be blood; if the signs of effusion are preceded by an attack of pleurisy, the fluid is at first probably serum, and later pus. The signs of effusion are as follows: There is a history of pleurisy or of a traumatism; the patient has a tendency to lie on the affected side; that side of the chest is fuller than the other side, because it is distended with the fluid; consequently it measures more. Place the end of a tape on the spinous processes behind and bring it around to the middle line of the sternum, and you will find a difference of an inch or more between the two sides. The fluid bulges out the intercostal spaces and separates the ribs farther from one another. The fluid pushes the heart to one side, and it is not uncommon to find it on the right side of the chest when the left pleural cavity is filled with fluid. Even the large, heavy liver is displaced, and of course that displacement is downward. On percussion the area occupied by the fluid is as dull as a board, and on palpation there is no friction or vocal fremitus. What do you hear on auscultation? Absolutely nothing. In many cases the level of the fluid changes with the position of the patient, just as happens in ascites. Sometimes there is so much fluid that there is dulness up to the level of the clavicle. No wonder that the patient wishes to lie on the affected side, so as to allow the fluid to find its lowest level, instead of pressing over against the healthy lung and interfering with his respiration. The well lung has more to do than it had before, consequently there is exaggerated vesicular resonance heard on auscultation. If in spite of all these signs the surgeon is an unbelieving Thomas, he can thrust his hypodermic needle into the side and settle the question definitely. Edema of the chest-wall is considered an indication that the contained fluid is pus.

Treatment.—The presence of a considerable quantity of fluid causes compression of the lung, and the longer this pressure continues the less likely is the lung to return to its normal position. If the fluid be pus, the patient becomes emaciated and falls into that train of symptoms which we if necessary sum up in the one word—hectic. For the simple removal of fluid the operation of paracentesis thoracis is resorted to. This was formerly done by a simple trocar and cannula, but Dr. Bowditch greatly improved upon this method by the invention of the syringe which bears his name and which has led to the various forms of aspirators. In the withdrawal of fluid the two points to be kept in view are to get rid of the fluid as thoroughly as possible and to prevent the entrance of septic germs, either on the needle or by the entrance of air. The aspirating needle and the skin over a considerable area should be

as carefully sterilized as for a laparotomy. The opening made by the needle should afterward be closed by iodoformized collodion and absorbent cotton. The most suitable place to insert the needle is just below the lower angle of the scapula or at the side of the chest just in front of the latissimus dorsi muscle. If the fluid is found to be serous, the prospect of its not returning is fairly good; if it is purulent, further operative procedures will almost surely be required.

Thoracotomy.—An empyema, like a collection of pus anywhere else, should be treated by incision and drainage. The simplest operation consists in making an incision about two inches in length over the eighth or the seventh, or even as high as the sixth, intercostal space and just in front of the latissimus dorsi muscle. The skin is drawn upward, so that the opening will be valvular. Dissecting through the thoracic wall, the pleura is reached, and to be on the safe side an aspirating needle is thrust into it. If pus escape, the pleura is then incised to the length of about an inch. Two drainage-tubes are inserted side by side. When necessary the pleural cavity can be washed through these tubes.

It often happens that the ribs are close together and compress the rubber drainage-tubes, rendering them useless. The proper thing to do under these circumstances is to resect a piece of the rib (about an inch), and the seventh is generally the one chosen.

Thoracoplasty, or Estländer's Operation.—In favorable cases the pus-cavity is drained away, and the lung, expanding to its former position, fills the pleural cavity once more. It often happens that our hopes in this respect are disappointed; the empyema continues and the lung remains collapsed. It then comes to be a question of Mohammed going to the mountain, since the mountain refuses to come to the prophet. Estländer's operation is designed to cause the chest-wall to fall in to meet the lung.

In the simpler class of cases it is only necessary to make an incision from the axilla downward and remove pieces from the third to the eighth rib. In the more obstinate cases it is necessary to make an incision both in front and behind, removing so much of the ribs as is requisite to cause the required "staving in."

In old intractable cases Schede has devised a still more radical operation. He made an incision from the level of the axilla in front, sweeping downward in the form of an ellipse to the lower limb of the pleura and ending at the second rib behind (Fig. 271). The flap is dissected upward and the scapula lifted from the trunk. The ribs, the entire muscular wall, and the pleura are removed from the second rib downward, the line of section being in front at the cartilage and posteriorly at the tubercles. The cavity is then curetted and the flaps replaced.

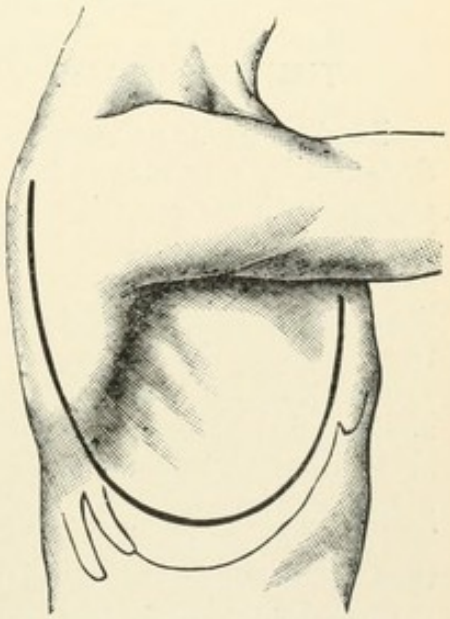


FIG. 271.—Incision for Schede's operation of thoracoplasty (Esmarch and Kowalzig).

This is a serious operation. In a case requiring less surface of chest-wall I make a less extensive incision, as seen in Fig. 272.

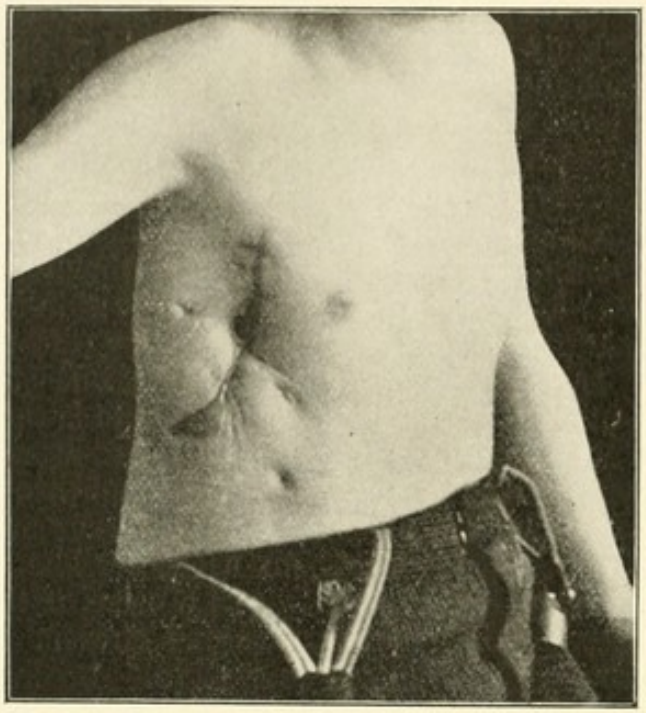


FIG. 272.—Result of thoracoplastic operation.

CHAPTER XII.

THE DIAGNOSIS AND TREATMENT OF SYPHILIS.

Modes of Transmission.—Syphilis is an hereditary disease, but it does not by any means follow that all the children of parents who are one or both tainted with syphilis shall be syphilitic. According to the law of Profeta (sometimes called Profeta's immunity), the children of such parents may be born healthy, remain healthy, and be all their lives proof against syphilis as if they had at one time suffered from the disease. This immunity is explained on the ground that the tissue-products of the virus pass into the fetal blood and protect the system against future contamination; just as vaccine virus protects against small-pox. The mother of syphilitic children, who have inherited the disease from a tainted father, may herself remain free from the disease. This is known as Colles' immunity, and is accounted for by assuming that the tissue-products of the virus have passed from the fetal into the maternal circulation and protected the mother.

As a general rule, syphilis is contracted by impure sexual intercourse, but it must not be forgotten that the disease is frequently acquired or transferred by other avenues. It may be contracted by kissing, by smoking an unclean pipe, or by drinking out of a contaminated vessel. The surgeon, accoucheur, or nurse runs a risk in the

discharge of professional duties, and there is danger every time an abraded surface comes in contact with instruments or other articles contaminated with the syphilitic virus.

The *diagnosis* of syphilis is greatly simplified by dividing the disease into stages, as follows:

1. The stage of incubation. This is the period which intervenes between the time of exposure to the virus and the first appearance of the initial sore.

2. The period of primary symptoms, in which chancre and affections of the adjacent glands appear.

3. This is a period of repose. It lasts about six weeks, and during this time the virus is incubating for the secondary symptoms. It is sometimes called the period of secondary incubation.

4. Secondary symptoms, characterized by mucous patches, erythematous, pustular, papular, and tubercular affections of the skin. This period may last from one to three years.

5. The secondary symptoms may subside, and under proper treatment the patient may be apparently cured, but it is by no means certain that the virus is entirely exhausted. He must be kept under observation for a period varying from two to four years. During this time his children, if any are born to him, are likely to be syphilitic. At the end of the fourth year one of two points is settled—either that he has been cured or that he has entered upon another stage of the disease—viz. the period of tertiary syphilis, which is unlimited in duration. The bones now suffer, and we find periostitis, osteitis, nodes, etc. Gummata are found in one or more parts of the body, and there are tuberculo-ulcerous syphilides of the skin.

No two cases of syphilis are exactly alike, and yet the family likeness is marked in all. The whole category of syphilitic manifestations, protean in their form and irregular in their clinical history, possess certain peculiarities that belong to no other class of eruptive diseases. When called upon to differentiate the lesions peculiar to the secondary or tertiary stage of this malady, no part of the body should escape inspection. The closest scrutiny should be made of old scars, alopecia, enlarged glands, gummata, mucous patches, condylomata of the genital and anal regions, ulceration of the pharynx, iritis, and macular eruptions.

The Primary Sore—Hard Chancre.—At the end of the period of incubation, which is never before the tenth day and may be prolonged to or beyond the thirtieth, the "initial lesion," "primary sore," or "hard chancre" begins to appear. It is an *abrasion*, an *erosion*, or a papule that subsequently breaks down and ulcerates. Its shape is round or oval. Its edges are slanting and adherent to the tissue beneath them. The *discharge* is scanty and serous unless the sore has been irritated. Its *base* is indurated, but it must be borne in mind that the peculiar induration which has earned for it the name of "hard chancre" is caused by cell-proliferation, and is not fully developed before the tenth to the fourteenth day. The chancre is painless. Within a week the glands become indurated. The inflammation is indolent, and there is no tendency to suppurate. The sore is usually solitary; if several lesions appear, they come simultaneously.

The *diagnosis* between "hard" and "soft" chancre is of the utmost

importance. A soft chancre or chancroid has a short period of incubation; it appears *in from twenty-four hours to eight days.* Chancroid makes its appearance as a pustule. Its shape is round or oval; its edges present the appearance of having been punched out and undermined; the discharge is creamy and puriform; its base is soft and supple, tender, and at times exquisitely painful upon pressure. The ulcer follows the natural anatomical lines or folds of the integument. It is frequently complicated with bubo and inclined to suppurate.

The following table presents the differential diagnosis between chancre and chancroid:

CHANCRE.	CHANCROID.
Cause.—Syphilitic germ or virus.	Inoculation by the secretion of chancroid.
Incubation.—Ten to thirty days; average three weeks.	First symptom makes its appearance in three to seven days. Sometimes within twenty-four hours.
Number of Lesions.—Usually solitary; when more than one, all appear at the same time.	Usually more than one after appearing successively, by auto-inoculation.
Color.—Dull, sometimes red or dirty white; secretion serous and scanty, frequently scales.	Dirty yellowish color, like wet chamois skin. Secretion purulent and profuse, not inclined to the formation of scales; the surface is always moist.
Subjective Symptoms.—Pain usually absent; not much tenderness on pressure.	Exquisitely tender, especially on pressure.
Induration.—Base of ulcer hard and inelastic by the tenth day.	Base of ulcer pliable; no induration.
Edges.—Sloping and adherent.	Present the appearance of having been punched out; frequently undermined.
Glands.—Both sides indolent; not inclined to suppurate.	More often one side affected and inclined to suppurate. In about one-third of all cases a bubo is present.
Treatment.—Apart from cleanliness, local treatment is of no importance.	Local applications the all-important treatment. Internal medication is of no use.

The chancre must be differentiated from herpes progenitalis, balanitis, venereal warts, epithelioma, and chancroid.

The herpetic lesion differs from that of syphilis in its multiplicity and in its vesicular and transitory nature, and, like balanitis, in yielding quickly to treatment; also, as in balanitis, there is no ulceration, no induration, and no glandular complications.

Venereal warts differ from chancres in that they are more indurated, seldom ulcerate, are not accompanied by adenopathy, and are more persistent. They are rarely found in other than the progenital region.

Epithelioma usually occurs after middle life in both sexes, whereas syphilis is more often observed in young adults, and the lesion of epithelioma is usually far more persistent than that of syphilis, and is generally found in the glans penis, presenting the appearance of a flattened papule, a shallow erosion, or a warty elevation. It may be accompanied by induration and adenopathy, but is usually inactive and only affects the glands in the advanced stage of the disease.

Treatment of Chancroid.—There are two methods of treatment. The first relies upon cleanliness and the local application of antiseptic remedies. This is frequently all that is required to arrest the destructive action of the peculiar microbe and the further progress of the lesion. Many surgeons never omit, in any case, to adopt the second method, cauterization, which aims to destroy at once the germs and convert the

chancroid into a healthy sore. It is quite necessary that all irregular habits of life should be duly corrected, and when the lesion is serious and other complications threaten, the recumbent position should be rigidly enforced. In simple cases, occurring in patients otherwise healthy and robust, no internal medication is required. In other cases, that are weakened by excesses or disease, it will be proper to administer tonics and direct attention to all the details that will improve the general health.

The antiseptic treatment of the disease consists in keeping the ulcer thoroughly clean by washing it with soap and warm water, followed by an irrigation of dilute peroxid of hydrogen, sublimate solution (1 : 2000), carbolic acid (1 : 40), or the application of lint which has been previously wet in either of the latter two. The ulcer should be completely covered, and in no case must it be allowed to lie in contact with the healthy mucous membrane or skin, as the parts are sure to become infected and new lesions are certain to appear. This precaution must be carefully observed in females: the walls of the vagina and vulva should at all times be separated by the interposition of lint or absorbent cotton previously wet with one of the above solutions. These should be changed at intervals of two or three hours.

Many surgeons prefer to keep the ulcer thoroughly cleansed by frequent ablutions of antiseptic solutions and apply to it a powder, constituting a dry method as opposed to the wet or moist dressing. For this purpose iodoform, hydronaphthol, aristol, acetanilid, and calomel are valuable. Iodoform undoubtedly occupies the first place as the most potent agent that can be applied; its power to overcome the microbe of chancroid is second to none; its chief objection is its odor: if, however, care be taken in its application to prevent its falling on the clothing, scarcely any odor will be noticed. A very good plan is to make an ethereal solution and spray it on the ulcer; the ether will speedily evaporate, leaving a thin film. Care must be taken that the undermined edges are thoroughly reached. When the floor of the chancroid loses its dirty yellowish appearance and becomes red and filled with healthy granulations, the application of iodoform may be omitted, and the use of mild odorless antiseptics substituted.

For the purpose of cauterization the actual cautery or chemical agents may be employed. The actual cautery is preferable if it is convenient; if not, nitric acid or carbolic acid can be used. The ulcer should be thoroughly cleansed and carefully dried; a 4 to 8 per cent. solution of cocain is then applied to the surface of the ulcer or a few drops may be injected subcutaneously beneath the base. Care must be observed that every part of the lesion is brought in contact with the cautery. After cauterization, lead-water dressings are applied, and the patient put to bed until the reaction has subsided. Cauterization is becoming less frequently used than formerly; it often fails to arrest the progress of the lesion; the sore assumes a fierce and obstinate aspect, and the pain and soreness are greatly increased. Cauterization, therefore, as a routine practice should be condemned. In all cases where the ulcer is intractable with pain, swelling, phimosis, and paraphimosis, the parts should be submerged in hot boric-acid water for hours at a time. In the female the vagina should be frequently and repeatedly

irrigated with a saturated solution of boric acid as hot as can be borne. In the treatment of phagedena, phimosis, and paraphimosis no more potent and effectual remedy can be adopted than hot water; hot sitz-baths may be employed, the patient spending the greater part of his time in the bath. The vitality of the microbe is destroyed by the persistent use of water at a moderately high temperature.

Some authorities advise incision of the prepuce for the relief of phimosis or paraphimosis. This procedure should not be adopted until the measures already mentioned have been tried, as it is almost impossible with the greatest attention to antisepsis to prevent the infection of the wounds. Should an incision be made, the chancroid should previously be cauterized, as also the wounds as soon as they are made.

Bubo not infrequently complicates chancroid. It may be of an indolent, non-suppurating character or it may assume the virulent type. It is well to employ the usual remedies to combat suppuration, as pressure with a spica bandage, rest in the recumbent position, iodin externally or a solution of iodoform in collodion frequently applied to the swelling. The proper strength is iodoform 15, collodion 1$\frac{5}{3}$. Injections of various antiseptics into the bubo itself have been followed by dangerous results, and are not usually effectual. When it becomes obvious that suppuration has taken place or when further intervention is ineffectual, free incision should be made with careful antiseptic precautions, all glandular tissue wholly or in part involved should be removed, the parts curetted if necessary, washed with hot boric-acid solution, and dressed with iodoform gauze.

Treatment of chancre consists in cleanliness; in the majority of cases no other treatment is necessary. Small pieces of lint made moist by dipping them in solutions of sublimate and frequently changed, calomel lightly dusted upon the ulcer, unguentum hydrargyri, aristol, and iodoform are all appropriate. In women the labia should be well separated by pledgets of lint. Buboes complicating chancres are best treated by frequent ablutions of hot water, followed by the inunction of mercurial ointment. The habits of the patient should be regulated to comply with the strictest rules of hygiene. In general, it is best to withhold specific medication until the appearance of secondary manifestations, since the early exhibition of these remedies has a tendency to retard to a remarkable degree the appearance of these lesions.

Syphilis has no respect for any of the tissues of the body: the integument, the bones, the viscera, and connective tissue are all liable to become invaded.

The Secondary Stage.—We have seen that the period of primary incubation occupies from ten to thirty days or more. The chancre and its attendant glandular swellings have taken their course, and the period of secondary incubation is going on. There is no stated period at which the chancre disappears. It may persist until after the evolvement of systemic symptoms or terminate earlier. It terminates in simple resolution except in those cases which ulcerate, and in these a characteristic scar remains.

The invasion of the different tissues of the body by the syphilitic virus is very slow and insidious, and during the early part of the sec-

ondary incubation gives no evidence of its presence. During the latter part, however, within a week or two before the eruption, the patient exhibits not infrequently a sallow complexion, and still later a marked degree of pallor. He complains of malaise and lassitude, loss of sleep and appetite, and a depression of mind and body. He has pains in the muscles and bones, and perhaps effusion into the knee- and elbow-joints. Just preceding the eruption there is an elevation of temperature; this is the syphilitic fever. The temperature is rarely high unless the eruption is to be of a pustular nature. It ranges from 101° to 103° F., sometimes 104° or 105° F. This fever endures for several days, possibly for weeks. A short time before the eruption the superficial glands become enlarged and constitute an important element in diagnosis. The extent and general involvement of these glands are in proportion to the severity or malignancy of the disease, and also to the susceptibility of the patient to the influence of the poison. The glands most frequently involved and conspicuous are the submaxillary, submental, occipital, femoral, and the anterior and posterior auricular. These vary in size from a pea to a small hickory-nut; they are movable, indolent, and painless. Within a few days a rash appears, usually, though not always, in the form of roseola, and is frequently so mild that it is overlooked by the patient and even by the medical attendant.

The lesions of secondary syphilis are inclined to be superficial and confined to the integument; they are somewhat rapid in their development and progress as compared with lesions of the tertiary stage. They are also more symmetrical, show a more benign disposition, and are more easily influenced by specific medication. This stage includes those lesions of the skin that are described as erythematous, papular, pustular, and vesicular syphilis.

The **syphiloderm** may be confounded with all other known affections of the skin. While they are not confined to any particular portion of the integument, the different forms of eruptions exhibit a marked preference for certain localities. On account of their close resemblance to the non-specific affections of the skin they demand careful study and consideration.

The following points should be observed: their color, situation, pigmentation, polymorphism, absence of subjective symptoms, grouping and shape of lesion. No single case of syphilis will be likely to include all of these distinctive features, and neither of them, taken singly, would justify a diagnosis of syphilis; taken together, they constitute a complete index to the character of the malady in question. They are essentially chronic, and are not generally accompanied by even a moderate degree of inflammation.

Color.—In their early stages they are of a bright-pink or pinkish-red tint, but not so red as is common in exanthemata. The older they become the more they fade, until they assume a brownish-red, copper, or raw-ham color. Pressure upon the early lesions causes them to disappear, but later, when they have acquired the copper color, it becomes permanent. It should, however, be remarked that the natural complexion of the patient modifies to a great extent the appearance of the lesion. In the blonde it is red, in the brunette it is brownish red, and in persons who are broken down, pallid, and cachectic there is

more of a livid purple hue. Upon the lower limbs in nearly all cases the color is darker than upon the trunk and upper extremities.

Location.—Syphilitic eruptions show a preference for certain parts of the body where non-specific eruptions do not often develop. They are common upon the scalp about its junction with the forehead, at the angles of the mouth, upon the nose, about the anus and genitals, upon the palms and soles, and in the groin.

Polymorphism.—In non-specific eruptions of the skin there is usually a uniformity in the type of the eruption. In syphilis it is quite common to find erythematous, papular, and pustular lesions on different parts of the body at the same time.

Subjective Symptoms.—The lesions, owing to their indolent, chronic, and non-inflammatory character, do not excite much distress. Pain and itching are usually absent.

Mucous Patches.—On mucous membranes syphilis assumes a form which is very characteristic. When a papule—that is, an inflammatory swelling of the corium and papillæ—occurs upon a mucous surface and is subjected to constant moisture and warmth, the epithelium becomes macerated and disappears. The surface occupied by the papule becomes broader and its color changes. Sometimes, as on the palate or lips, the mucous patch has a whitish appearance, as if it had been touched with nitrate of silver. In the skin it is red and shining. The shape is circular or oval and the epidermis is thickened. The appearance of mucous patches is such that when once seen they cannot be mistaken for anything else.

The nails should always be examined in syphilis. Inflammation around them occurs in two forms, the dry and the moist, and occasionally results in their dropping off.

Irregularity in the Evolution of Syphilis.—In many cases the course, character, and duration are extremely mild; the secondary manifestations are so simple and yield so readily to treatment that this form has been called "benign syphilis." In other cases from the commencement of the initial lesion the progress of the disease is rapid, the lesions develop precociously, the secondary stage is wanting, and the tertiary stage appears instead. It is fierce and intractable; its ravages are frightful and hideous to observe. All efforts to arrest its onward march are unavailing, and the unfortunate victim yields the palm to the Mephisto of all diseases that afflict mankind.

Syphilides appear in two forms, the dry and the moist. In diagnosis the most common source of error is between syphilitic tubercles and lupus vulgaris. The following table, from *An American Text-Book of Surgery*, is valuable:

Tubercular Syphilide.	Lupus Vulgaris.
Occurs chiefly among adults; considerable infiltration of skin.	Occurs commonly in young persons; when in adults there is often history of a similar eruption in childhood.
Tubercles opaque and of deep brownish-red color.	Not so marked. Tubercles often translucent and lighter in color.
The characteristic ulcer produced in a month or two.	The same amount of ulceration would require several months, or even years, for its development.

Tubercular Syphilide.	Lupus Vulgaris.
Ulcers usually distinct.	Ulcers apt to be confluent.
Ulcers deep and extensive.	More superficial and involving smaller area.
Ulcers small, circular, and punched out.	No regular form or perpendicular edges.
Secretion copious and sometimes offensive.	Secretion slight and inoffensive.
Crusts bulky and greenish.	Crusts thin and dark-colored.
Scales irregular in shape and attachment.	Scales arranged more regularly, attached in the center and loosened at the edges.
Cicatrices soft, white, circular.	Cicatrices distorted, irregular, puckered.
History and concomitant symptoms of syphilis.	No history except as a coincidence.
Local treatment ineffective; internal specific treatment effects a cure.	Eruption disappears only under very active local treatment, as curetting, or under the influence of tuberculin.

The Tertiary Stage.—Tertiary lesions do not manifest themselves, as a rule, before the third or fourth year, and in a large proportion of cases do not develop at all. Their early appearance signifies a severe type of the malady. This stage includes those lesions that are usually termed tubercular, bullous, ulcerative, and gummatous syphilides. They are slow and indolent in their development and course, deep-seated, intractable to treatment, show a lack of symmetry, are scantily distributed, and are often terribly distinctive. The lesions of the secondary stage are found to be superficial; those of the tertiary period are deep. To give them in detail would be beyond the scope of this work, for they involve almost every organ and tissue in the body, and have been referred to as these organs have been discussed. A brief summary is all that can be given:

1. *Tubercular syphilides* are large and greatly hypertrophied papules, and stand upon the borderland between the secondary and tertiary stages. They are flattened pimples attended with a thickening of all the tissues of the skin. They occur singly or in groups.

2. *Gummata* are almost identical with tubercles, but have these distinctions: they go beyond the skin and involve the subcutaneous cellular tissue; they make their appearance at any time between the first and the thirtieth year after the appearance of the initial sore; they pass through four stages—viz. formation, softening, ulceration, and repair.

3. *Lesions of the Bones.*—The forms of bone-disease comprise periostitis, osteo-periostitis, and osteo-myelitis. The characteristics of syphilitic bone-lesions are the following: they are painful; the pain is worse at night and the affected part is exquisitely sensitive to touch; the disease responds readily to iodid of potassium. The bones commonly affected are the tibia, ribs, sternum, clavicle, skull, and face-bones. The disease most likely to be confounded with it is tubercular osteitis.

Syphilitic Osteitis.	Tubercular Osteitis.
Location.—Common in the bones of the skull.	Seldom attacks these bones.
History.—History of chancre and evidences of syphilis in other tissues.	History of tuberculosis, and manifestations in lungs, glands, or other organs.
Effects of Treatment.—Yields to antisyphilitics.	Affected by no treatment except removal or injection with iodoform.
Course.—Seldom suppurates.	Generally ends in suppuration.

4. *Syphilis in the Testicles.*—In the genitals of men we frequently have the chancre, followed by gummatous deposits in the epididymis

and core of one or both testes, the distinctly circumscribed indurated mass being readily recognized by palpation. Syphilitic epididymitis is to be differentiated from gonorrheal epididymitis by remembering that syphilis usually attacks the globus major, while gonorrhea affects the globus minor, and also from the history of a chancre in one and discharge in the other. Sometimes in cases of urethral chancre it is hard to get a correct history, as there would be a discharge from both, which might, however, be differentiated by the microscope.

Tuberculosis of the testicle usually follows involvement of the prostate, and tuberculous subjects are rarely syphilized. Syphilitic deposits may sometimes be found in the corpora cavernosa, urethra, or base of of the penis, but they are rare in these localities. Syphilitic orchitis is a not infrequent accompaniment of late syphilis, and, as it comes on insidiously, is often present without the patient's knowledge.

In the female syphilitic gummata are sometimes observed in the vulva, and deposits or ulcers may be discovered in any part of the genital tract, but are rarely found in the uterus, tubes, or ovaries.

The main points of difference between syphilitic orchitis, encephaloid carcinoma of the testicle, and tubercular orchitis are brought out in the following table, from *An American Text-Book of Surgery*:

Syphilitic Orchitis.	Encephaloid Carcinoma of Testicle.	Tubercular Orchitis.
Syphilitic history.	No history of any special condition.	Tubercular history.
Usually occurs at about twenty-five or thirty years of age.	Any age.	Not often seen after thirty.
Begins in the testicle.	Begins in the body of the organ.	Begins in the epididymis.
Is situated primarily in the connective tissue.	Begins by the deposit of small nodules in the seminiferous tubules.	Exists primarily in the tubules.
Tends to fibrous overgrowth.	Tends to formation of patches of softened, white, pultaceous material.	Tends to fatty, caseous, or purulent degeneration.
Slow in its progress.	Rapid in its course.	Slow in its progress.
Skin of the scrotum rarely involved.	Skin of the scrotum finally involved.	Skin involved only just before the formation of abscess.
Ulceration or suppuration rare.	Ulceration and fungus common.	Suppuration common.
Fistulæ uncommon.	Fistulæ common.	Fistulæ common.
A feeling of great weight, with only such pain as results from dragging on the cord.	Pain severe and lancinating in advanced stages.	Little pain.
Tumor very hard, uniform.	Soft and fluctuating.	At first hard, knotty, irregular.
Skin of scrotum purplish, but unaffected.	Network of large veins over surface of tumor.	Skin congested, but otherwise unaffected.
Of moderate size; rarely exceeds twice its normal diameter.	Attains great size.	Of moderate size.
Painless on pressure.	Painless on pressure.	Often painful on pressure.
Both testicles often affected.	Generally only one testicle affected.	Often both testicles affected.
Fungus rare.	Fungus always present in advanced stages.	Fungus common.

Syphilitic Orchitis.	Encephaloid Carcinoma of Testicle.	Tubercular Orchitis.
No discharge or bleeding.	Bleeds freely; offensive discharge.	Not so apt to bleed; discharge not so offensive.
Lasts many years,	Rarely extends beyond twenty months.	Lasts several years.
Curable.	Usually fatal.	Generally incurable.
No involvement of inguinal glands as a rule.	Inguinal, iliac, and lumbar glands and cord affected.	Usually no inflammation of glands.

Treatment.—It is better to wait in all cases until the appearance of the secondary lesions before trying to administer specific treatment. Although many excellent authorities advise the administration of mercury as soon as the diagnosis is fully established, at the present day the majority of authorities advise delay. Early treatment postpones the appearance of the lesions, but does not modify their general character, and it is thought that in some cases it increases their severity. The experience of the past three or four centuries places mercury at the head of the list of remedies on account of its potency in controlling and subduing the ravages of this malady. From time to time many medicines, mineral and vegetable, have been lauded as possessing superior efficacy, yet none of them have acquired the confidence of the medical profession that mercury possesses.

At the beginning of treatment all hygienic measures should be adopted to improve the general health and condition of the patient. The use of tobacco, both smoking and chewing, should be interdicted, as the habit seems to invite the development of lesions of the mucous membrane of the mouth and throat. The teeth should receive careful attention, and be placed in perfect condition by removing all accumulations of tartar, filling cavities that may exist, and smoothing down rough and jagged edges and points that may irritate the tongue and mucous membrane of the cheeks.

All habits of intemperance and excess must be abandoned, and the daily life of the patient made to correspond with the most advanced rules contributory to health. Mercury may be introduced into the system through different channels and by different methods—by hypodermic injections, by the mouth, by inunction, or by fumigation.

Different preparations of the drug and different modes of administration are advocated by individual authorities. Whatever method is observed, it should be remembered that it is neither to be administered too lavishly on the one hand, nor too niggardly on the other, and always with careful observations as to its effects upon the system of the patient and upon the lesions of the disease. Among the preparations of mercury that are employed are corrosive sublimate, calomel, yellow and red oxide, biniodid, mercurial ointment, oleate, salicylate, and many others. Iodid of potassium is chiefly applicable to the later stages of syphilis, and is not surpassed by mercury in its power and efficacy to dissipate and resolve gummatous lesions. The iodids are often extremely valuable in the treatment of syphilis when the patient does not seem to tolerate the use of mercury. Iodid of potassium is more often used by the inexperienced in the treatment of the early lesions, but in the hands of the expert it is reserved for the later trouble.

In its administration it is well to prepare a solution of 1 ounce of the drug to 1 ounce of water. The dosage must be regulated in accordance with the severity of the demands of the case and the degree of tolerance manifested by the patient. It is better to commence its use by prescribing from 5 to 8 drops of this solution, well diluted, after meals, gradually increasing the dosage by the addition of 1 drop a day until 30, 40, or even 60 drops have been reached. If serious symptoms of iodism ensue, its use must be abandoned or rather the dose diminished. In urgent attacks of cephalalgia and meningitis and in osteo-periostitis the dose must often be large, but abandoned or greatly diminished as soon as relief is obtained.

The iodids are capable of producing the most satisfactory results in properly selected cases. They often disagree with many patients, but by careful administration of a graduated dose and by keeping the diet bland and unirritating there are but few cases that cannot be coaxed into tolerance. Their beneficent effect will well repay the patient and gratify the surgeon for all the details and painstaking care that have been observed in their exhibition. They will occasionally produce the symptoms of iodism. The toxic effects of the iodids are frequently manifested by a pronounced metallic taste in the mouth, all the symptoms of acute coryza, eruptions on the skin resembling acne and urticaria, distention of the abdomen with gas, pain, and constipation. With abandonment of the drug the toxic effects rapidly disappear. There are, no doubt, rare and isolated cases that are so peculiarly susceptible to the influence of iodids that their use must be avoided and some preparation of mercury substituted.

Mercury may be introduced into the system by either the external or the internal method. The external method employs inunction and fumigation; the internal method consists in the administration of the drug by the mouth or its subcutaneous injection with the hypodermic syringe. The method of internal use has been modified by many syphilographers into different systems styled "continuous," continuous tonic, and interrupted. The matter may be greatly simplified by observing the following directions, which if carefully followed will prevent the development of any toxic effects. Calomel is not used very much at the present time for internal administration, but is a very excellent preparation to be employed in fumigation, etc. Corrosive sublimate, protoiodid, and the tannate are undoubtedly as suitable as anything that can be selected. The "auld lang syne" doses are no longer in vogue. The bichlorid may be given in doses of $\frac{1}{48}$ to $\frac{1}{8}$ gr.; protoiodid, $\frac{1}{50}$ to $\frac{1}{4}$ gr.; tannate, $\frac{1}{2}$ to 1 gr. As the malady to be treated is essentially a chronic disease, it is obvious that the exhibition of remedies must be prolonged; therefore it is not proper to see how large a dose of mercury the patient will tolerate at a given time, but to carefully determine how large a dose he can take continuously and not affect his general health, and at the same time prove curative. The student should be impressed with the fact that he is treating an individual and not syphilis alone, and that each individual is a law unto himself. If the administration of mercury by the mouth seems to disagree with the patient in doses that are sufficient to control the progress of the malady, or if the case develops stomatitis or gastro-enteritis, it will be neces-

sary to resort to inunction, hypodermic injection of mercurials, or fumigation.

When the disease has existed for several months, and just presents itself for treatment, it is better to commence the use of inunction or fumigation at once. Inunction consists in rubbing into the skin metallic mercury or some form of it mixed with a fatty substance. It is the oldest of all known methods, and is very potent in its results. It relieves the alimentary tract from the frequent disagreeable effects of mercury. The officinal blue ointment is a very reliable form; the dose to be employed should correspond to the size, weight, and general condition of the patient; the patient should be directed to properly cleanse the skin with warm water and soap; from 1 to 3 scruples should be rubbed in until it has disappeared. Any region of the body may be selected. Should a dermatitis develop on the surface to which the inunction has been applied, another part may be selected. While this process is being followed the diet should be generous and nourishing. Iron, quinin, and strychnin may be given with very beneficial effects, and especially in those cases that are prone to take on the anemia, pallor, and weakness peculiar to the condition known as syphilitic cachexia.

Fumigation is, without doubt, the most speedy and efficacious method that can be employed in cases of emergency. It must be used with considerable care. The elaborate apparatus found in bath-houses is by no means necessary. All that is essential is a spirit lamp; directly over the flame a metallic plate of tin or copper is placed, holding upon its surface from 40 to 60 grains of calomel and cinnabar in the proportion of 20 parts of the former to 40 of the latter; a kettleful of boiling hot water is placed by its side; the patient is stripped of all clothing and placed upon a chair in an improvised tent made of a blanket or of bed-ticking, which is made to fit the neck closely, leaving the head exposed. About half an hour is usually necessary for a bath, and it should not be repeated oftener than every second or third day. The effect of the bath in some cases is to produce great weakness, and a temporary resort to alcoholic stimulants may become necessary to avert a profound feeling of faintness. The bath should never be given immediately after eating, but preferably before retiring at night. Some patients do not seem to tolerate the baths; the depressing effect is often caused by using too much of the steam vapor. From ten to twenty baths are usually necessary to produce satisfactory results.

Hypodermic injections of the soluble and insoluble salts of mercury are recommended by some authorities. The advocates of this method claim for it rapidity of effect: it relieves the stomach and digestive tract; it admits of more perfect accuracy in dose; it can be employed in all stages of the malady; it is followed by but few relapses; it is very simple, cleanly, and inexpensive. The injections are made every second or third day, and of the following solution: Hydrarg. chlor. corros., gr. j; glycerin, aqua dest., *āā.* ʒj. Of this inject 10 minims. The toxic effects of the drug are often speedily developed, and salivation may be produced at the second or third injection. Abscesses, boils, nodes, and sloughing of the tissues frequently follow this form of treat-

ment. The strictest antiseptic precautions in all details must be observed in adopting this method.

Finally, syphilis is a disease that requires prolonged treatment. If it is treated as it should be, the patient must be under the medical attendant's care for two and a half or three years. As soon as a diagnosis has been made at the beginning of treatment, the patient should be made acquainted with the seriousness of his trouble. It is usually not necessary to say much regarding the horrors of syphilis: he has undoubtedly already an exaggerated opinion as to the ravages that are about to overwhelm him. No class of cases requires so much good judgment and discretion in their treatment as the venereal affections, and especially syphilis. While we are warranted in encouraging the patient with hope and a satisfactory prognosis in the great majority of cases, we must not forget to impress upon his mind that it not infrequently exhibits a very irregular course, and cases that are apparently simple and mild, if neglected or abandoned, may manifest the severest features of the disease. He should be informed that he is not to marry for six months after the disappearance of the lesions, and only then if he has at the same time been under specific treatment for two or three years.

Hereditary Syphilis.—In the great majority of cases the disease is inherited from the mother. Women who have contracted syphilis, and while passing through its early and active stages have become pregnant, are rarely able to carry the products of conception to full term; every pregnancy results in abortion until the disease wanes in its severity. The virus loses its intensity and potency, and becomes so attenuated as to exert no longer its influence upon the viability of the fetus. A very large percentage of the infants of syphilitic mothers are dead, or if viable at birth die soon afterward. Some live on to early childhood, a few beyond the age of puberty. As a general rule, it may be regarded as a fatal disease. At birth an infant may present the manifestations of syphilis and speedily succumb to its deadly influence. In other cases the infant at birth may look as plump, fresh, and vigorous as babies usually do, but between the first and third month it begins to show signs of failing health; its appetite fails, it loses flesh, the skin becomes sallow; it is restless, loses sleep, and is feverish. Following these symptoms there appears a rash, the syphilitic roseola; it may be only a mild efflorescence that is mistaken for "red gum" or "undue heat," and it may be overlooked, or may develop an unmistakable form of eruption, the macular syphilides, the lesions being bright and red with tendency to desquamate. The color of the eruption is often a dirty brown. At this time also coryza develops: the discharge is at first of a serous nature, but becomes purulent and bloody; it is offensive in its odor, excoriates the lip and nostrils, interferes with breathing, and constitutes the "snuffles." The early manifestations of hereditary syphilis are usually confined to the skin, and consist of the erythematous, papular, pustular, and sometimes tubercular forms. Bullous lesions quite often appear, and are described as syphilitic pemphigus; they always indicate a very serious and grave condition, and rarely if ever improve under treatment. Papules of a moist character are found at the corners of the mouth, upon the genitalia and anal region. Gummatous

deposits, ulcers, furuncles, and abscesses are frequent. Should the infant survive the early stage and live to attain childhood, the bones may become involved. Those most frequently attacked are the tibia, ulna, radius, femur, and bones of the skull. There is in the early months often a swelling of the phalanges and the metatarsal and metacarpal bones, constituting dactylitis syphilitica. Children who possess the syphilitic taint are liable to attacks of interstitial keratitis, purulent discharges from the ear persistent and intractable. The teeth of second dentition present singular markings that were first pointed out by Mr. Hutchinson as presenting conclusive evidence of the disease. The upper central incisors are the test teeth. When first cut they are short, narrow, and very thin. After a time a crescentic portion from the edges breaks away, leaving a broad, shallow notch. The two teeth often stand widely apart, but sometimes converge. While he regards the markings of the teeth as of great value in the late manifestations of the disease, there are other signs which greatly aid in establishing a diagnosis—viz. sunken bridge of the nose, prominent frontal eminences, scars at the corners of the mouth, silky softness of the skin with absence of color, and a history of past attacks of interstitial keratitis. This disease usually affects both eyes and causes very great impairment of sight, lasting over several months. It then clears away, leaving the corneæ a little cloudy; afterward there remains a steel-gray luster on the iris. A peculiar form of phagedenic ulceration, sometimes erroneously called lupus, may affect any part, but is often seen upon the nose. The disease shows itself in the bones in the form of periosteal nodes. Mucous patches, as in acquired syphilis, affect the mouth and throat; the nails are frequently affected, and there may be alopecia, both transient and permanent. Care must be taken in the diagnosis of syphilitic bone-disease that it is not confounded with rickets. In rickets the shafts of the bones become thin and are not enlarged as in syphilis; there are not the characteristic nodes; the fontanelles are open and are not prematurely closed by the development of osteophytes. In rickets the bones are more flexible than in syphilis.

Should the patient survive the period of infancy, there may be a complete absence of syphilitic manifestations until the age of puberty, when they suddenly reappear.

Hereditary syphilis produces arrest of development: the patients look younger than they really are, and generally these subjects are far below the average in physical and mental power. In females there is little or no development of the mammæ, menstruation is delayed, the hair in the axilla and on the mons veneris is very scanty; the joints, nervous system, and viscera are frequently affected. To present a typical picture of a patient afflicted with hereditary syphilis the words of Cauganeux are to the point: "Had I in a few words to present the ideal clinical type of late hereditary syphilis, I should select a young girl eighteen or twenty years old, whose eyes should present traces of interstitial keratitis; the teeth should be eroded and crescentically notched, at the same time they should be small and irregular; the hearing should be partially or totally lost in consequence of frequent attacks of otorrhea; the genitals, possessing all the attributes of virginity, should be small, the mons veneris and axillæ smooth, the

mammæ without prominence, and menstruation scarcely established. Add to these all the tertiary lesions you please and you will have before you a complete picture of hereditary syphilis. To the triology of Hutchinson, keratitis, defective incisors, otorrhea, I propose to add two other signs—general congenital atrophy and general arrest of development."

Treatment of Hereditary Syphilis.—The treatment of hereditary syphilis should not begin *in utero*, as indicated by some writers. Only when the diagnosis has been actually and undeniably established is it quite proper to administer specific treatment to the mother, and thus modify the intensity of the virus as it relates to the fetus. For this purpose it is better to rely upon inunction. When the child is born and is known to be affected inunction may also be adopted. The skin of the infant is very sensitive, and care must be observed that dermatitis does not develop. The flannel binder that is applied to the belly may be used for the purpose of inunction. From 10 to 20 grains of the officinal mercurial ointment, with one or two scruples of vaselin, may be smeared upon the bandage; the natural movements of the child will produce the necessary friction. Baths may be ordered daily of corrosive sublimate, 10 grains to a pailful of warm water, allowing the infant to remain in the bath from ten to fifteen minutes, after which it is carefully wiped and dried. Should there be present in the folds of the neck or about the genitals and anus moist papules, they may be dusted with equal parts of calomel and boric acid. Especial care should be observed that the skin is kept scrupulously clean.

Keyes advises the use of corrosive sublimate internally, ½ grain to 6 ounces of water; of this a teaspoonful may be given hourly for the first day, the second day every two hours, the third day every three hours, or at longer intervals should it seem to disagree. Should the babe maintain its weight and seem to thrive, the treatment may be continued under careful observation; if it emaciates and grows pale, the mercurial treatment must be diminished or withheld for a time. Iodid of potassium should not be administered to a young infant, as it will inevitably disagree with the function of digestion and interfere with nutrition. Later on, during the manifestations of the disease in childhood, it will exert a beneficent influence if prescribed in judicious doses and with the ordinary care that should always be observed in the administration of this drug. Local lesions should receive the topical applications that are advised in the acquired form. The nutrition of the infant or child should be maintained by the selection of proper food that can be easily digested and thoroughly assimilated. Infants will not do well when bottle-fed, and the mother's breast is always to be recommended in preference to any other means of nourishment.

CHAPTER XIII.

THE DIAGNOSIS AND TREATMENT OF TUMORS.

IT is perfectly natural for the patient and surgeon to divide all tumors into two great classes—benign and malignant. The one class means simple inconvenience; the other means terrible and prolonged suffering. One implies hope, the other despair. A benign or innocent tumor has the following characteristics: It does not produce pain except by pressure; it generally has a capsule beyond which it does not spread. and if it is diffuse it never infiltrates the surrounding tissues; it never spreads to the lymphatic glands; if once removed, it never returns; it never endangers life except when by its size it presses upon vital organs.

A malignant tumor is very different. While the benign or innocent growth is attended with little or no pain, the malignant tumor, as a rule, condemns its victim to a life of anguish; it is not confined within a capsule, but infiltrates the surrounding tissues; it affects the lymphatic glands; it disseminates—that is, breaks out in distant organs; it is almost sure to return after removal; except in the rare cases in which the disease can be totally removed by operation the termination is death. In the examination of a given tumor the first inquiry will relate to the history of the growth. Is it congenital or acquired? Is it growing, receding, or stationary? Is it idiopathic or the result of an injury?

After obtaining a history the tumor may be examined by inspection and palpation. The position of the growth should be noted, and the structure to which it is attached, as skin, fascia, muscle, periosteum, or bone. Is it movable or fixed? Is its outline sharply defined, or does it gradually shade off into the neighboring parts? What is its consistence? Is it either hard, soft, firm, gelatinous, or fluctuating? Is it smooth or lobulated? The condition of the neighboring lymphatic glands should next receive attention, and any enlargement should be carefully noted.

Many tumors have already been considered under the special organs; what follows is a brief account of the more common growths and their characteristics. It is often impossible to decide the nature of a neoplasm before its removal; all we can undertake to say is that the growth is one which should be removed by operation, leaving its histological characters to be afterward determined by the use of the microscope.

Connective-tissue Tumors.—Of benign tumors the most common are lipomata, fibromata, myxomata, chondromata, osteomata, gliomata, neuromata, angeiomata, lymphangeiomata, and myomata.

Lipomata, or fatty tumors, are found, as a rule, upon the trunk and the parts of the limbs nearest to the trunk. They are made up of fat, and are the most common of all neoplasms. Middle life is the period most liable, as in most persons at that time the body shows a tendency to the formation of fat. Fatty tumors are classified according to the positions they occupy as subcutaneous, subserous, submucous, subsynovial, intermuscular, intramuscular, periosteal, and meningeal. Lipomata by their weight frequently change their position. Fig. 273 represents a

growth which began a little to the right of the umbilicus, but gradually sank to the scrotum, distending the latter enormously; the mass hung down to a point midway between the knees and ankles. It was successfully removed by Dr. Phelps of Hawarden, Iowa, to whom the writer is indebted for a photograph of the case.

The subcutaneous lipomata are easily recognized by their being lobulated, diffuse, and closely connected with the skin. When the skin overlying the tumor is raised it becomes dimpled, owing to the fasciculi of connective tissue which pass between it and the tumor. The deeper tumors are most difficult of recognition. A fatty tumor connected with the periosteum of a long bone closely resembles a sarcoma. It grows more slowly, however, and if circumscribed has few of the characters of sarcoma. In the groin it may simulate abscess or hernia. Abscess is preceded by a history of suppuration, and hernia has its characteristic positions and an impulse on coughing. In the abdominal cavity all we can say is that a tumor is present, but its real character must be determined after removal.

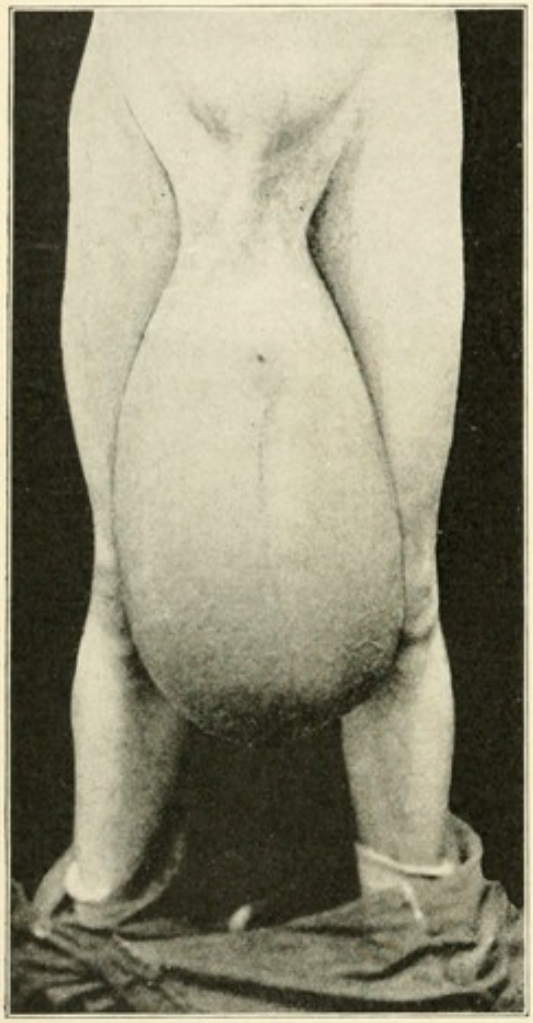


FIG. 273.—Lipoma commencing to the right of umbilicus and gradually changing its position by gravitation (from a photograph in the collection of Dr. Phelps, Hawarden, Iowa).

Treatment.—The removal of fatty tumors is attended with little difficulty or risk except when the growth is in the abdomen.

Fibromata, or fibrous tumors, are composed of fully-developed fibrous tissue and form dense circumscribed masses, sometimes lobulated, sometimes uniform in outline (Fig. 274). When connected with mucous membrane they constitute a large proportion of the polypoid growths usually met with. These tumors occur wherever connective tissue is found, and may therefore be met with in any part of the body. They are hard, freely movable, elastic, and heavy. Their most common situations are the uterus, skin, fascia, capsules of the joints, the synovial fringes, periosteum, nose, gums, and nerves. The simple fibroma is composed of bundles of wavy fibrous tissue; the fibers are long and fully developed. In the growing points the immature cells may be seen undergoing transformation into fibers. In fibro-sarcomata the cell-elements predominate, and they do not become fully developed into perfect fibers.

A peculiar form of fibroma which is met with in the corium or subcutaneous tissue is known as subcutaneous painful tubercle. It is

commonly met with in the lower extremities, and more frequently in women than in men. It is sometimes exceedingly painful, but in size is seldom larger than a pea.

Molluscum fibrosum is a remarkable condition in which the skin and subcutaneous tissue become the seat of enormous fibrous growths, causing either numerous small tumors or a diffuse neoplasm which hangs in folds about the body. Its cause is obscure.

Chondromata, or cartilage-tumors, and **osteomata,** have been considered in connection with Diseases of Bone.

Myxomata are tumors in which mucin is the preponderating element, and consist of connective tissue as a framework in the meshes of which a fluid is contained that is almost identical with Wharton's jelly of the umbilical cord. These growths occur as nasal and aural, rectal, and some forms of uterine polypi, cutaneous myxomata, and neuro-myxomata; their appearance is so characteristic that diagnosis is not difficult.

Myo-fibromata are morbid growths composed of muscular and

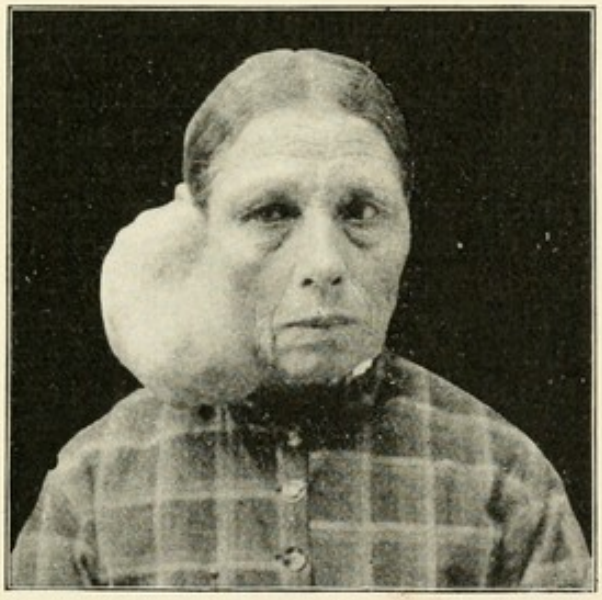


FIG. 274.—Fibroma (from a photograph in the collection of Dr. Strickler).

fibrous tissue combined. The muscle-fibers are of the unstriped variety and occur in closely interlacing bundles. Many uterine tumors fall under this class.

Angeiomata, or vascular tumors, are composed of arteries, veins, or capillaries, or of cavernous spaces containing blood.

Gliomata are tumors having about the same consistence as the cortical substance of the brain, and are found in the central nervous system only. They have no characteristic diagnostic symptoms apart from other brain or spinal tumors.

Neuromata are composed of nerve-filaments or tissue, but the term is often applied to neoplasms growing upon nerves, no matter what their histological characters may be. A common form of neuroma is the bulb which forms upon a divided nerve after amputation, and which is often exceedingly painful. It seems to be produced by the nerve-fibers doubling back upon themselves and forming a tortuous mass.

In the treatment care should be taken to form a flap of the nerve-sheath so as to cover in the divided end of the nerve after cutting away the tumor.

Sarcomata are composed of embryonic connective tissue, the cell-elements largely preponderating over the intercellular substance. A convenient classification of sarcomatous tumors is based upon the shape and disposition of the cells, and is as follows: 1. Round-celled sarcoma; 2. Lymph-sarcoma (resembling lymphatic glands); 3. Spindle-celled sarcoma; 4. Myeloid sarcoma (resembling the red marrow of bones); 5. Alveolar sarcoma; 6. Melano-sarcoma.

Sarcomata are found wherever there is connective tissue; hence we look for them in connection with fascia, subcutaneous cellular tissue, periosteum, intermuscular septa, marrow of bone, the ovary, the testicles, occasionally in the brain, and rarely in the spinal cord and nerves. They first make their appearance as nodules, single or multiple; they are usually firm, but may be soft. They have one remarkable characteristic, and that is the rapidity of their growth, and this distinguishes them from all other tumors. They are frequently observed after injuries. It is not uncommon to see the disease occurring in a strong young man who several months previously had received a blow or fractured a bone. Cicatrices are sometimes the seat of these tumors. They are rarest in children, rare between ten and twenty years, most frequent in middle life, and rarer, again, in old age. Except when located in or on a nerve-trunk sarcomata are usually painless until they begin to ulcerate. As a rule, the softer the tumor the more rapid is its growth and the worse the prognosis. Sarcomata, except in their early stages, have no capsule. They rapidly infiltrate the fibrous tissue with which they are connected, and give the tumor a diffuse character. In addition to spreading by infiltration, they are liable at any time to reproduce themselves in distant organs, especially the lung. They do not spread to neighboring lymphatic glands, and this constitutes one of the main differences between them and carcinomatous tumors.

The *treatment* is complete extirpation when this is possible. If there is not a reasonable prospect of getting away the whole of the diseased structure, it is useless to operate.

Epithelial Tumors.—In this type of tumors epithelium is the distinguishing and essential feature, as connective tissue is in the growths we have been considering.

Warts.—The simplest form of epithelial growth is the wart or papilloma. It is an outgrowth from an epithelial surface, and is composed of an axis of fibrous tissue surmounted by epithelium and containing blood-vessels. Warts are common on the hands—especially of children, who do not keep their skin as clean as they should—the anus, the glans penis, the labia, and other parts which are subjected to irritating discharges, such as gonorrhea.

Villous papillomata are warty growths arising from mucous membrane, and especially that of the bladder.

Intra-cystic Papillomata.—Warty growths are found upon the lining membrane of certain cysts—*e. g.* cysts of the mammary gland and cysts of the paraoöphoron and Gärtner's duct, and in cysts of the thyroid glands.

Psammomata are warts found only in the pia mater of the brain and spinal cord.

Epithelioma.—As long as the epithelium is limited by the basement-membrane the growth falls within the category of warts; when the epithelium passes beyond this and infiltrates the subjacent connective tissue, it is an epithelioma. The most common situation of this variety of morbid growths is at the junction of skin and mucous membrane; hence we find them on the lip, at the verge of the anus, and on the prepuce. They may also occur on any part of the skin, and are more apt to appear upon scar-tissue. The first appearance of an epithelioma is a fissure, a wart, or a nodule on the cutaneous or mucous surface.

The disease may remain stationary for months or even years, but sooner or later ulceration takes place and may involve a considerable area (Fig. 275). The characters of the ulcer must be closely studied.

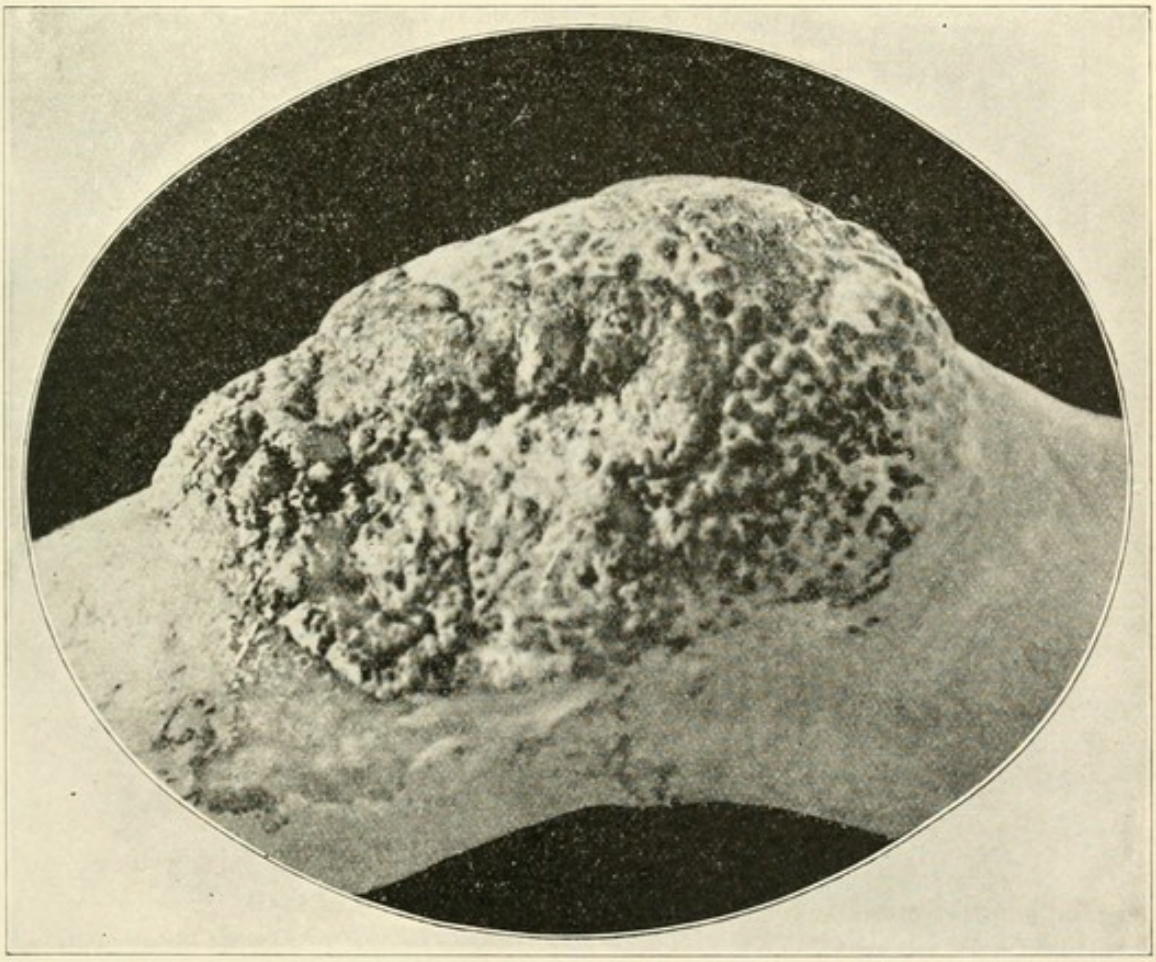


FIG. 275.—Epithelioma of the knee (from a photograph in the collection of Dr. Strickler, New Ulm, Minn.).

Its base and margins are indurated, and may stand up as a perpendicular wall; the surrounding skin is not inflamed; the surface of the ulcer is warty or like a cauliflower or excavated; it has a foul, fetid discharge containing sloughs of tissue. The lymphatic glands in the neighborhood sooner or later become enlarged. In some cases a tumor of considerable size is formed. A typical epithelioma, and the

most common of all, is that found in the lower lip of men (see Epithelioma of the Lip). Epithelioma is very rare under thirty years of age, the great majority of cases occurring between forty and seventy.

Adenomata.—These tumors are composed of gland-tissue, but differ from normal gland-structure by their failure to produce the secretion peculiar to the gland which they resemble. The ovary, mamma, and thyroid are the glands most commonly affected. In the intestine a small adenoma may cause intussusception. They are not encapsuled, do not invade the surrounding tissues, do not affect the neighboring lymphatic glands, nor produce secondary deposits. They occur in young persons, and are always found in connection with a secreting gland. Upon these characteristics we must rely to differentiate adenomata from other tumors. They are not dangerous to life, and usually call for removal on account of the pressure-symptoms to which they give rise.

Carcinomata, or cancers, are tumors of pronounced malignancy (Fig. 276). They have no capsules, but infiltrate the neighboring

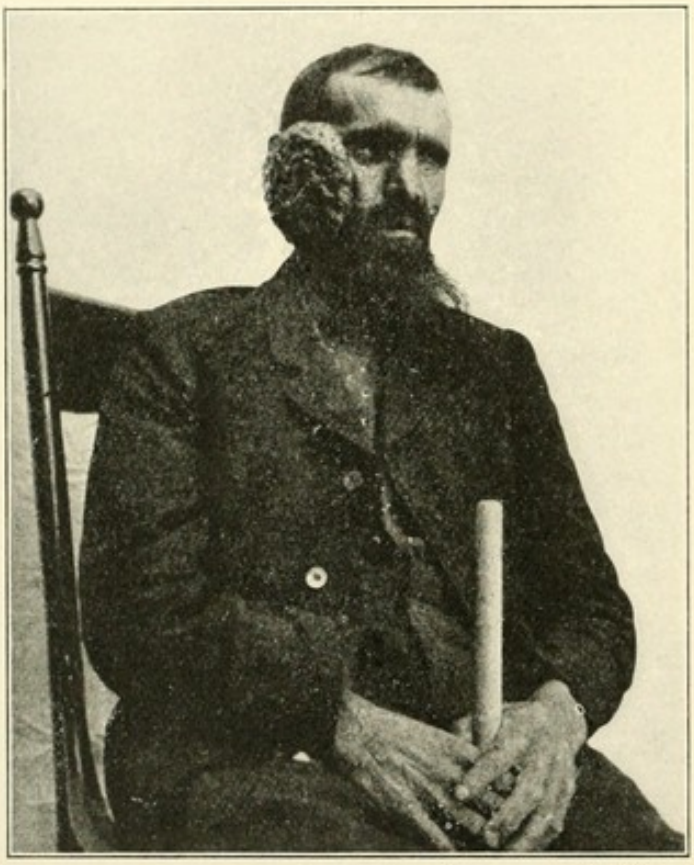


FIG. 276.—Medullary cancer: recurrence six months after removal of the eye (from a photograph in the collection of Dr. Lincoln).

tissues, and at a comparatively early period spread to neighboring lymphatic glands. Every part of the body which has secreting glands is liable to carcinoma. The most common situations are the mammæ, the glands of the cervix utero, the prostate. It is rare before the age of twenty-five, increasing in frequency with each decade thereafter.

Although the division of cancer into scirrhus, encephaloid, and col-

loid is not a good classification from a pathological standpoint, it is convenient clinically.

The differential diagnosis between encephaloid, scirrhus, and sarcoma is thus summarized by Gross:

ENCEPHALOID.	SCIRRHUS.	SARCOMA.
The tumor is soft and elastic, but not uniformly.	Uniformly hard and inelastic, feeling like a marble beneath the skin.	May be firm, tense, and elastic; generally uniformly soft and apparently fluctuating.
It grows rapidly, and soon acquires a large bulk, perhaps ultimately attaining the volume of an adult's head.	Growth is slow and bulk comparatively small, the tumor rarely, even in the worst cases, exceeding the volume of a large fist.	May remain stationary or nearly so for many years; awakened into activity, it progresses more rapidly than encephaloid, and may attain an enormous volume in a short time.
The pain is slight and erratic until ulceration begins, when it becomes more severe and fixed.	The pain begins early, is distinctly localized, and is of a sharp, darting, burning, or lancinating character.	No pain until ulceration sets in, and even then usually insignificant.
There is always marked enlargement of the subcutaneous veins.	In scirrhus these vessels retain their natural size or are only slightly enlarged.	The subcutaneous veins only slightly, if at all, enlarged.
The ulcer is foul and fungous, with thin, undermined, and livid edges, and is subject to frequent and copious hemorrhage.	The ulcer is encrusted with spoiled lymph, and has steep, abrupt edges, looking as if it had been scooped out of the part; bleeding little and seldom.	Tendency to ulcerate slight and late in the disease, the sore being superficial and not subject to hemorrhage.
There is generally early lymphatic involvement.	Usually not until late, or shortly before ulceration occurs.	Singularly free from lymphatic involvement, or, if the glands are affected at all, they become so quite late.
Occurs at all periods of life.	Seldom before the age of forty-five.	Generally before forty, and most commonly between that age and twenty.
Is most frequent in the eye, testicle, mamma, lymphatic glands, bones, skin, and cellular tissue.	Never occurs in the eye and testicle, and rarely in the bones, skin, and lymphatic glands.	Always begins in the connective tissues, particularly sarcoma of the extremities; most common in skin, periosteum, and bone; infrequent in lymphatic and secreting glandular organs.
The disease usually terminates fatally in from nine to twelve months.	Seldom sooner than eighteen months or two years.	No reliable data; patients, however, often survive many years, even after repeated extirpation.

CHAPTER XIV.

DISEASES AND INJURIES OF THE NECK.

Congenital Malformations.—These, though not very common, are seen from time to time, and include cysts and fistulæ due to imperfect development of the branchial clefts.

Branchial cysts may be situated at the base of the tongue, constituting one kind of ranula.

Branchial cysts in the neck may be divided into four groups: (*a*) dermoid cysts, (*b*) cystic hygroma, (*c*) simple cyst or hydrocele of the neck, and (*d*) malignant cyst.

The **dermoid cysts** are usually smaller and firmer, and are to be distinguished from the other varieties by the absence of fluctuation.

Cystic hygroma is a collection of cysts in a bed of fibrous tissue. This cystic tumor often attains a large size and has a very irregular outline. The irregular surface is the main diagnostic feature.

Simple cysts also often attain a large size. They have a smooth surface, and if tense feel almost solid; otherwise fluctuation may be elicited.

Malignant cysts are extremely difficult to diagnose, and are generally mistaken for abscesses; even after operation the diagnosis is often doubtful. The manner in which the wound breaks down and the rapid infiltration of surrounding tissues soon render painfully evident what the surgeon has to deal with.

Treatment.—Dermoid cysts should be removed *in toto*, and, as a rule, this can be done without difficulty. The complete removal of simple cysts or cystic hygromata is usually a somewhat serious undertaking on account of their thin walls and intimate relation to surrounding structures. Incision and drainage are preferable. Operations on malignant cysts are usually hopeless, as they almost constantly recur. However, their removal has sometimes to be undertaken for relief of pain, and is exceedingly difficult on account of the manner in which they surround and infiltrate the sheaths of the vessels and nerves.

Branchial fistulæ are situated along the edges of the sternomastoid muscles and may communicate with the pharynx. Their situation serves to distinguish them from tracheal fistulæ, which are situated mesially.

Treatment, when desirable, must be directed to exciting granulation and consequent adhesion at the distal extremity of the fistula, avoiding mere occlusion of the external orifice.

Cellulitis of the neck may prove a most serious condition, depending on its position with regard to the layers of fascia, and also on the extent to which it spreads. For instance, if deep enough it may produce dangerous dyspnea by pressure on the trachea, or it may produce dangerous pressure on the other important structures in the neck, or it may extend to the mediastinum or axilla. A special form of cellulitis of the neck is the submaxillary form, better known as Ludwig's angina. In this condition the swelling around the submaxillary gland encroaches so much on the floor of the mouth that there is great difficulty in swallowing or breathing. As in other forms of angina, there is great depression. The disease often proves fatal, sometimes gradually, sometimes from edema of the glottis, suddenly.

Treatment.—Incision is of course the correct procedure in every case, and even when there is so much induration that the diagnosis is not absolutely certain, one will err on the safe side in making a diagnostic opening. The incision should not be deep, and should be performed after the method of Hilton; that is, make a small opening and burrow in the cellular tissue with a pair of closed forceps, and when pus is found exuding alongside the blades, they can be opened to allow admission of the exploring finger. After evacuation of the pus a counter-opening may be made if necessary to establish drainage.

Abscesses of the neck may arise in connection with carious

teeth, as a periadenitis in connection with scrofulous glands or in connection with necrosis of the lower jaw or cartilage of the larynx.

These abscesses are to be treated on general principles.

Cicatrices the result of burns, producing one form of wry-neck, are to be treated as cicatrices elsewhere.

Injuries of the Neck.

Contusions of the neck may cause spasm of the glottis, which may result in death unless tracheotomy be performed, or there may be fracture of the hyoid bone or cartilage of the larynx, and subsequent subcutaneous emphysema or injuries to the floor of the mouth, with difficult respiration and deglutition.

The *treatment* consists in keeping the parts at rest as far as possible by forbidding the patient to talk and by the use of the nasal tubes. Evaporating lotions may also be applied to the neck.

Wounds of the Neck.—Cut-throat may serve as an example of wounds of the neck. Unless the individual is left-handed the cut will be found to extend obliquely from above downward and from left to right across the middle line. The wound may extend into any part of the larynx or trachea, and even to the esophagus, without injuring the carotids, which lie somewhat deeply and are protected by the sterno-mastoid muscles.

The dangers resulting from cut-throat are hemorrhage, entrance of air into veins, septic pneumonia, and septicemia.

Treatment.—In every case the patient must be carefully watched during treatment, lest he renew his attempts at self-destruction. All hemorrhage must be carefully arrested, and if there appears to be dyspnea, it will be well to ensure safety by the introduction of a tracheotomy-tube. Divided structures should be sutured where necessary. If the patient is much collapsed from hemorrhage, transfusion of normal saline solution will be indicated. If the skin-wound be allowed to close before the tracheal wound, we will have emphysema of the neck. The remedy is obvious: keep the skin-wound open till the trachea has been closed by nature or by art.

Tumors of the Neck.

Tumors of the neck, if they reach any considerable size, are apt to produce serious symptoms from pressure on the many important structures in the region, and if malignant the danger is increased immensely, for the difficulty of removing them without injury to the structures is great, and in many cases cannot be overcome.

Glandular Tumors.—These are by far the most common of all tumors of the neck. They may be divided into (*a*) syphilitic, (*b*) tubercular, and (*c*) malignant gland-disease.

Syphilitic enlargement of the glands of the neck, especially of the glandulæ concatenatæ under the posterior edge of the sterno-mastoid muscles, is very common in secondary syphilis, and one of its most distinctive features. Glands thus affected seldom or never suppurate, and may be treated by mercury given internally or by inunction.

Tubercular glands are very common, and have usually as an

exciting cause irritation extending from some other part; for example, from a carious tooth or from eczema of the scalp. At first they are firm and hard, freely movable, and can easily be shelled out, but later periadenitis develops, and their removal is rendered more difficult, or they may caseate or suppurate and give rise to an abscess.

The *treatment* is removal, and this is one of the most common and often most difficult operations in surgery, frequently involving a tedious dissection and exposure of the carotid sheath. The complexity and number of the veins in this region also add considerably to the difficulty and danger. Even though a divided vein be ligatured, embolism following detachment of a thrombus is a danger which must not be overlooked.

When the glands have become adherent it is well to scrape the capsule in addition. Abscesses should be opened and scraped.

The **malignant glandular enlargement** may be primary, as in Hodgkin's disease and some rare cases of carcinoma, but it is generally secondary to some primary deposit about the lips, tongue, pharynx, esophagus, or mammæ.

Hodgkin's disease, or malignant lymphoma, is a progressive

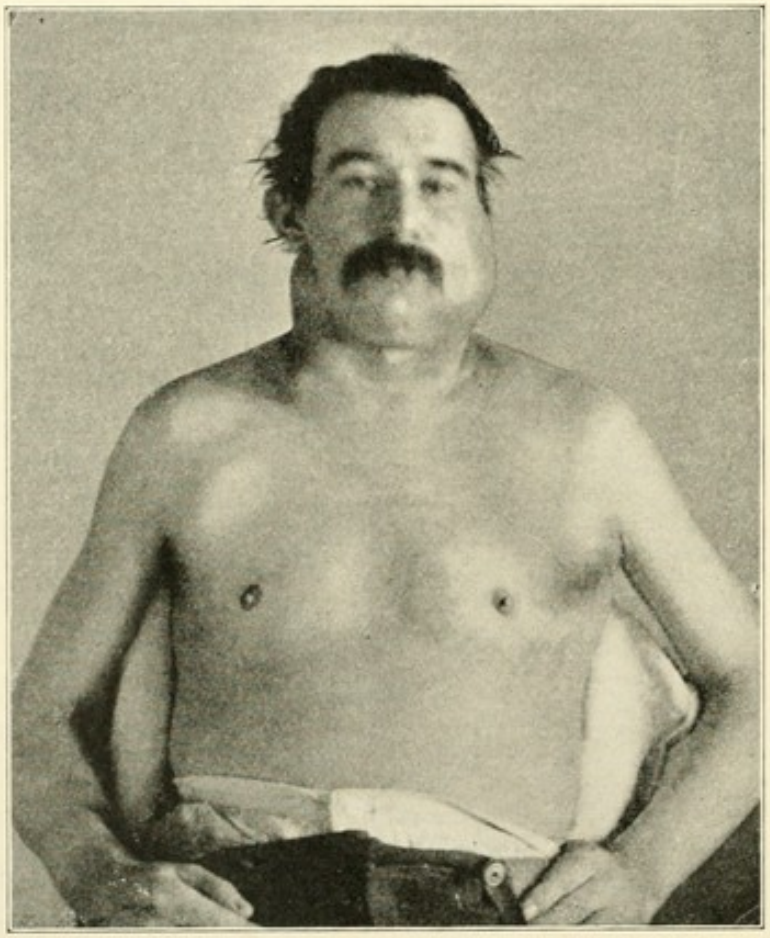


FIG. 277.—Hodgkin's disease (from a patient of Dr. J. E. Moore).

enlargement of glands accompanied by anemia. Its surgical interest depends mainly on the difficulty of diagnosis in the early stages of the disease from tubercular gland disease, and also to a certain extent from syphilitic enlargements. From syphilis the diagnosis must be made by a careful inquiry as to the presence of other secondary symptoms or

the former existence of a chancre. The differentiation from tubercular glands is more difficult, but the following points may be of service: Tuberculosis of the glands most frequently affects the submaxillary group, while in this disease the glands along the sterno-mastoid muscles are more frequently affected (Fig. 277). The age of the patient is important, Hodgkin's disease being more common in young adults. The extension of the disease to glands in other parts of the body and the progressive anemia will settle the point ultimately. Again, tubercular glands tend to suppurate. This is not observed in malignant lymphona. Tubercular glands, owing to periadenitis, coalesce into masses, while in Hodgkin's disease the glands remain separate from one another. Possibly a microscopic examination for tubercle bacilli may be a valuable aid to diagnosis at an early stage.

Treatment.—Surgical interference, except for relief of pressure-symptoms, is, as a rule, useless. Some glands might be excised at an early stage to admit of examination microscopically. Arsenic, phosphorus, and other drugs have been employed by physicians in the treatment of this disease without satisfactory results.

Actinomycosis and leprosy may also affect the glands of the neck, but do not call for special attention in this section.

Other tumors of the neck are lipomata, simple sebaceous cysts, and cysts in connection with the bursa above the thyroid cartilage, but they do not call for any comment apart from that made in the introduction to this subject.

The *treatment* is the same as for the condition occurring in other parts of the body.

Diseases of the Parotid Gland.

Parotiditis, or **mumps,** is an acute infective inflammation of the parotid gland, and is attended by the usual febrile symptoms, with the local addition of pain in swallowing. The disease sometimes assumes the proportions of an epidemic, and whole families and even schools may be laid up. In a small percentage of cases a curious complication of orchitis in boys and mastitis or ovaritis in girls arises. The inflammation usually resolves spontaneously, but in a few cases suppuration ensues.

Treatment.—In a non-suppurative case relief of pain is the chief objective, and this may be attained to a considerable extent by hot or other anodyne applications, as lead and opium. Where suppuration has occurred the abscess must be opened, and here care must be taken to avoid injuring the facial nerve or Steno's duct by making the incision parallel to these structures.

Tumors of the parotid include adenoma, chondroma, or fibro-chondroma also sarcoma and carcinoma. The diagnosis between simple and malignant tumors is often extremely difficult, and must depend on the usual questions of age, rapidity of growth, and glandular infection.

Treatment.—When the tumor is simple and placed superficially removal may be comparatively easy, care being taken to avoid injury to the facial nerve and Steno's duct by making the incision parallel to

these structures. When the tumor is malignant or extends deeply the dissection becomes much more difficult and dangerous, and involves serious risk to the external carotid artery, which passes through the gland, and also to the internal carotid artery and internal jugular vein, which lie in contact with its deep surface.

Diseases of the Thyroid Gland.

The thyroid gland has had much attention directed to it of late on account of the discovery that myxedema, a disease depending on atrophy of the gland, can be cured by the administration of thyroid glands procured from some of the lower animals, especially the sheep. Myxedema comes under the consideration of the physician rather than the surgeon, but an artificial variety known as cachexia strumapriva may be observed after complete removal of the gland.

Goiter, or Bronchocele.—The thyroid gland occasionally undergoes enlargement, known as goiter or bronchocele. Goiter forms a soft pulsatile swelling of uniform size. On auscultation over the tumor a blowing murmur can be frequently heard, due to the increased vascularity of the gland. It may cause danger to life by pressure on the trachea, and the compression is generally lateral, causing the lumen of the tube to become triangular. Occasionally from sudden congestion of a goiter the dyspnea may become urgent.

Several varieties may be distinguished:

1. Goiter depending on increased growth of tissues already existing in the gland and called parenchymatous, fibrous, or cystic according to the preponderating tissue.

2. Malignant goiter, depending on a malignant new growth in the gland, either carcinomatous or sarcomatous.

3. Exophthalmic goiter, where the goiter is complicated by exophthalmos or protrusion of the eyes and attended with rapidity of the heart's action. This disease is also medical rather than surgical, although operative measures have been occasionally resorted to in the hope of obtaining relief.

Diagnosis.—Goiter may be easily distinguished by observing the intimate relation of the swelling to the trachea, and also by noting the fact that the tumor moves up and down on deglutition. Malignant goiter will be distinguished by the rapidity of growth and the speedy involvement of neighboring lymphatic glands.

Treatment.—The general condition of the patient should be attended to, and for this purpose iron and other tonics are indicated. Local applications may be tried, such as iodin or the iodid of mercury, which has so great a reputation in India. To obtain the best results from the use of iodin it is necessary to inject the tincture into the tumor.

Cysts should be incised and stuffed with gauze, and where the dyspnea is becoming great the isthmus should be divided, and this sometimes results in cure of the goiter. Total extirpation should be a last resort, as the dangers of the operation are considerable from hemorrhage and interference with the recurrent laryngeal nerve, and there is the risk of cachexia strumapriva resulting. This latter condition, however, may be overcome by the internal administration of thyroid extract.

When there is sudden increase of the bulk of the goiter, causing urgent dyspnea, ice should be applied, and, if this is ineffectual, there must be no delay in the performance of tracheotomy.

CHAPTER XV.

INJURIES AND DISEASES OF THE BREAST.

MANY changes in the condition of the breast are of a physiological rather than of a pathological character. The breast of an infant a few days after birth may become engorged, swollen, and tender. These conditions soon subside, but under improper management inflammation, suppuration, and abscess may result. At puberty, just before or just after the first menstruation, the breasts of females show a rapid development, increasing in size and presenting an areola around the nipple. Should the enlargement be confined to one side, it may to a careless observer simulate a tumor. The most critical time in the history of the gland is when it assumes its highest function—viz. during pregnancy and lactation. During pregnancy the acini increase in size, forming rounded nodules, and these may be the starting-points of benign but not of cancerous tumors. After delivery the breast becomes engorged in a marked degree, and if at this period there should be a breach of surface on the nipple by which pyogenic germs can gain an entrance, suppuration and abscess are almost sure to follow. Another critical period for the breast is the menopause. The acini now become atrophied, and during this period of involution carcinoma may begin.

Thus there are three critical periods in the life of the mammary gland, and each has its special danger. During pregnancy a benign tumor may begin to develop; at the beginning of lactation suppuration and abscess may occur; at the menopause cancer may attack the gland.

Examination of the Breast.—The patient should be seated or should recline upon a couch, in a good light. The nipple is first examined. It varies greatly in shape, and may be prominent, flattened, or retracted. A retracted nipple is a characteristic of cancer of the breast, but it must be associated with other symptoms of cancer to be of any value. According to Gross, it is present in a little over 50 per cent. of the cases.

Other changes in its shape are unimportant. Cracks or fissures are significant, especially after delivery, as they may prove to be portals of infection for pyogenic germs.

A discharge from the nipple is observed under certain circumstances. In infants of either sex such a discharge is perfectly harmless and should be let alone. When suppuration takes place, it is usually due to meddlesome manipulation of the nurse, who thereby causes irritation of the gland and infects the nipple with germs from the hand. During menstruation a discharge from the nipple is sometimes seen. A blood-stained serum is suspicious of cancer, and is sometimes one

of the earliest symptoms. The diseases to be sought for in the nipple are—

1. *Eczema.*—This may be a simple skin-disease, running a course similar to eczema in any other part and yielding to the ordinary remedies; but there is always a risk of the disease running into that which is known as Paget's disease.

2. *Paget's Disease.*—This disease is a chronic destructive inflammation of the papillary layer of the nipple and the areola surrounding it. It is found in women between forty and sixty years of age. At first the so-called eczema is dry and the epithelium is shed like scales of bran; later it has a watery discharge of a yellowish color and sticky. The surface of the nipple or areola becomes raw, red, and irritable, and this condition may spread until within its circumference is embraced a good part of the skin of the chest. It is attended with a tingling, burning pain. Although Paget's disease is not a form of epithelioma, it no doubt paves the way for that disease by its constant and long-continued irritation. It usually heals under soothing applications. If it does not, it should be excised. A chronic ulcer with thickened edges, an irregular hardened base, and a foul-smelling, ichorous discharge is almost sure to be epithelioma. Enlargement of the glands in the axillæ would be corroborative evidence.

Diseases of the Mammary Gland.—Inflammation of the Breast; Mastitis or Mammitis.—This is nearly always met with in nursing women about the first or second week after delivery. The septic infection is in nearly every case due to the existence of chapped nipples. The early symptoms are a stiffness and uneasiness of the breast followed by a chill and a rise of pulse and temperature. The breast becomes hard, hot, painful, and swollen. The inflammation may end in resolution or go on to suppuration and the formation of an abscess. If suppuration takes place, the breast continues painful and throbbing, the induration and swelling increase, and after a few days fluctuation can be felt. There are three different positions in which the pus may collect: (*a*) in front of the gland, (*b*) in the substance or between the lobules (interlobular), (*c*) behind the gland (post-mammary). The first of these is superficial and "points" promptly; the second is deeper, and fluctuation may be wanting even after other symptoms show that an abscess has formed. The third form is still more obscure, but there is pain when the breast is pushed back against the chest-wall; there is swelling at the axillary border of the gland, and this border is rendered tense and prominent when the gland is pushed back; the axillary glands are enlarged, and there is pain when the pectoral muscles are brought into action.

Treatment.—Everything possible should be done to diminish congestion in the breast. The milk should be drawn off at frequent intervals by means of a breast-pump, the bowels kept relaxed by saline aperients, and the breast fomented with a large moist gauze dressing saturated with boric-acid solution and covered with oiled silk. This is better than the old linseed poultices employed by our grandmothers, and which fulfilled three conditions—heat, moisture, and filth. As soon as it is evident that pus is going to form, a free incision should be made at the point where inflammation appears to be most intense. The incision

or incisions should radiate from the nipple, so as to avoid cutting the milk-ducts transversely. The usual precautions against sepsis should be taken, and local anesthesia secured by the injection of cocain. The weight of the inflamed part adds greatly to the discomfort, but this can be overcome by supporting the breast in a sling. Sometimes abscesses form in several places, either at the same time or consecutively, and tax to the utmost the patience of the physician and the sufferer.

Chronic mastitis is of great interest to us on account of the close similarity it sometimes bears to cancer. The inflammation occurs in one or more of the lobules; the acini disappear or are converted into retention-cysts; in the spaces between the acini small round-cells are proliferated, which become organized into dense cicatricial tissue. By degrees the affected lobules become hard, irregular in shape, and adherent to the surrounding tissues. The nipple may even be retracted, so that when we add the severe pain, we have many of the features which make up the picture of cancer. In many cases the patient is afflicted about the time of the menopause just as in scirrhus, and when she seeks advice it is because she fears the disease is cancer.

The *diagnosis* must rest upon the following points: The swelling is hard, but it is not the stony hardness of scirrhus; the surface is nodular from the presence of retention-cysts which are soft, and not hard like cancerous nodules; both breasts may contain one or more lobules which are simultaneously affected; the size of the breast may increase at each menstrual period, and the disease may continue stationary for so long a time as to preclude the possibility of cancer. If, in spite of all the evidence that can be gathered, there is still a reasonable doubt, the duty of the surgeon is to advise an exploratory incision. Preparations should be made for a microscopical examination of the tissue while the patient is under the anesthetic, and if the disease prove to be cancer, the radical operation should be carried out forthwith.

The *treatment* of chronic mastitis is not satisfactory. Tonics are required, and the best of these is iron. Iodid of potassium, with liquor potassæ in small doses well diluted, has been recommended by Paget. The breast should be well protected against irritation, and this can be effectually done by a belladonna plaster, as suggested by Moullin.

Neuroses of the Breast.—A very large proportion of patients who consult the surgeon for diseases of the breast labor under a horrible dread of cancer. Some have tumors, and some have not. Of the latter class, many suffer from a form of neuralgia. It is common among young married women, and is often associated with ovarian disease. The pain is of a sharp, severe, lancinating character, extending to the axilla and running down the arm. The gland and the skin over it are extremely hyperesthetic, great tenderness being complained of even to the slightest touch. No tumor can be felt. This is enough to settle the diagnosis, as cancer never produces the hyperesthesia that these people complain of and there is always a tumor.

Treatment.—Driving the idea of carcinoma out of the patient's mind is a great step toward her recovery, and, once the diagnosis has been arrived at, the surgeon should not consent to make further examination of the breast. Any ovarian or uterine disease, if present, should receive its appropriate treatment: the best hygienic surroundings,

change of air and tonics, and healthful occupation of body and mind are indispensable.

Tumors of the Breast.—The examiner should be familiar with the normal condition of the mammary glands, so that he may not imagine he has found a tumor when the healthy gland is grasped between his finger and thumb. Let the patient be seated, stand behind her, and with your fingers flat upon the breast press the gland against the ribs. If there is no tumor, you will find only the normal thickness of the gland between your fingers and the chest-wall. Now grasp the gland between the finger and thumb and examine its density, and search for nodules or other irregularities in its contour. If there is found a greater sense of resistance than normal, and the patient is not suckling, it may be set down as chronic induration of the mamma. If, in addition, there are hyperesthesia and neuralgic pain, as described in the preceding paragraph, the patient has a neurosis of the breast. If you find a tumor, grasp it with one hand and the gland with the other, and ascertain whether or not the one moves independently of the other. Is it situated toward the center or the periphery of the breast? Is it smooth, nodular, or lobulated? Are the edges sharply defined or rounded, or do they shade off into the surrounding tissues? Is it hard, soft, elastic, or fluctuating? Is there ulceration, and if so what is the nature of the discharge? A bloody or thin serous discharge is characteristic of cancer. A mucous discharge is suggestive of glandular cysts. Milk is a physiological secretion during lactation, and if found in connection with a tumor, that tumor is probably glandular.

Next examine the axillæ in quest of enlarged lymphatic glands, the outposts of the enemy. Note whether they are matted together or hard and ulcerated. Pass up to the parts above the clavicle and continue the search.

No matter what classification of tumors may be adopted by the pathologists, the clinician, and even the patient, naturally divides all morbid growths into two classes—the benign and malignant. The space between them is broad and the limits well defined. The one means recovery and the other death.

The benign tumors of the breast are cysts, adenomata, fibromata, myxomata, lipomata, and chrondromata.

Cysts are recognized by their glandular shape, their painlessness, slow growth, and fluctuation.

Adenoma is a rare form of tumor occurring usually in women between twenty-five and forty who have had many children. The structure of the tumor is essentially that of the gland. It is recognized by its slow growth, by its resemblance to the normal condition of the gland in the pregnant woman. There are retraction of the nipple and no involvement of the axillary glands. The treatment is excision.

Adeno-fibroma.—This is the most frequently met with of all the benign tumors of the breast. Clinically, it is impossible to distinguish it from the preceding variety. The microscope can only settle the question. The tumor is hard in proportion to the amount of fibrous tissue it contains. It is circumscribed and elastic, freely movable beneath the skin, and when small may be taken for a cyst. It is lobu-

lated and its growth is slow. The patients are for the most part young and unmarried.

Adeno-sarcoma.—In this variety a more embryonal form of connective tissue enters into the composition of the tumor, and it approaches the malignant type. Its growth is rapid, but the axillary glands are not involved. The tumor is heavy, freely movable, slightly nodulated, and elastic. It is distinguished from carcinoma by its being less hard, by the absence of glandular involvement, and by its free mobility.

Treatment.—Free removal of the tumor. In operating for the removal of tumors which show no signs of malignancy it is important to avoid an unseemly scar. This can be done by turning up the breast and making the incision on its lower surface, so that when the wound is healed the scar is covered by the breast.

Malignant Tumors of the Breast.—**Sarcoma.**—Every variety of sarcoma is found in the breast, round-celled, spindle-celled, and giant-celled, as well as every form of degeneration which affects these growths. The spindle-celled sarcoma is, however, by far the most common. It begins as a single tumor, and at first appears as innocent as an adeno-fibroma, from which it is almost impossible to distinguish it. As time advances the true nature of the tumor becomes apparent, for it starts up and grows with frightful rapidity. The growth is round or oval, soft, and lobulated. In the cystic variety it is firm in some places, soft and elastic in others. After a time ulceration takes place: a large fungating mass is formed which bleeds on the slightest touch, and all the while the glands, except in rare cases, remain perfectly healthy.

The *diagnosis* of sarcoma in its early stage is by no means easy; it is plain enough when it arrives at the stage of ulceration. Then we have a large fungating mass of the most malignant character, painful and growing rapidly. We know it is not cancer, for the glands are not involved; we therefore conclude it must be sarcoma. At this later period the hope of cure is very slight. To be of any value to the patient the diagnosis should be made early, so that the growth may be removed before it assumes malignant appearances. The safest course is to remove any tumor that has the characters of either an adeno-fibroma, an adeno-sarcoma, or a pure sarcoma.

Treatment.—The tumor should be removed as early as possible. When it recurs, as it is almost sure to do, it should be removed again and again, in the hope that at last it may cease to recur. The dissection should always be well outside the capsule, so that none of the growth be left.

Carcinoma.—Two elements play an important part in the formation of cancerous tumors—viz. connective tissue and epithelial cells. The tumor is hard or soft according to the preponderance of either of these. If connective tissue is in excess, the growth is hard; if epithelial cells displace connective tissue, the tumor is soft. In this way we find all grades of consistency, from the scirrhus of stony hardness at one end of the line to the soft or medullary cancer at the other.

About 80 per cent. of all mammary tumors are carcinomata. The

remaining 20 per cent. are adeno-fibromata and other forms of adenoid growths, sarcomata, and cysts.

Scirrhus, or Hard Carcinoma.—The patient herself is usually the first to notice that a new growth is taking place in her breast, and she consults the surgeon to dispel or confirm her fears.

In examining such a patient begin with the history. Carcinoma attacks women at or after the climacteric. There is often a history of injury to the breast, as a blow or a fall. The irritation produced by Paget's disease is a fruitful source of cancer. Passing the fingers over the breast in the manner already described, a tumor is felt which is of stony hardness, and, if found at an early stage, is a mere nodule, ill defined, and it cannot be separated from the lobules around it. The most common situation is the outer and upper quad-

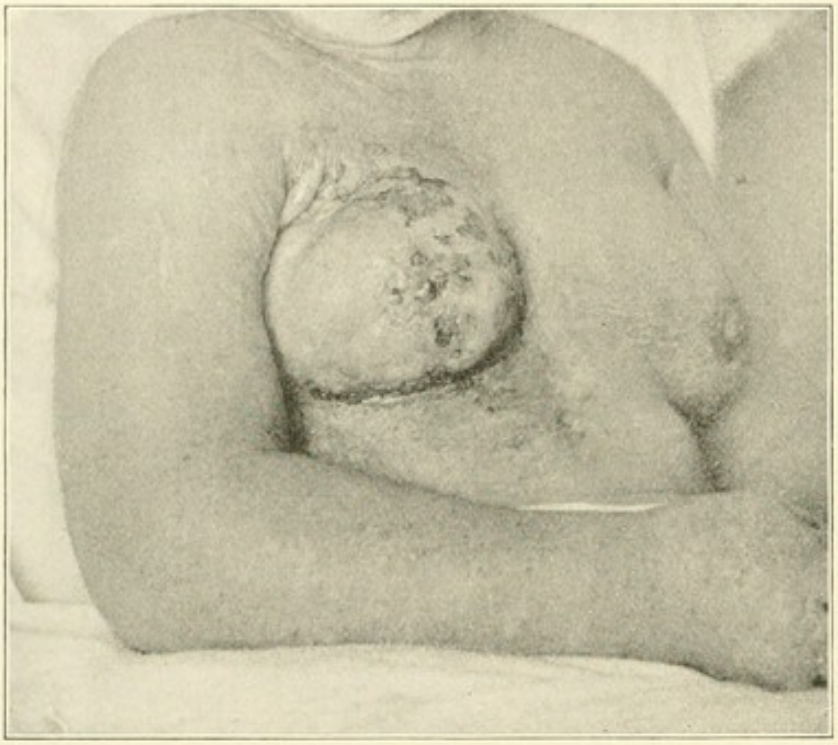


FIG. 278.—Advanced carcinoma of the breast (from a photograph in the collection of Dr. T. S. Roberts).

rant of the gland—that is to say, the nearest point to the axilla. The mode in which this tumor grows is of the greatest importance. It has been compared to a crab turned upon its back and grasping everything within its reach; hence the name cancer. It grows by infiltrating the surrounding tissues. Having studied the hardness and mode of growth, four cardinal symptoms should now be looked for:

1. Contraction of the tumor. This causes a drawing in of the milk-ducts, and produces the *retracted nipple*, which is a very important sign. It also produces a drawing in of the skin at points here and there all over the tumor—the so-called "pig-skin."

2. Are the glands affected? The axillary glands are not far off, and at an early stage the disease spreads to them. They are of a stony hardness, like the tumor itself.

3. Pain. This is generally a very prominent symptom, and from

time immemorial has been described as sharp, stabbing, or lancinating. It begins when the tumor has reached some size, and either catches in its clutches the filaments of the intercostal nerves or presses upon them. At first it is more likely to be felt at night, but later it is unceasing. In exceptional cases there is absence of pain throughout the greater part of the course of the disease, and this fact should not be lost sight of in making a diagnosis.

4. The cancerous cachexia. When the disease begins the patient is otherwise in robust health, as a rule. In the course of time, pain, worry, loss of sleep, and the horrible dread which attends cancerous disease tell upon the constitution and show their effects in the patient's countenance, giving it a peculiar pinched expression and drawing down the corners of the mouth. Further evidences of cancer are—(*a*) A discharge from the nipple associated with a solid tumor. The discharge is usually of a serous character mixed with blood. According to Gross, this is peculiar to cancer. (*b*) Ulceration. In the course of time the pressure of the tumor upon the skin causes the latter to slough, leaving an unhealthy fungating mass with a foul-smelling discharge (Fig. 278). (*c*) Nodular growths in the skin. Sometimes there is an eruption of firm nodules in the skin of the breast and chest; these nodules run together and form a tough, inelastic pachyderm.

Soft or Medullary Cancer.—This form of carcinoma occurs in about 5 per cent. of all cases of cancer of the breast. Its symptoms are the same as those of scirrhus, except that the tumor is soft, less globular in outline, its growth is more rapid, ulceration occurs at an earlier period and causes a fungous protrusion which readily bleeds. The glands also are affected earlier in the disease.

The progress of carcinoma, if unrelieved by operation, is from bad to worse: ulceration, sloughing, pain by day and by night, swelling of the arm due to pressure of the affected glands upon the axillary vein,—all these wear and waste the patient till she dies of exhaustion, or a spread of the disease to a more vital organ brings death more quickly.

Treatment.—One method of treatment, and only one, merits consideration, and that is complete removal at the earliest possible moment. Formerly it was deemed sufficient to remove the breast and the tumor, keeping well into the surrounding tissues, so as to leave none of the cancerous growth. This operation is not now considered sufficient. The whole breast, the tumor, the glands of the axilla, and, if necessary, those of the neighboring part of the neck as well, must be thoroughly taken away.

The operation should only be undertaken when it is possible to remove the whole of the disease. It is therefore contraindicated under the following circumstances:

1. When the disease exists in one or more of the internal organs, as the lungs or liver. These organs should be carefully examined in every case.

2. When the axillary and cervical glands are so extensively involved as to preclude the possibility of removing all the diseased tissue.

3. When the skin is studded with nodules, not only over the breast, but a considerable part of the chest.

4. In *cancer en cuirasse*, a form in which the disease occurs mostly in the skin and forms a cuirass-like casing for the chest.

Although the modern operations are more radical and extensive than those formerly resorted to, the mortality has been steadily decreasing. It was formerly 17.35 per cent., and, according to Williams, the rate has been reduced to 9.4 per cent. Of 464 cases reported by Bull, Dennis, Weir, Halsted, and Keen, the mortality was only 0.86 per cent. The mortality in this country does not certainly exceed 5 per cent., and the average of permanent cures is 20.87 per cent.[1]

Operation.—Of all the procedures that have ever been adopted for the removal of carcinoma of the breast, the most radical and thorough is that of Professor Halsted. The essential features in this operation are removal of the pectoralis major muscle entirely, or all except the clavicular portion, as the operator is enabled thereby to remove in one

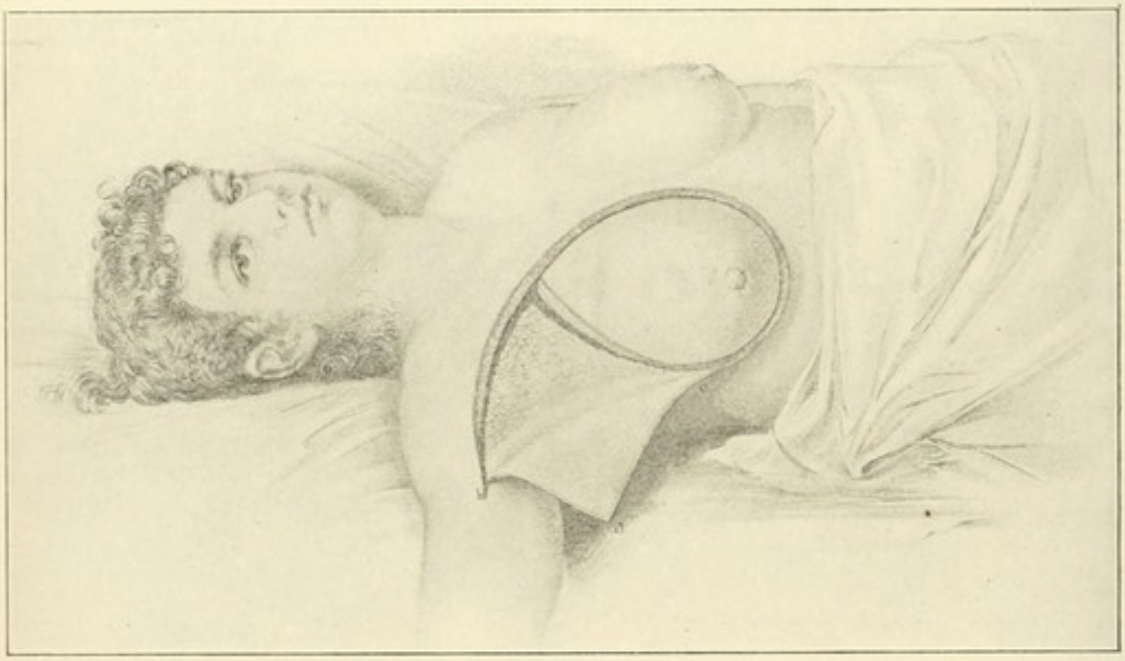


FIG. 279.—Halsted's operation for removal of breast: incision.

piece all of the suspected tissues. The reasons for removing suspected tissues in one piece are—(1) lest the wound become infected by the division of tissues invaded by the disease or of lymphatic vessels containing cancer-cells, and (2) because shreds or pieces of cancerous tissue might readily be overlooked in a piecemeal extirpation.

Of 50 cases operated upon by this method, only 3 showed local recurrence. The operation, as described by Professor Halsted, is as follows:

"(1) The skin-incision is carried at once and everywhere through the fat.

"(2) The triangular flap of skin (*a*, *b*, *c*, Fig. 279) is reflected back to its base-line, C A. There is nothing but skin in this flap. The fat which lined it is dissected back to the lower edge of the pectoralis major muscle, where it is continuous with the fat of the axilla.

"(3) The loose tissue under the clavicular portion (the portion

[1] *American Text-Book of Surgery.*

usually left behind) of the pectoralis major is carefully dissected from this muscle as the latter is drawn upward by a broad, sharp retractor. This tissue is rich in lymphatics, and is sometimes infiltrated with cancer—an important fact.

"(6) The splitting of the muscle is continued out to the humerus, and the part of the muscle to be removed is now cut through close to its humeral attachment.

"(7) The whole mass, skin, breast, areolar tissue, and fat, circumscribed by the original skin-incision, is raised up with some force, to put the submuscular fascia on the stretch as it is stripped from the thorax close to the ribs and pectoralis minor muscle. It is well to include the delicate sheath of the minor muscle when this is practicable.

"(8) The lower outer border of the minor muscle having been passed and clearly exposed, this muscle is divided at right angles to its fibers and at a point a little below its middle.

"(9) The tissue, more or less rich in lymphatics and often cancer-

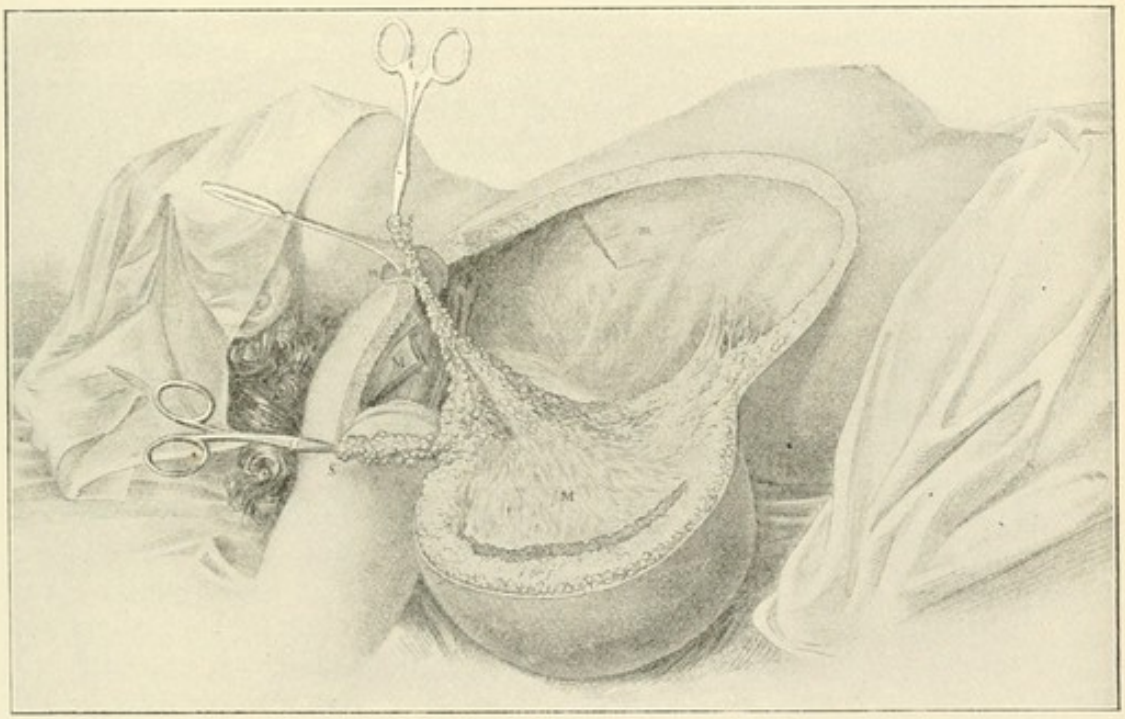


FIG. 280.—Halsted's operation for removal of breast: extirpation.

ous, over the minor muscle, near its coracoid insertion, is divided as far out as possible, and then reflected inward in order to liberate or prepare for the reflection upward of this part of the minor muscle.

"(10) The upper, outer portion of the minor muscle is drawn upward (Fig. 280) with a broad, sharp retractor. This liberates the retractor, which until now has been holding back the clavicular portion of the pectoralis major muscle.

"(11) The small blood-vessels (chiefly veins) under the minor muscle, near its insertion, must be separated from the muscle with the greatest care. They are imbedded in loose connective tissue, which seems to be rich in lymphatics and contains more or less fat. This fat is often infiltrated with cancer. These blood-vessels should be dissected out very clean and immediately ligated close to the axillary vein. The

ligation of these very delicate vessels should not be postponed, for the clamps occluding them might of their own weight drop off or accidentally be pulled off, or the vessels themselves might be torn away by the clamps.

"Furthermore, the clamps, so many of them, if left on the veins, would be in the way of the operator.

"(12) Having exposed the subclavian vein at the highest possible subclavicular point, the contents of the axilla are dissected away with scrupulous care, also with the sharpest possible knife. The glands and fat should not be pulled out with the fingers, as advised, I am very sorry to say, in modern text-books, and as practised very often by operators. The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels.

"In liberating the vein from the tissues to be removed, it is best to push the vein away from the tissues, rather than, holding the vein, to push the tissues away from it. It may not always be necessary to expose the artery, but I think it is well to do this; for sometimes, not usually, the tissue above the large vessel is infiltrated, and we should not trust our eyes and fingers to decide this point. It is best to err on the safe side, and to remove in all cases the loose tissues above the vessels and about the axillary plexus of nerves.

"(13) Having cleaned the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla, the lateral wall of the thorax. We must grasp the mass to be removed firmly with the left hand, and pull it outward and slightly upward with sufficient force to put on the stretch the delicate fascia which still binds it to the chest. This fascia is cut away close to the ribs and serratus magnus muscle.

"(14) When we have reached the junction of the posterior and lateral walls of the axilla, or a little sooner, an assistant takes hold of the triangular flap of skin and draws it outward, to assist in spreading out the tissues which lie on the subscapularis, teres major, and latissimus dorsi muscles. The operator, having taken a different hold of the tumor, cleans from within outward the posterior wall of the axilla. Proceeding in this way, we make easy and bloodless a part of the operation which used to be troublesome and bloody. The subscapular vessels become nicely exposed and caught before they are divided. The subscapular nerves may or may not be removed at the discretion of the operator. Küster lays great stress upon the importance of these nerves for the subsequent usefulness of the arm. We have not as yet decided this point to our entire satisfaction, but I think that they may often be spared to the patient with safety.

"(15) Having passed these nerves, the operator has only to turn the mass back in its normal position and to sever its connection with the body of the patient by a stroke of the knife from *b* to *c*, repeating the first cut through the skin.

"All that has been removed is in one piece. There are no small pieces or shreds of tissue. I believe that we should never cut through cancerous tissues when operating if it is possible to avoid doing so.

The wound might become infected, either by the knife which has passed through diseased tissue, and perhaps carries everywhere the cancer-producing agents, or by the simple liberation of the cancer-cells from their alveoli or from the lymphatic vessels.

"The operation as we perform it is literally an almost bloodless one. From the first to the last each bleeding point is stopped with an artery-forceps as quickly as possible. When practicable the vessels are clamped before they are divided. If no blood is lost, there is no perceptible shock from the operation. This is true of almost every operation. The symptoms which are so often ascribed to shock are due almost invariably to loss of blood. I have performed this operation for breast-cancer on patients whose pulse before the operation was so feeble that the anesthetizer and bystanders have pronounced it barely perceptible. As a rule, the pulse is little, if any, feebler after the operation than it was before it.

"The edges of the wound are approximated by a buried pursestring suture of strong silk. Of the triangular flap of skin (*a b c*) only the base is included in this suture. The rest of this flap is used as a lining for the fornix of the axilla. The apex of this flap is consequently shifted to a new and lower position.

"The axilla is never drained, and invariably heals by first intention. The uncovered wound often heals by the so-called organization of the blood-clot."[1]

CHAPTER XVI.

DISEASES AND INJURIES OF THE FEMALE GENERATIVE ORGANS.

I. METHODS OF EXAMINATION.

When the patient presents herself for examination, she should be permitted to tell in her own way all she has to say concerning her illness: by this means the examiner may not only gain much valuable information, but what is said and the manner in which it is said will give an insight into the character and disposition of the individual which will have great influence on the subsequent treatment. Should the patient become too voluble in recounting her ailments, a thermometer placed under her tongue will check the flow of language and afford the surgeon a brief respite.

As diseases of the female genital organs present many features peculiar to themselves, I would recommend the following schedule as more suitable than that laid down for ordinary surgical cases:

I.—**Family History.**—Parents, brothers, sisters, and near relations; number dead and ages at death; state of health of living members of the family.

II.—**Personal History.**—1. *Age.*

[1] *Annals of Surgery*, Nov., 1894.

2. *Marriage.*—Number of children; age of first child; condition of health of the children; number of children living; number of children dead; causes of deaths; number of abortions and miscarriages; character of previous labors—prolonged, difficult; instrumental interference; character of puerperium.

III.—**Previous Illnesses.**—1. *General Diseases.*

2. *Disorders of Menstruation.*—First appearance of menstruation; when irregularities began; character of past menstrual periods; pain; amount of discharge; duration.

3. *Leukorrhea.*—Date of its first appearance; amount; color; blood; number of napkins used daily; whether more severe before or after menstruation.

4. *Pain.*—When it began, intensity, location, duration, recurrence, character; increased by motion, sitting, lying, standing; continuous, paroxysmal; exacerbations; before, during, following, or between menstrual periods; feeling of weight; bearing-down; pressure in pelvis; radiation to back, pubis, thighs, rectum, or umbilicus.

IV.—**Present Illness.**—(1) When it began; causes; continuous; intermittent. (2) *Menstruation, leukorrhea, and pain,* as given under previous illnesses. (3) *Circulatory system.* (4) *Digestive system.* (5) *Nervous system.* (6) *Respiratory system.* (7) *Urinary system.*

V.—**Physical Examination.**—(1) Urine, amount, color, reaction, odor, specific gravity; albumin, sugar, casts, cells; frequency of micturition; pain, scalding, bearing-down, lancinating. (2) General appearance. (3) Heart. (4) Lungs. (5) Abdomen. (6) External genitalia. (7) Perineum. (8) Vagina, cul-de-sac. (9) Uterus, cervix, position, length; patulous os and canal; direction of long axis; lacerations; consistency. Body of uterus, position, size, shape, consistency, mobility; length and direction of cavity.

Appendages, { Fallopian tubes; Ovaries; Broad ligaments.

VI.—**Pelvic Viscera.**—Bladder; rectum; anus.

Positions for Examination.—The various positions for examination recommended are—1, Erect; 2, Dorsal; 3, Semi-prone (Sims' position); 4, Knee-chest; 5. Trendelenburg.

The **erect** position is of limited value, and is chiefly employed in detecting a slight degree of prolapse of the uterus. The patient is asked to strain down while in the erect position, the examining finger impinging against the cervix. This method may also be employed in the diagnosis of large tumors and in displacements of the uterus. Occasionally a pessary which will hold the uterus in place in the Sims' and dorsal positions will fail to do so in the erect position.

The method is employed as follows: The examiner places himself in front of the patient, resting on his left knee; the right knee is semi-flexed and supports the right arm; the left hand supports the waist, and the vaginal examination is made with the index finger of the right hand.

The **dorsal** position is the one most frequently adopted (Fig. 281). The bladder and rectum should be empty: the clothing should be loose about the waist. The table on which the examination is made

should be of convenient height and covered by a blanket or cushion. The patient lies on her back, her head supported by a pillow; the legs are flexed upon the thighs, and the thighs upon the abdomen; the feet should rest in stirrups, or the feet and knees can be supported by the Clover's crutch or by an assistant on either side. The patient should be covered with a sheet and exposed as little as possible. It is less embarrassing to the patient if the vaginal examination be made before the inspection of the external genitals or the use of the speculum. The examination should be preceded by an antiseptic vaginal irrigation; all instruments should be sterilized, and the hands of the examiner should be thoroughly cleansed and rendered aseptic, special attention being paid to the finger-nails, which should be cut short for fear of scratching the vaginal mucous membrane. The examining finger should be covered with an aseptic non-irritating lubricant, such as green soap or vaselin. Green soap is preferred, because the odor of the secretions can be easily removed by washing. The index finger of the left hand is usually preferred, but it is well to cultivate the sense of touch in both hands.

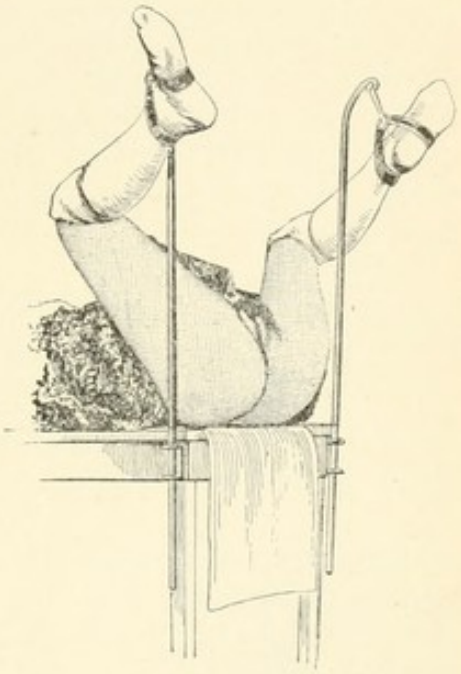


FIG. 281.—Woman in the dorsal position with feet supported in Edebohls' stirrups.

The Semi-prone or Sims' Position (Fig. 282).—The patient lies upon her left side, her hips at the left-hand corner of the table. The knees are drawn up toward the chest as much as possible, with the



FIG. 282.—Sims' position.

right knee a little farther up than the left and almost touching the table. The left arm is drawn behind the patient's body. The knees are to be kept well flexed.

The **genu-pectoral** or **knee-chest position** (Fig. 283) is almost entirely confined to the manipulation for replacing a retroflexed uterus. It has been found of service in the operation for vesico-vaginal fistula, but is open to serious objections, because of the danger

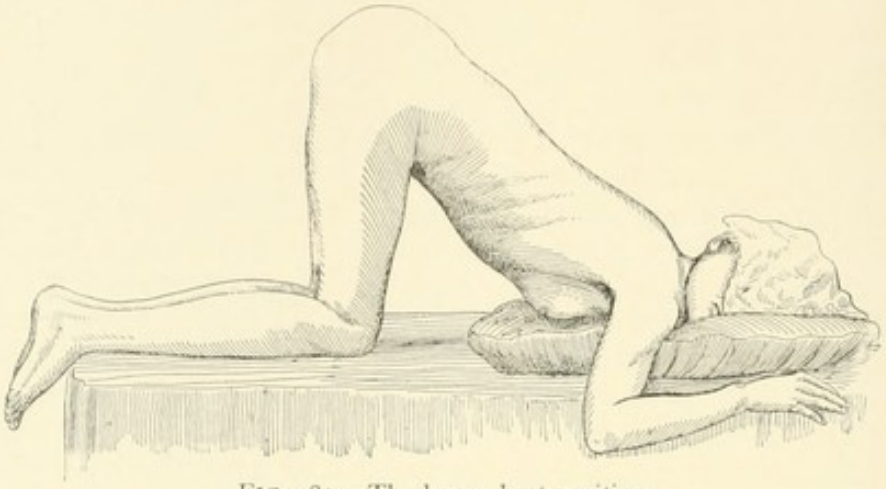


FIG. 283.—The knee-chest position.

of anesthesia in this position. The patient is placed upon a table; the weight of the body is supported by the knees (which are separated) and the sides of the face and front of the chest; the arms are drawn back along the sides of the body. In this position the patient is supported by a special appliance or by assistants.

The **Trendelenburg position** is now very extensively used in abdominal operations, and consists in placing the patient on her back, with the knees greatly flexed and the whole body and limbs so elevated as to form a steep incline from the shoulder to the knees; the back is slightly arched. This position causes the abdominal to gravitate away from the pelvic viscera, thus facilitating operations in the latter cavity (Fig. 284).

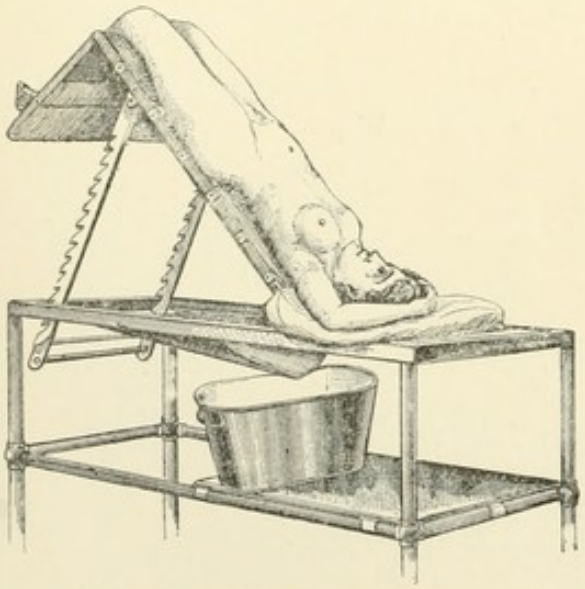


FIG. 284.—Trendelenburg position.

Vaginal Examination.—An antiseptic vaginal douche should always precede this examination; the bowels and bladder should be empty, and the hands of the examiner sterilized as for a surgical operation.

The examination should be made in the dorsal position, with the knees flexed, the feet resting in stirrups at the sides of the table or supported by an assistant. The index finger is lubricated with green soap, vaselin, or any antiseptic non-irritating oil; it is introduced by first passing it over the perineum into the vagina; the remaining fingers of the examining hand are semi-flexed and press against the perineum or gluteal fold; the thumb is extended in the direction of the groin.

The examining finger passes along the posterior wall of the vagina till the cervix is reached. Much information is now gained as to the degree of sensitiveness of the external genitals and vagina, the condition of the perineum, the dryness and heat of the vaginal mucous membrane, the presence or absence of the hymen and foreign growths of the external genitalia, the existence of spasmodic contraction of the sphincter vaginæ, and the size of the vagina. In palpating the cervix note the size and direction of its long axis, the presence of lacerations, and the condition of the os, whether patulous and soft or hard and resisting. When the cervix cannot be easily reached the index and middle fingers may be inserted and greater pressure brought to bear upon the perineum. At times it is more satisfactory to examine in the Sims' or knee-chest position, in order to bring the cervix within reach. The examining finger may be swept along the sides of the vagina to detect cicatrices and hypertrophied folds of mucous membrane, and along the posterior wall to ascertain the condition of the rectum.

Bimanual Examination (Fig. 285).—By this method the vaginal examination is greatly facilitated. With the examining finger

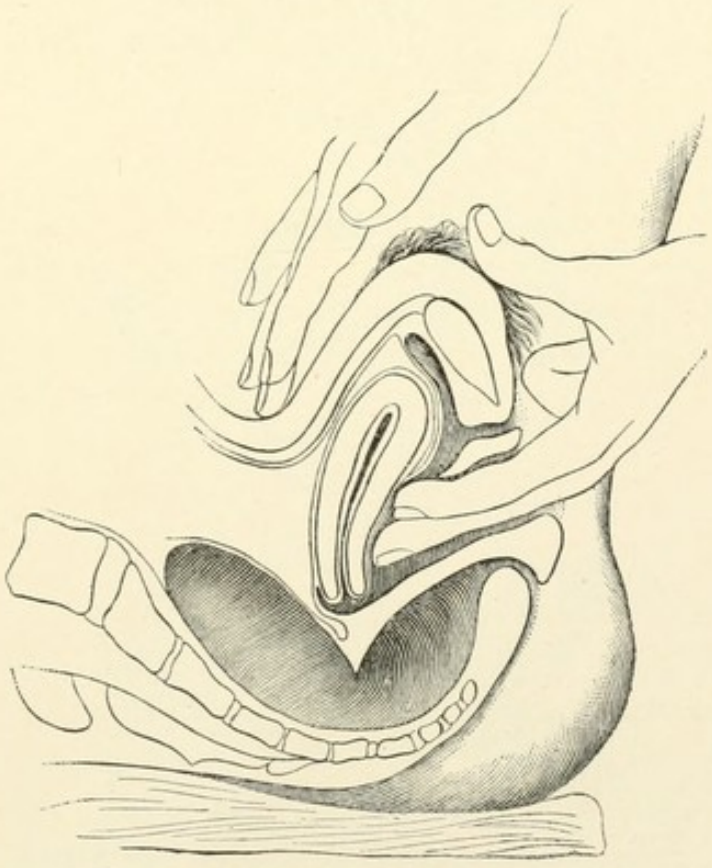


FIG. 285.—Bimanual palpation of the uterus.

in the vagina and the fingers of the other hand making counter-pressure upon the hypogastrium the structures lying between the two approximating fingers may be outlined. The exact position, size, and degree of mobility of the uterus are to be demonstrated by the examining finger impinging against the cervix, while the fingers of the other hand make firm pressure in the suprapubic space. In extreme

retroflexion, or where the abdominal wall is tense or very thick, it may be impossible to palpate the uterus in this way. Where there is extreme sensitiveness or rigidity of the abdominal muscles anesthesia is indicated. After palpating the uterus each iliac space is to be explored. The tubes are frequently felt as two cord-like bodies running from the fundus of the uterus to the sides of the pelvis; these, when enlarged as a result of inflammatory processes or tubal pregnancy, can be readily outlined and the degree of mobility demonstrated. The ovaries lie beneath the distal end of the tubes, and under favorable conditions may be felt as elastic oval bodies the size of a pecan-nut. The cul-de-sac, in front, behind, and at each side of the uterus, should be carefully palpated to detect the presence of any foreign growth, induration, or point of tenderness. All foreign bodies should be carefully outlined, to ascertain their relation to the uterus, their size, shape, elasticity, and sensitiveness to touch. This examination should be made under cover of a sheet.

Rectal Examination.—Vaginal or bimanual examination may be supplemented by rectal examination (Fig. 286). The index finger,

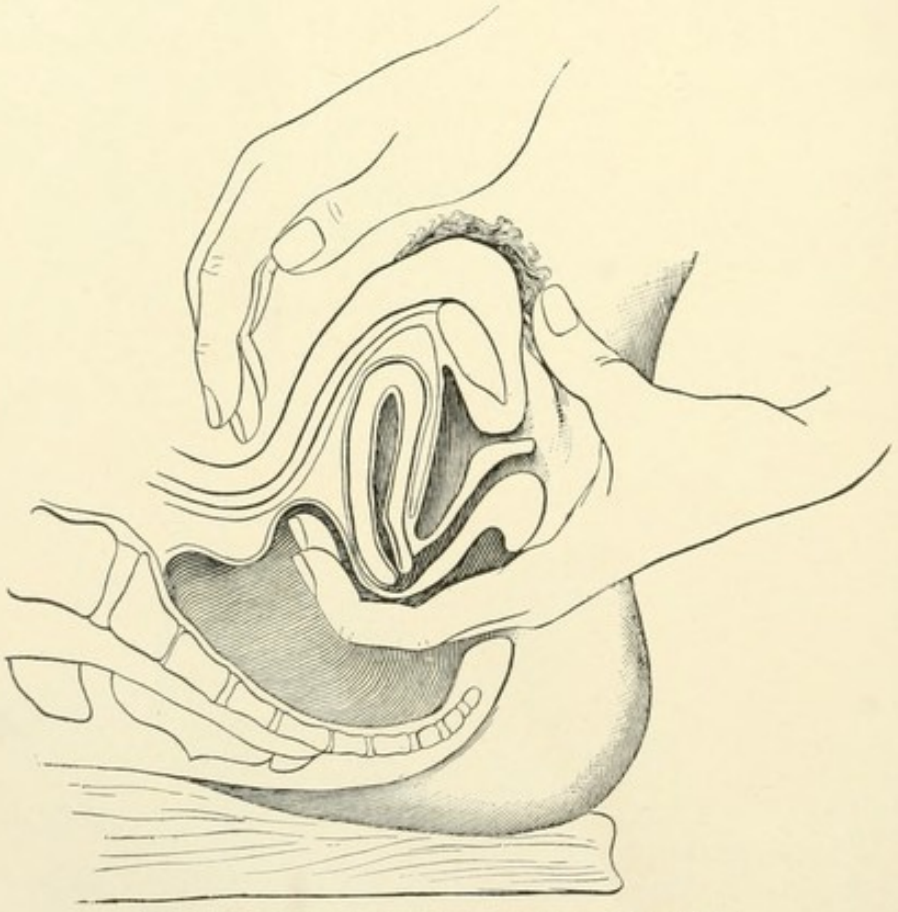


FIG. 286.—Bimanual rectal palpation of the pelvis.

having been previously lubricated, is introduced into the anus by a rotary motion and firm pressure against the perineum. The fundus, the posterior surface of the uterus, and the posterior cul-de-sac may thus be palpated. With the other hand on the abdomen bimanual recto-abdominal examination is made. This method should never be

neglected in examining the pelvic organs; it is especially indicated in virgins in cases of imperforate hymen and in atresia vaginæ.

Inspection of the External Genitalia.—This should follow the preceding examinations. Hypertrophy of the clitoris and vulvæ,

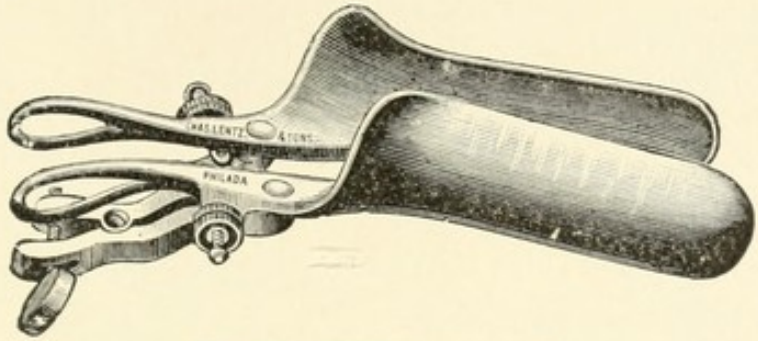


FIG. 287.—Goodell's speculum.

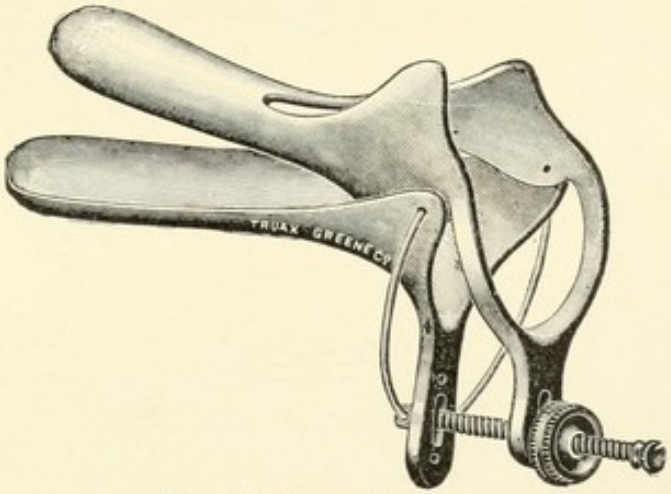


FIG. 288.—Brewer's speculum.

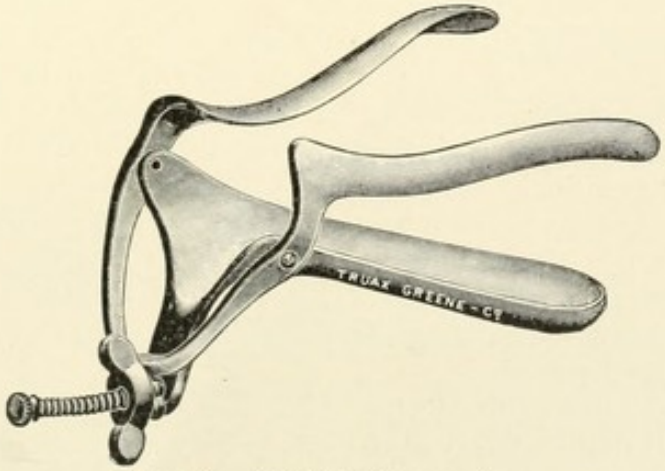


FIG. 289.—Nott's trivalve speculum.

vulvitis, vaginitis, abscesses of the Bartholinian glands, urethral caruncle, the character of the leukorrheal discharge, the condition of the perineum, and the presence of hemorrhoids, rectal fissures, strictures, and fistulæ, are to be noted.

Examination with Speculum.—Of the various specula in the market,

three varieties are adopted in general practice: 1. Cylindrical specula. These are introduced with the patient occupying the dorsal position, and are of service in making topical applications to the cervix and uterus, but they have these objections—viz. they do not permit of an unobstructed view of the anterior wall of the vagina; they inflict pain where the vagina is small and sensitive; and their lumen is too small to admit of free instrumental manipulation.

2. The bivalve speculum is most serviceable in general practice where an assistant is not at hand. The best in the market are Goodell's (Fig. 287), Brewer's (Fig. 288), and Nott's (Fig. 289). They are introduced in the dorsal position, and afford a view of the cervix, cul-de-sac, and anterior vaginal wall.

3. Sims' speculum (Fig. 290) where there is an assistant affords the

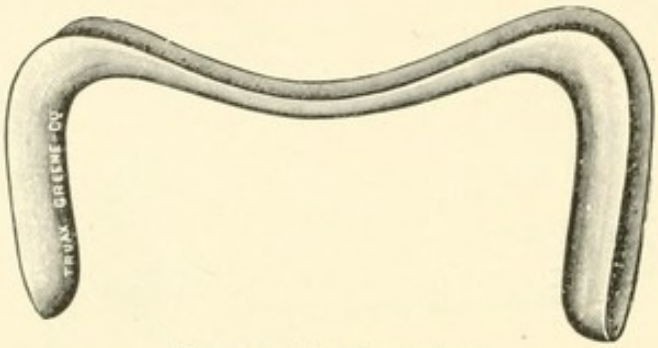


FIG. 290.—Sims' speculum.

greatest advantage; it permits of a maximum amount of room in the vagina; the view of the cervix and anterior vaginal wall is not obstructed; it is easily introduced, and facilitates and renders possible many operations upon the vagina, cervix, and uterus, As a rule, it is used in the Sims position.

Simon's hollow blades, mounted upon a handle and made in sets of various sizes, are useful.

Uterine Sound.—The simplest uterine sound is the best; it has a graduated flexible stem, a button end, and a spatula-shaped handle. The uterine sound should never be used without first ascertaining the size, shape, position, and condition of the uterus by bimanual examination, and after positively excluding the question of pregnancy.

The probe should be bent to correspond with the curve of the cavity of the uterus. Before introducing it irrigate the vagina with an antiseptic solution and wipe the cervical canal with pledgets of cotton. The probe must be sterilized, the patient placed in the dorsal position, and a speculum inserted.

Gentle traction on the cervix with a tenaculum by straightening the canal aids the introduction of the probe and brings the os into view and within reach. Before withdrawing the probe the depth of the cava uteri and the length of the cervix can be measured by placing the finger on the probe at the os externum or catching it at this point by forceps. The probe demonstrates the length and width of the uterine canal, the direction of its long axis, and the patency of the canal. The probe should never be used in correcting a retroflexed uterus, for fear of injury to the organ. Metritis, perimetritis, and salpingitis have followed

its use, but such consequences are rare, and the instrument remains a valuable aid to diagnosis, especially to the inexperienced.

Artificial Dilatation of the Uterus.—The uterus should be dilated with the strictest of aseptic precautions. The following methods are in vogue:

1. Gradual dilatation by tents made of sponge, tupelo, slippery elm, or laminaria. This method cannot be recommended except in special cases, because of the difficulty in thoroughly sterilizing the tents.

2. *Instruments of Divulsion.*—Ellinger's, or Goodell's (Fig. 291)

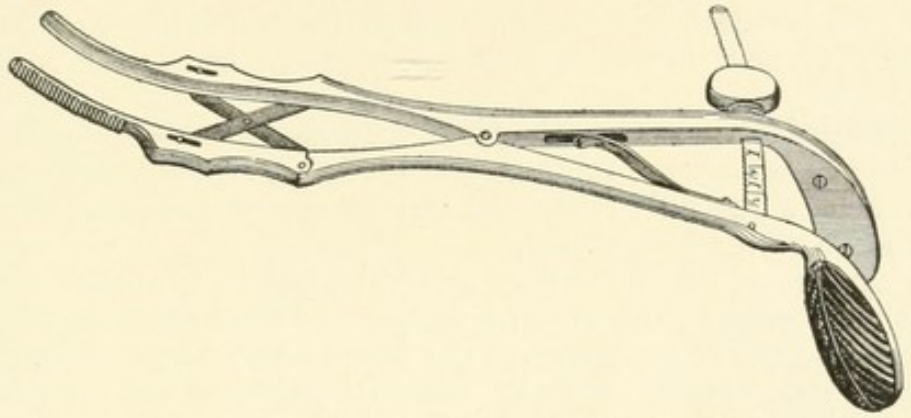


FIG. 291.—Goodell's modification of Ellinger's dilator.

modification of Ellinger's, dilator is the best and safest of all means of rapid dilatation of the cervix. The operation should require ten to thirty minutes, depending upon the rigidity of the cervix. Anesthesia is unnecessary, except where dilatation is to be complete.

3. *Immediate Progressive Dilatation.*—Of the instruments employed for this purpose, Hagar's cylindrical bougies are the best. Tait's conical form and Hanks's hard-rubber and ovoid form are also recommended (Fig. 292). They may be passed in the dorsal or Sims position. The

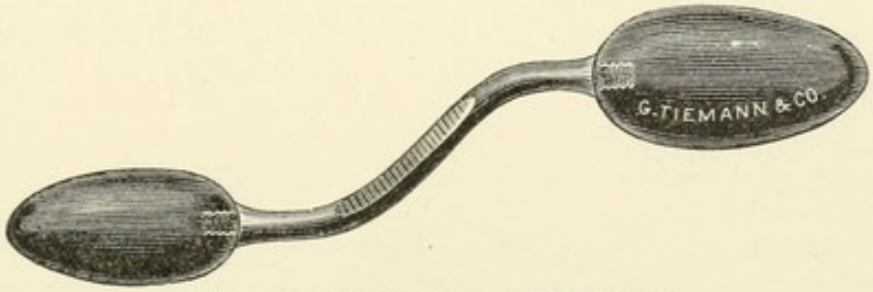


FIG. 292.—Hanks's large uterine dilator.

vagina is first irrigated and the speculum introduced. Lubricate the sterilized bougies with sterilized vaselin; begin with the size which will pass with least resistance, and gradually dilate by successively introducing the next larger size. When one is found to enter with difficulty, leave it in place for a few minutes till the spasmodic contraction has passed away, then proceed to the next larger.

4. *Incision.*—Where in urgent cases the preceding methods have failed, and the only point of constriction is at the external os, one or more incisions may be made at the point with scissors, and closed with sutures later.

5. *Complete Bilateral Division of the Cervix.*—This methed is rarely resorted to, and is only indicated in case of the extraction of large intra-uterine growths, where the cervical canal resists dilatation or where the rigid cervix resists the above methods and the indications for dilating are urgent.

6. Where time is no factor the uterus may be packed with iodoform gauze—the gauze removed in forty-eight hours and more replaced till sufficient dilatation has been effected.

When it is necessary to make a microscopic examination of uterine tissue, a wedge-shaped piece can be removed or the uterus can be dilated and curetted, and the product of the curettage examined by allowing it to float in water, after which it can be placed under the microscope.

Examination of the Urethra and Bladder.—In pelvic disorders in the female the urethra and bladder are frequently involved and should be carefully examined. A thorough examination of the urine should never be omitted.

1. *Inspection.*—By inspection urethral caruncles, prolapse of the mucous membrane of the urethra, stricture of the urethra, urethrocele, cystocele, and the secretions from the urethra may be observed.

2. *Palpation.*—By vaginal and bimanual palpation the relative position of the bladder and uterus, the degree of distention of the bladder, stone in the urethra and bladder, and tender points in the urethra should be sought for.

3. *Sound.*—By the sound the presence and site of stricture of the urethra can be demonstrated, though stricture in the female is of comparatively rare occurrence. Also by the sound sensitive points along the urethra, due to inflammation and ulcers, are detected.

4. *Endoscope.*—Skene's endoscope is almost invariably used, and consists of a small glass test-tube, which is first passed as far as the bladder; into this tube is inserted a mirror obliquely placed on a handle, by which it is turned in all directions, and with artificial light directed upon it from a hand-mirror the entire mucous membrane of the urethra can be inspected; in this manner direct inspection can be made of fissures, ulcers, and inflammation.

Digital examination of the urethra and bladder may be made without injury by gradually dilating with Simon's dilators, and then introducing the index finger.

Examination of the Ureters.—The pelvic portions of the ureters may be palpated by bimanual examination, and are felt as cord-like bands running from the sides of the bladder upward and backward to the bases of the broad ligaments. The abdominal portion of the ureters may be palpated by passing a ureteral catheter to the pelvis of the kidney.

Method of Catheterizing the Ureters.—The patient is placed in the dorsal position, with the pelvis close to the edge of the table and the legs and thighs strongly flexed. The bladder is emptied by a catheter, and the urine set aside for comparison with what is to be obtained later. About 200 c.c. of an anilin solution is injected into the bladder. The posterior vaginal wall is now retracted with a Sims or Simon speculum, and a full view of the anterior wall obtained. Over

the anterior surface of the wall, and about halfway up, will be seen two prominent folds sweeping outward on to the lateral walls in the direction of the cervix. These are Pawlik's ureteral folds, and just above and running parallel to them are the ureters. The ureteral catheter is now introduced, and its point turned toward the floor of the bladder, where by slight pressure its position can be felt by the finger or seen by the eye. The point of the instrument is now made to sweep outward in the direction of the ureteral fold in search of the ureteral opening. When once engaged in the opening the catheter is slipped backward and outward toward the posterior pelvic wall. It can then be pushed as far as the pelvis of the kidney. From the vagina the ureter can now be palpated with the finger. In a few moments urine begins to flow from it in little jets. The urine is also free from the color of the fluid which was injected into the bladder, proving that it comes from a higher source.

II. ANOMALIES OF THE FEMALE GENITAL ORGANS.

True **hermaphrodism** is a congenital anomaly in which there is a union of characteristics of the two sexes in the same individual: the tendency is toward the male type. Klebs divided true hermaphrodism into—1. Bilateral—an ovary and testicle on both sides; 2. Unilateral—on one side an ovary and a testicle, on the other side an ovary or a testicle; 3. Lateral—ovary on one side, testicle on the other.

In apparent or pseudo-hermaphrodism the female may simulate the male type in one or more of the genital organs, which are excessively developed, as in the case of an enormously developed clitoris, simulating the penis, and a hernial descent of the ovary into the labial fold, simulating the testicle; or the male organs may simulate the female organs, as in hypospadias, the fissure of the corpora cavernosa being mistaken for the vagina, and an atrophied penis may be mistaken for the clitoris.

Anomalies of the External Genital Organs.—Vulva.—Atresia is rarely seen in the vestibule. A complete absence of the vulva, with the skin stretched over the entire region, is a rare malformation.

Hypospadia in the female is a very rare congenital defect, and is due to arrested development of the urogenital sinus, resulting in the formation of a common outlet of the vagina and rectum; more commonly the rectum opens into the vagina—a condition known as *ano-vaginalis.*

Non-development of the Vulva.—This condition usually coexists with a failure of development of the internal genital organs, and consists of a thin flattened labia, a narrow flattened vestibule, a small clitoris, and imperfectly developed mons veneris and pubic hair.

Hypertrophy of the Vulva.—Thickened labia majora are of rare occurrence and do not demand operative interference.

Hypertrophied labia minora, or, more rarely, supernumerary labia minora, when they become inflamed, tender, and interfere with coition and locomotion should be excised.

Anomalies of the Hymen.—The normal hymen is a thin concentric membrane guarding the outlet of the vagina and perforated in

the center by an opening large enough to admit the little finger. The following anomalies are found: 1. The hymen may be absent or represented merely by one or more papillæ. 2. Imperforate hymen, the membrane completely closing the vaginal outlet. 3. Where the perforation is very small or there are a number of small perforations, the so-called cribriform hymen. 4. Hypertrophied hymen, where the membrane protrudes through the vulvar outlet. 5. Serrated hymen, where the free margin is dentated. 6. Thickened hymen, where the membrane is tough and resisting; coition and even labor may occur without rupturing the thickened hymen.

Hypertrophy of the Clitoris.—The clitoris may become so large as to simulate the penis. When it becomes inflamed or irritated, and causes discomfort in walking or interferes with coition, amputation of the clitoris is indicated.

Anomalies of the Internal Genital Organs.—The vagina varies greatly in length and breadth. There may be complete or partial atresia of the canal, with or without a developed uterus. The vagina may exist merely as a fibrous and muscular band, or it may be partially or completely divided by a septum antero-posteriorly or laterally. A so-called second hymen may exist—that is, a membrane stretched across the vagina above the hymen, and which partially or completely divides the canal into an upper and lower segment. If there be complete atresia of the vagina with a perfectly formed uterus, tubes, and ovaries, the menstrual secretions will be retained; the pain resulting will be increased at each menstrual period; the vagina will become distended with blood, and must be emptied through an artificial outlet. The operation consists in making a transverse incision in the perineum between the rectum and urethra; the tissues are dissected up to the cervix or uterus by a blunt instrument or the finger, and if the cervix is found patent it should be dilated. If the cervix is closed, the uterus may be punctured with a trocar, the opening enlarged by stretching with bougies or by taking a flap of skin from the buttocks and attaching it to the margin of the artificial opening in the uterus. When there are no menstrual secretions from an undeveloped uterus and appendages, no operative interference is indicated. If from the presence of the ovaries great menstrual disturbance results, the operation of ovariotomy may be indicated.

Anomalies in Development of the Cervix.—Anomalies are frequently found in the development of the cervix and in the size, shape, and degree of patency of the os and canal.

Stenosis of the cervical canal is of the greatest clinical importance. This condition is often associated with a small cervix and fundus and anteflexion. As a result of the obstructed menstrual flow, dysmenorrhea, endocervicitis, and endometritis develop, rendering the patient sterile. The treatment consists in gradual dilatation of the cervix by instruments of divulsion, followed by curetting. The operation should be done under anesthesia.

Atresia of the Cervix.—This condition may be congenital or acquired, and may affect the os externum, the os internum, or the whole cervical canal. In the congenital variety the condition is rarely noticed before puberty, at which time the menstrual secretions collect and cause

dysmenorrhea. The diagnosis is readily made by an attempt to pass a sound and by the distended uterus and tubes, which are felt by bimanual examination.

The acquired form may result from the use of caustics, from ulceration and inflammatory processes, and rarely from unknown causes. (For treatment see Hematometra.)

Arrested Development of the Cervix.—The cervix may be absent or only partially developed. The vaginal portion may be wanting, a condition which may exist alone or together with a failure in the development of other parts of the genital tract.

Hypertrophy of the Cervix.—Congenital hypertrophy of the vaginal portion of the cervix occasionally exists; the cervix may protrude from the vulvar outlet, become inflamed, and interfere with locomotion and coition, in which case Hagar's amputation of the cervix should be performed.

Anomalies of the Uterus.—Anomalies of the uterus chiefly arise from arrested development of the organ, and consist of a greater or less duplicity of the uterus from partial or complete failure of the duct of Müller to unite. When development has been arrested at a very early stage there may be entire absence of the uterus, or it may be represented by a mere bundle of muscle and connective-tissue fibers. If arrested late in the development, the organ simply remains in the infantile state. When it fails to develop at puberty, there is often associated with infantile uterus anteflexion and an hysterical temperament; the ovaries may be fully developed and the menstrual periods recur with more or less regularity, but there are menstrual disturbances which may be so severe as to demand ovariotomy. The treatment of infantile uteri is not satisfactory: the faradic current has been applied to the interior of the uterus, but the dysmenorrhea and sterility may be considered incurable.

From failure of development and from a failure of Müller's duct to unite the following anomalies may result:

1. Uterus unicornis, where one Müller's duct is absent or partially developed, the uterus consisting of but one side. There is but one tube, but both ovaries may be well developed. No treatment is indicated.

2. Uterus didelphys, double uterus. In this condition there are two separate and distinct uteri.

3. Uterus bicornis duplex. In this form there are two vaginæ, two ovaries, and two uteri, joined externally by bands of connective tissue and peritoneum.

4. Uterus bicornis, unicollis bifid. There is but one vagina and one cervix, but two uteri, the Müller's duct having united to a variable distance, but failing to unite above.

5. Uterus cordiformis. As the name implies, the uterus is heart-shaped; the partial failure of fusion is shown in the presence of a depression in the broadened fundus uteri, there being but one uterus, one cervix, and one vagina.

6. Without any external manifestations the uterine cavity may be divided by a septum into two compartments, or this septum may only partially divide the cavity.

Anomalies of the Fallopian Tubes.—These are of little practical interest to the gynecologist. There may be two tubes separated throughout, or two or more fimbriated extremities on one tube; there may be two openings into the uterus with a single tube; the lumen of the tube may be unusually large or small, or even absent.

Anomalies of the Ovaries.—The ovary may be altogether wanting or unusually small; there may be one or more supernumerary ovaries, or in an apparently normal ovary the Graafian follicles and ova may be absent.

III. TRAUMATIC LESIONS OF THE FEMALE GENITAL TRACT.

Injuries of the Vulva and Perineum.—These injuries may be due to—1. External violence, as from a blow, fall, kick, or coitus. 2. Parturition. When the skin has been torn the hemorrhage may be free and even dangerous, and where the skin remains intact the blood may collect in the loose subcutaneous connective tissue, causing a tumor, discoloration, and pain—the so-called pudendal hematoma. Injuries in the region of the clitoris are often dangerous because of the great vascularity of the part.

Treatment.—If there is simple contusion, rest and cold applications will suffice; when hematoma exists, rest in bed and firm, soft pressure will promote the resorption of the clot. Where suppuration develops, strict antiseptic precautions should be resorted to, the abscess opened and drained, and a sterilized dressing with T-bandage applied. Hemorrhage, as a rule, can be controlled by pressure from sterilized gauze; if not, the vessels may be ligated or the tissues tied *en masse*.

Injuries of the Vagina.—These injuries are rare, and occur from coitus, from blows, kicks, and falls.

Treatment consists in giving a thorough antiseptic vaginal douche, followed by packing with iodoform gauze or by suturing the lacerated surface with silk or catgut, dusting with iodoform powder, and dressing with iodoform gauze. The cervix is seldom injured by causes other than parturition.

Injuries due to Parturition.—Vulva and Perineum.—The vulva and perineum are frequently injured during labor from mechanical interference, by the use of the forceps, or by the causes of natural dystocia, including a relatively large presenting body or a relatively small outlet; also by any undue measures taken for the purpose of hastening the progress of labor, as ergot and rupture of the bag of waters before the completion of dilatation. The perineum being the true support of the pelvic organs, such injuries are of the highest importance in the causation of pelvic disorders. Too much stress has been laid upon injuries of the perineum as the causal factor of many female diseases. Many cases are seen where the injury has existed for years, and yet the woman suffers no inconvenience; on the other hand, injuries of the perineum are frequently the starting-point of subsequent ailments, and repair of the injury has resulted in complete relief.

These injuries cannot always be prevented, but by avoiding all pernicious means of hastening labor, by allowing the bag of waters to rupture spontaneously, and by protecting the perineum in the second

stage of labor many injuries will be prevented which would otherwise occur.

Varieties.—The injuries may be submucous and subcutaneous, but, as a rule, both the mucous membrane and the skin are divided. For the sake of convenience of description three degrees are recognized: First degree, a rupture extending part way to the sphincter ani; second degree, a rupture extending to the sphincter ani; third degree, a rupture extending through the sphincter ani and including more or less of the recto-vaginal septum. The rupture may be in the median line, may be transverse to the median line, or may pass around the sphincter ani.

Symptoms.—The symptoms are all referred to the lack of support to the pelvic organs; there is a feeling of weight and insecurity in the pelvis. The posterior vaginal wall may bulge forward, giving rise to the formation of a rectocele, which interferes with the function of the rectum, a great effort being required to effect a movement of the bowels, and this effort seems to exaggerate the condition. The anterior vaginal wall may become thickened and bulge backward; this condition is known as vesicocele, which, if it includes the bladder, may seriously interfere with the evacuation of that viscus. The residual urine collects in the pouching bladder, becomes ammoniacal, and gives rise to a cystitis; hypertrophy and prolapse of the vagina result to a greater or less degree and augment the above conditions. Great annoyance to the patient may arise from the entrance and forcing out of the air in the vagina. Displacement of the uterus follows the loss of support afforded by the perineum. Many vague reflex symptoms referred to the pelvis, abdomen, chest, and limbs have been credited to the injury to the perineum. Where there is a complete laceration through the sphincter ani there is a loss of control over the bowels, the feces and gas escape without warning and without control, and the life of the individual becomes a burden. An irritating mucous discharge from the inflamed rectum may complicate lacerations which involve the bowel.

It will thus be seen that the injury is associated with general relaxation of the tissues of the pelvis. When examining for a lacerated perineum the labia should be separated by the fingers and the posterior vaginal wall inspected, since the greatest injury is found at this site.

Treatment.—1. *Primary or Immediate Operation.*—In general it may be said that every lacerated perineum should be repaired at the earliest possible date. The time should not exceed six hours after the rupture, though twelve to forty-eight hours have elapsed and perfect results been obtained. Much argument is waged over the advisability of repairing lacerations of the third degree immediately after labor, but there seems to be no reason to justify delay or unnecessary operative interference in these lacerations. The patient should be brought to the edge of the bed, with the legs flexed upon the thighs and the thighs flexed upon the abdomen, the limbs supported by assistants. A catgut suture is used, passing from one side of the laceration to the other, including the whole of the lacerated tissue: about half an inch in front of this, if required, another suture may be inserted; the sutures should be buried throughout.

2. *Secondary Operation.*—The secondary operation should not be performed short of three months after the injury, because before that time involution has not sufficiently progressed.

(*a*) *Incomplete Laceration* (Fig. 293).—A laxative should be given the day previous and an enema an hour or two before the operation; the pubic hair should be shaved and the external genitals scrubbed with soap and water, and sterilized by antiseptic solutions; a vaginal douche of bichlorid 1:2000 should be given, and the patient anesthetized and placed in the dorsal position, with the legs supported by a Clover's crutch or by assistants.

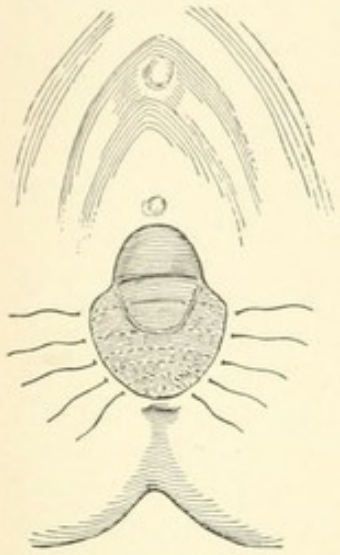


FIG. 293.—Diagram of operation for simple rupture.

The surface to be denuded is first outlined by a pair of angular scissors; the line of incision will correspond to a line formed by continuing the hymen around to the corresponding side, carrying the upper border on each side to a point just below the level of the anterior vaginal wall. The index finger of the left hand should be inserted into the rectum as a guide. The surface to be denuded is variable and should extend to the crest of the rectocele. Hemorrhage may be checked by continual irrigation or by sponges, and the denuded surfaces brought into apposition by sutures, beginning at the lowest point and passing from near the anal margin on the right side, through the recto-vaginal septum, to a corresponding point on the opposite side. Other sutures are passed in front of this at regular intervals; the upper sutures are passed under the reflected surface. The sutures are then tightened, beginning from below, care being taken not to draw them too tight for fear of cutting through the tissues. Silk or silkworm gut may be used.

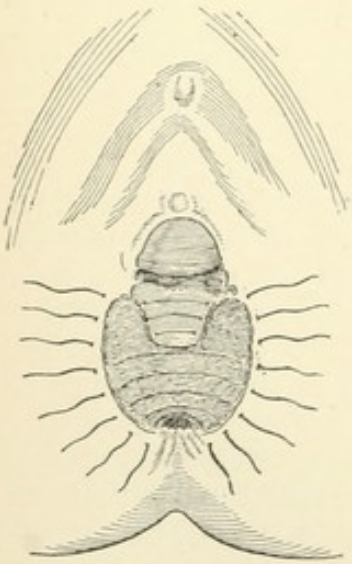


FIG. 294.—Diagram of operation for complete rupture.

After-treatment.—The patient should remain in bed two weeks, the urine being drawn by a catheter for three days, and the bowels opened about the second day either by a mild cathartic or enema, and kept open. The wound is dressed by dusting with boric-acid powder or iodoform powder, and over this is applied a sterilized absorbent dressing retained by a T-bandage. The stitches are removed by the seventh to the tenth day.

(*b*) *Complete Rupture* (Fig. 294).—When the sphincter ani and the recto-vaginal septum are divided, these structures must first be united by sutures, care being taken to accurately approximate the divided ends of the sphincter ani. The divided margins are denuded by the scissors or knife, the stitch passed from the vaginal side and including the entire recto-vaginal fold, penetrating at the upper and inner divided end of the sphincter, and returning at cor-

responding points at the opposite side, passing from within outward. With one or more of these sutures in place and tied, the perineum in front of the sphincter is repaired as in incomplete rupture. The preparatory and after-treatment is the same as in incomplete rupture; great care should be taken in giving a rectal enema not to disturb the wound by the irrigating tube.

Emmet's Operation—Semilunar or Butterfly Operation.—This operation is indicated in transverse lacerations and where there is relaxation of the soft parts; it is intended to restore the severed tissues and to contract those which are over-distended and relaxed. In transverse laceration the levator ani and fascia are separated from the perineum proper; this operation is devised to reunite these structures.

In denuding the surface two landmarks are to be kept in mind: one is the line of the hymen, and the other is a sulcus which is found at each side and forms a depression between the center and side of the vagina. There is always a rectocele in these cases, and this also plays an important part in the operation. The patient is placed in the dorsal position, as in the previous operation. The denudation is begun by following the line of the hymen or a little outside of it, and beginning near the posterior commissure, running up the labium to a level with the lower edge of the meatus. The line is then carried along the side of the vagina and well up into the sulcus on each side. The rectocele is next denuded by following the median line of the vagina as far as the rectocele extends. The denuded area assumes a shape seen in Fig. 295.

In placing the sutures begin at the upper angle of one sulcus. Pass the stitch from the outside, not straight across, but downward and inward, to about the middle of the denuded area; then pass it upward and outward to a point on the undenuded surface of the posterior vaginal

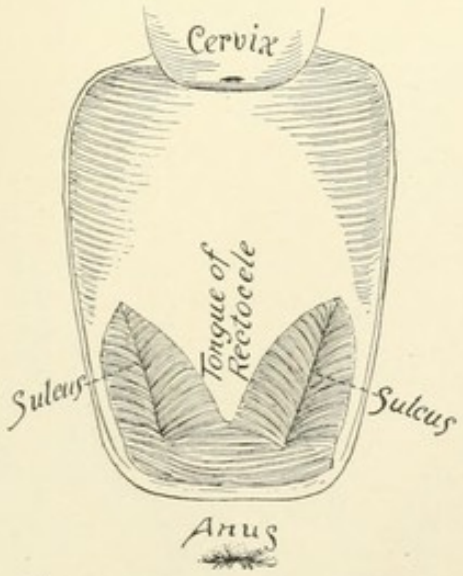


FIG. 295.—Area of denudation in Emmet's operation.

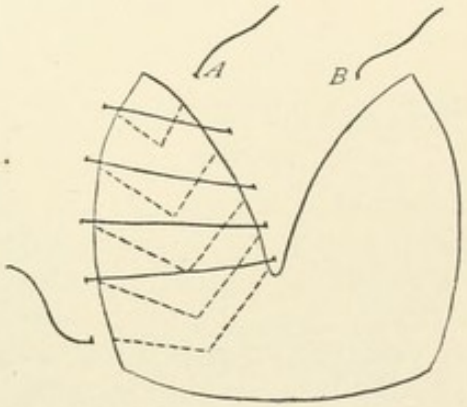


FIG. 296.—Area of denudation and method of placing stitches.

wall which corresponds with the point at which the needle entered. Three to five stitches are needed, and they can be interrupted or of continuous catgut. The other sulcus is treated in the same manner (Fig. 296). All that is left now is a raw surface posteriorly, which is closed by stitches placed in the manner adopted for the incomplete laceration.

Flap-splitting Operation of Tait.—This operation is only indicated in superficial laceration of the perineum: it will not remove a rectocele or

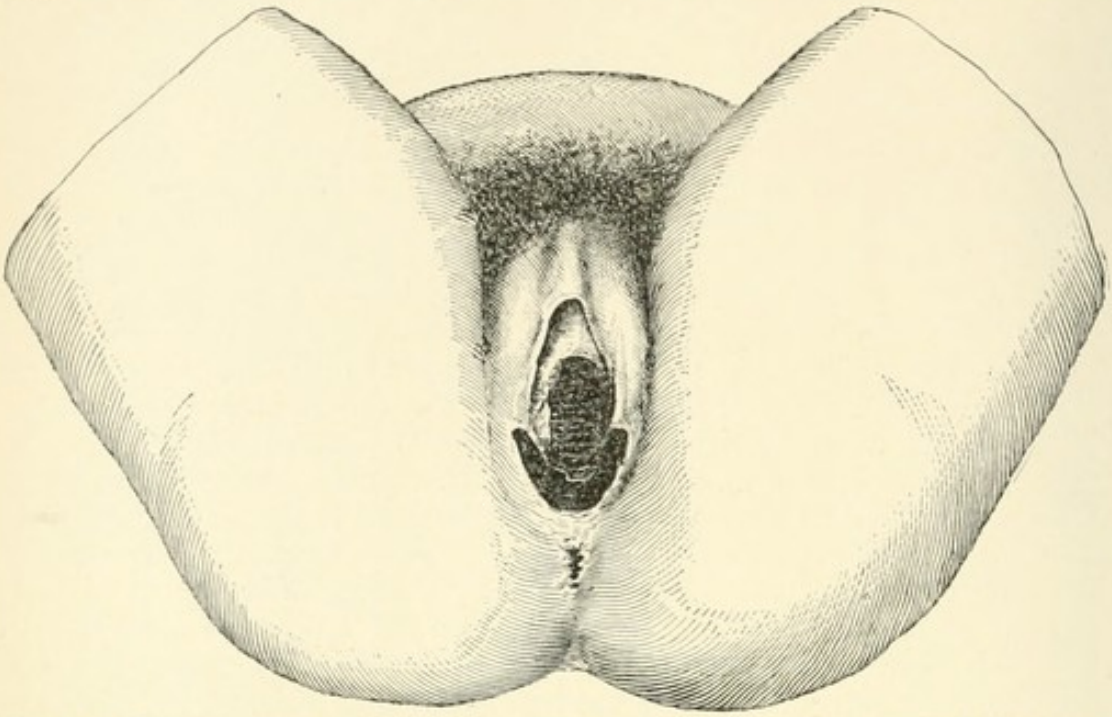


FIG. 297.—Flap-splitting for incomplete laceration of the perineum: relaxation of the vaginal outlet (Macphatter).

narrow the vagina, hence its field of usefulness is limited indeed. The operation is thus described in the *American Text-Book of Gynecology:*

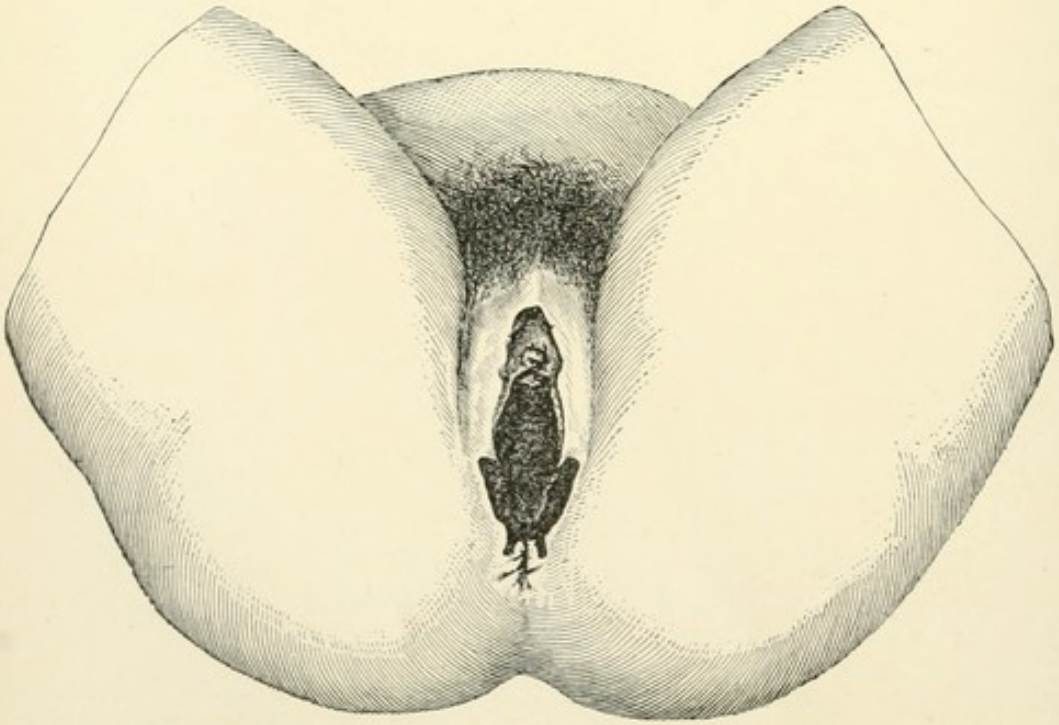


FIG. 298.—Flap-splitting for complete laceration of the perineum: laceration through the sphincter ani muscle (Macphatter).

"*For Incomplete Laceration* (Fig. 297).—The index finger of the left hand being introduced into the rectum as a guide, the point of one of

the blades of the scissors is thrust into the recto-vaginal septum, midway between the vaginal opening and the anus, to the depth of half an inch or more, care being taken that the instrument enters neither the vagina nor rectum. From this point the incision is made, first to one side and then to the other. The line of the incision is carried on one side outward and upward along the boundary-line between the vaginal mucous membrane and the skin of the labium. It is extended up the labium to that point at which it is desired the new vaginal floor shall

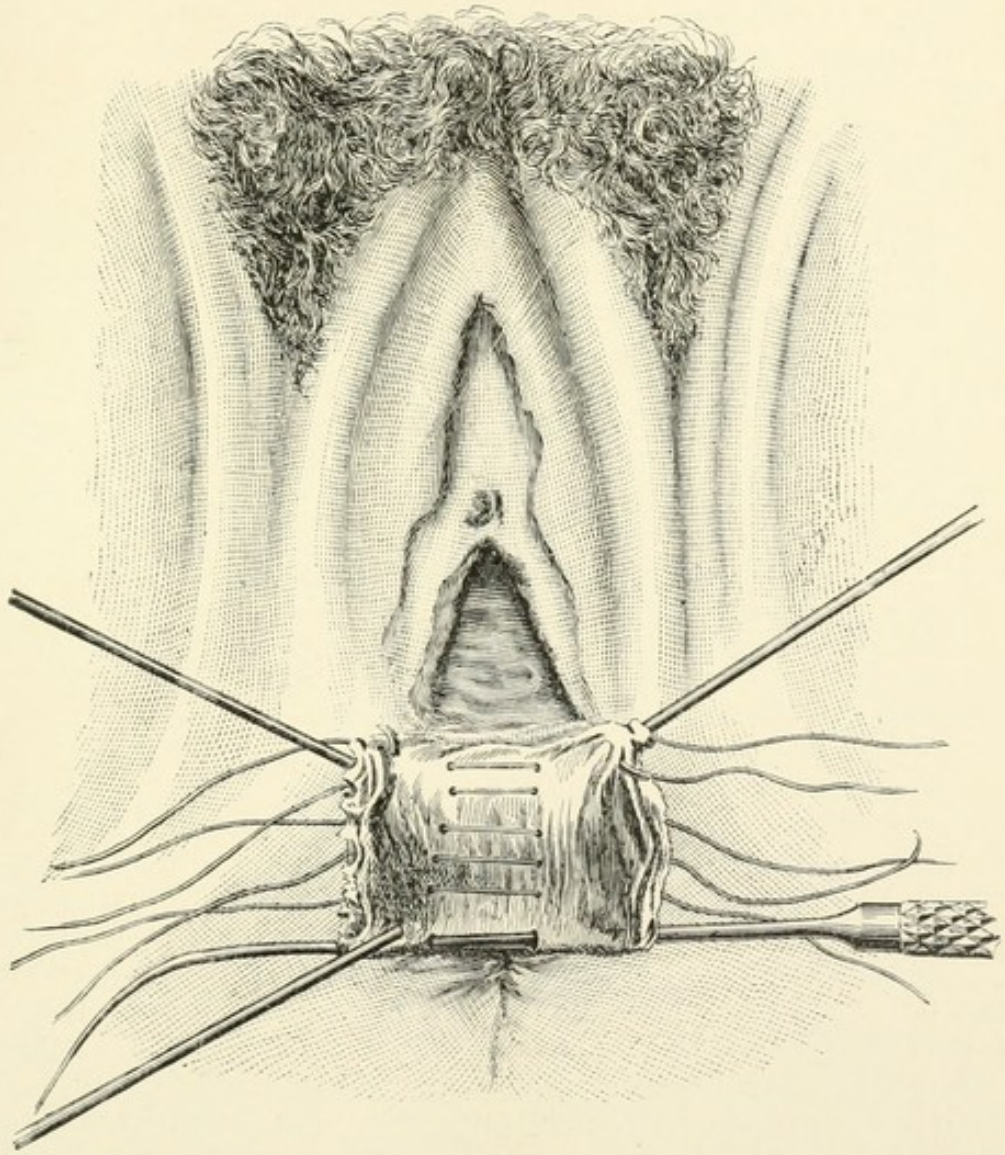


FIG. 299.—Introduction of sutures in flap-splitting operation (Baldy).

exist; this point is usually that at which the lower caruncle (remnant of the hymen) exists, which point, in addition, can be located by the existent scar-tissue. The depth of the incisions tapers gradually until they reach the highest point on the labia. When completed the incisions form the elliptical figure U."

"*For Complete Laceration.*—Where the sphincter ani muscle is involved in the laceration the method of repair is precisely similar, with the addition of two small slits. They are made by cutting down each side of the anus to the ends of the retracted sphincter muscle,

beginning the cuts at the curve of the original incision. Their length and depth are variable, depending upon the position of the retracted ends of the sphincter muscle, which must be exposed, so that when they are brought together the two ends may unite. When completed the incisions present the appearance as shown in Fig. 298.

"With the sides of the wound well separated the sutures are passed transversely. Beginning at the middle of the opening, the handled needle is made to pierce the skin about one-eighth of an inch from its cut edge, is carried three-quarters of the way to the bottom of the wound, where it is made to emerge, and, being reintroduced at a point directly opposite the point of emergence, is carried under the tissues of the opposite side until it appears on the skin-surface at a point directly opposite that at which it was first introduced (Fig. 299). The eye of the needle is now threaded with a silkworm-gut suture and the needle withdrawn, dragging with it the end of the suture. Several similar sutures are passed above and below the median one. The topmost suture must pass through the vaginal flap as it is held up by a tenaculum; the lower suture, if the laceration be a complete one, must include both ends of the retracted sphincter muscle. The corresponding ends of the suture are now tied, or, better, shotted; the pelvic floor is lifted up toward the pubis by the crowding in below of the gluteal tissues. The result forms a very firm and substantial support to the outlet, but in no way has any influence on any injury done to the vaginal floor."

IV. DISORDERS OF MENSTRUATION.

Amenorrhea.—By amenorrhea is meant an absolute suppression of the menstrual secretion. This condition must not be confused with an obstructed flow, as in atresia of the vagina.

Etiology.—1. In acute diseases, as typhoid fever, the menstruations cease, and reappear after convalescence. In chronic diseases, as tuberculosis, carcinoma, Bright's disease, leukemia, anemia, and syphilis, the menstrual flow becomes more and more scant, recurring at irregular intervals, and finally may wholly disappear, the result of malnutrition and anemia.

2. Emotion from fright or sorrow may suddenly check the menstrual flow: we often find amenorrhea in the insane and hysterical. Changes in climate, mode of life, and habits will often cause cessation of the menstrual periods. Long-continued mental strain from schoolwork is a frequent cause. Obesity and amenorrhea are not infrequently associated.

Local causes, which include congenital anomalies of the uterus and the appendages, rendering them incapable of performing the menstrual function, chronic inflammation of the uterus, ovaries, and tubes, also cysts and solid tumors of the ovaries, may cause amenorrhea, though late in their course. Pelvic inflammation involving the tubes and ovaries, when far advanced, rarely causes a partial or complete cessation of the menses. Hyperplasia of the uterus following pregnancy, also prolonged lactation, may interfere with the menstrual function.

"Catching cold," to which amenorrhea is often ascribed, is probably a vaso-motor disturbance.

Symptoms and Diagnosis.—The symptoms are largely referable to the causes of the amenorrhea. Various nervous phenomena may be manifest; these are referable to the accompanying anemia and hysteria. There may be a cutaneous eruption, as herpes, erysipelas, eczema, and acne; vicarious menstruation may develop in the form of epistaxis, hematemesis, hemoptysis, hematuria, subcutaneous hemorrhage, and bleeding piles.

A full history of the case will often lead one to the correct diagnosis, and should be followed by a thorough physical examination systematically performed. If the amenorrhea is primary, we are then led to suspect the presence of some congenital anomaly of the uterus and ovaries. If there are premonitory menstrual symptoms, but no menses, we are then suspicious of some obstruction to the flow, as atresia of the vagina or cervix or imperforate hymen. If the amenorrhea is secondary and pregnancy and lactation are excluded, we seek for the cause elsewhere than in the uterus, tubes, and ovaries. A bimanual examination is made to detect the presence of any pelvic inflammation or tumor, the size and position of the uterus, and the condition of the tubes and ovaries. By making a thorough examination of the blood, urine, chest, and abdomen causes least suspected may be found.

Treatment.—The cause of the amenorrhea should not be lost sight of, and the treatment must be directed to the removal of that cause.

The so-called emmenagogues are of service in certain individual cases, particularly in those cases ascribed to "catching cold;" the most generally employed are manganese dioxid and potassium permanganate.

Where the condition is dependent upon impoverished blood or nervous depression, tonics, alteratives, and all means of improving the general condition will be of service. Good results from electricity are claimed.

Fresh air, out-door exercise, gymnastics, a change of occupation, climate, and scenery, all aid in re-establishing the functional activity of the genital organs. Acute suppression is best treated with rest in bed, hot fomentations, and hot douches.

Menorrhagia.—The term menorrhagia implies an excessive menstrual flow either as to frequency of recurrence, amount of discharge, or its duration.

Etiology.—1. The *general causes* are—acute fevers, as yellow fever and typhoid fever; impoverished blood, as in anemia and chlorosis; obstructive lung-diseases, as pneumonia and emphysema; cardiac insufficiency; hepatic obstruction from cirrhosis of the liver; diseases of the spleen and kidney; abdominal tumors; chronic constipation, cachexia, hemophilia, purpura, scorbutic plethora, phosphorus- and arsenic-poisoning, and psychical emotions.

2. *Local Causes.*—These include nearly the whole category of pelvic disorders—congestion, displacements, inflammations, polypi and tumors of the uterus, endometritis, ovarian tumors, pelvic inflammation, retained products of conception, carcinoma of the cervix, and lacerated cervix. Menorrhagia may be caused reflexly, in the absence of any lesion, at puberty, from the first coition, and during lactation.

Diagnosis.—Menorrhagia must be distinguished from metrorrhagia,

which is a flow of blood from the uterus occurring between menstrual periods; these conditions frequently coexist and are dependent upon a like cause. The diagnosis is directed to the recognition of the cause, which in every case must be sought for by a systematic, thorough examination.

Treatment.—The cause determines the treatment; when not found the treatment must be palliative and symptomatic. In all cases the patient is to be placed in bed with the hips elevated, a light diet given, and the bowels kept freely open; ice may be applied to the hypogastric, sacral, and lumbar regions.

Of the internal remedies employed, ergot stands at the head of the list; tincture of opium may be given per rectum or by the stomach; hamamelis, belladonna, tannic and gallic acids, atropia, and digitalis are the chief of the many remedies advocated.

As a temporary means of controlling a severe hemorrhage the uterus may be packed with iodoform gauze, but usually packing the vagina will suffice.

Emmet has advised as the last resort to temporarily stitch the cervical canal. Prolonged hot-water douches, as hot as can be well borne, will be of great service.

Where the patient is profoundly exhausted and anemic a stimulant should be given; the hypodermic injection of strychnia, nitro-glycerin, and digitalis will be found to be most reliable. Where general debility ensues, tonics, physical exercise, and nourishing diet should be advised. When the cause is found it must be removed if possible. As a last resort ovariotomy or hysterectomy may be advisable.

Dysmenorrhea.—The term dysmenorrhea signifies painful menstruation. In the normal state the menstrual period is associated with a feeling of discomfort, indisposition, and slight pain at the beginning of the flow, but within normal limits the pain is never intense.

Dysmenorrhea is merely a symptom of some underlying cause, to ascertain the exciting factor of which a thorough examination is necessary.

The *treatment* will be directed to the cause.

A number of varieties are recognized. These are—1. Congestive or inflammatory; 2. Neuralgic; 3. Obstructive; 4. Ovarian; 5. Membranous.

1. **Congestive dysmenorrhea** is most frequently found in multiparæ, and is dependent upon a pelvic congestion or a pelvic inflammation, such as chronic endometritis, metritis, and parametritis; it is also produced by uterine fibroids and polypi. The pain is caused by the additional congestion incident upon the menstrual function, and appears days before the menstrual flow, disappearing with the flow. Where a pelvic inflammation exists constitutional symptoms develop. These are a slight rise of temperature, an increase in pulse-rate, and a feeling of general depression and discomfort.

2. **Neuralgic Dysmenorrhea.**—In the neuralgic variety no pelvic lesion exists or there is no uniformity of pelvic disorders. The endometrium is hyperesthetic, as shown by the uterine sound, which when introduced causes pain identical with the pain of dysmenorrhea. This is particularly true at the internal os.

Anemia and chlorosis are predisposing; gout, rheumatism, syphilis, and malaria act as exciting causes. Neuralgic dysmenorrhea is frequently associated with a neurotic temperament, a malposition or congenital defect of the uterus. Imperfect hygienic surroundings and luxuriant living will tend to bring about the condition. The pain is not constant; it may appear at any time, and increases in direct proportion to the flow. Other nervous symptoms may be present, such as neuralgia, headache, twitching, hysteria, etc. In making a diagnosis first exclude all possible causes for other forms of dysmenorrhea.

3. **Obstructive dysmenorrhea** is the result of some impediment to the outflow of the menstrual secretions. It may be due to stenosis of the cervix, either congenital or acquired from the use of caustics or from injury; to flexion and version of the uterus; to pressure of tumors upon the uterus; to polypi and submucous tumors of the cervix and uterus which occlude the passage; and to atresia of the cervix and vagina and imperforate hymen. The characteristic symptom is a gush of blood, preceded and accompanied by pain; the pain is paroxysmal and expulsive. A physical examination will detect the cause of the obstruction, and to this the treatment is directed.

4. **Ovarian Dysmenorrhea.**—In this form the ovaries are enlarged and tender—a condition known as chronic ovaritis. The pain precedes and continues throughout the menstrual period, gradually disappearing with the flow.

5. **Membranous dysmenorrhea** exists in the presence of chronic or subacute endometritis. With the flow of blood there is shed a membrane (*decidua menstrualis*) composed of the menstrual membrane in a hyperplastic state; all the histological structures of the membrane are increased in size and number: this may be expelled in shreds and bits of tissue, or may be cast off as a complete triangular cast of the internal surface of the uterus, with the openings of the Fallopian tubes and internal os at the three angles of the triangle. It is distinguished from the decidua vera of pregnancy by the absence of chorionic villi and decidual cells.

Treatment.—The first essential is to make the diagnosis of the predisposing and exciting causes and direct the treatment to their removal.

Palliative measures may be resorted to for relief of suffering and where no possible cause can be found. The habitual use of opiates cannot be too strongly condemned, and should only be used as a final resort; they should then be combined with atropin. In the neuralgic variety 10 to 20 grains of antipyrin may be given every hour for two or three doses, or nitro-glycerin in doses of 1 minim of a 1 per cent. solution till there is flushing of the face. Tincture of pulsatilla, ♏v three times a day for three days, often lessens or abolishes the pain. Other remedies are—tincture of cannabis indica, ♏xx every two or three hours; belladonna, atropin, stramonium; and hyoscyamus, given to the point of mydriasis.

For the spasmodic variety gelsemium, musk, ammonium, belladonna, and atropin are effectual.

Bromids and chloral have been given with good effect in ovarian dysmenorrhea.

Salicylate of soda and tincture of cimicifuga are indicated where rheumatism is an underlying factor.

Mercury and potassium iodid should be given where syphilis exists. Where there is congestion, sitz-baths, rectal and vaginal douches, and laxatives should be resorted to.

Local treatment is of the highest importance, and is to be directed to the existing lesions.

Membranous dysmenorrhea should be treated by curetting and packing with iodoform gauze. All constitutional disorders should be treated—anemia with arsenic and iron; rheumatism with salicylates, arsenic, and iodids; etc. This treatment should be carried on throughout the intermenstrual period. The general condition must be improved by tonics, exercise, fresh air, good food, and gymnastics.

V. MALPOSITIONS OF THE UTERUS.

Under the general heading of Malpositions will be considered anteversion, anteflexion, retroversion, retroflexion, prolapse, and inversion.

The normal position of the uterus is not constant. The organ is freely movable, and changes within the normal limits occur as the result of a change in the position of the patient, the distention of the rectum and bladder and other pelvic and abdominal viscera. Anteversion rarely has pathological significance, and when it does become pathological it is the result of adhesions drawing distended organs and tumors crowding the uterus forward.

Anteflexion.—In anteflexion the fundus of the uterus is thrown forward, making a distinct angle of flexion at the internal os. The cervix may retain its normal relation to the vagina or may be drawn upward and backward. The posterior surface of the uterus lies uppermost, and on it rests the weight of the abdominal viscera; thus the condition is aggravated. The uterine cavity is not increased in depth; the cervix may be normal or stenotic. This position is frequently associated with an infantile uterus. The uterus is drawn upward.

Symptoms.—There are no symptoms pointing directly to anteflexion, and all reliance must be placed upon the physical examination. The patient may urinate frequently at night. Just before the appearance of the menses there are usually intermittent cramping pains or the pains may be continuous. With the appearance of the menses the pains become less and disappear with the flow. The blood is usually dark and clotted, and followed by white, non-irritating leucorrhea. Sterility, dyspareunia, and amenorrhea are often associated with anteflexion.

Bimanual examination reveals the fundus thrown forward upon the bladder, the fundus being felt in the anterior vaginal vault. Rectal examination will demonstrate the absence of the uterus from its normal position, and the sound will reveal the depth and direction of the uterine axis. Traction upon the cervix will facilitate the introduction of the sound by straightening the canal.

The *treatment* consists in dilating the cervical canal, thoroughly curetting the endometrium, and packing the cava uteri with iodoform gauze, which is to be left in place for about six days, then removed,

and nothing further done. Conception will frequently follow and the painful menstruations are relieved.

Retro-positions.—Under this term we include retroflexion and retroversion not due to inflammatory adhesions or new growths.

Etiology.—Anything increasing the size, weight, and soft consistency of the uterus favors retro-positions; hence metritis, subinvolution, and pregnancy are frequent factors. Falls from a height and increased abdominal pressure, also operations, as the removal of the uterine adnexa, which deprives the uterus of its support, all operate in bringing on the condition.

Any lack of support to the uterus from below will directly bring about the change in position, and here we have the most common of all causes—laceration of the perineum.

Symptoms.—The universal complaint of women suffering from a retro-displaced uterus is pain in the back and a heavy dragging sensation in the pelvis. Through pressure upon the rectum and the pain occasioned by the movements of the bowels constipation results. The bladder becomes irritable through constant dragging upon it, and in consequence there is a frequent desire to urinate and a dribbling of urine when the patient laughs, coughs, or lifts. Leukorrhea is present, and there is pain radiating from the thighs. The menstrual flow may be increased through the accompanying endometritis. Reflex symptoms, such as hysteria, occipital headache, and melancholia, are not infrequent.

Bimanual examination will reveal a uterus which is low in position. The posterior lip of the cervix is first palpated by the examining finger; the fundus cannot be felt in its normal position. No angle of flexion is felt at the internal os in retroversion, and the fundus uteri is felt to lie against the rectum. In retroflexion the angle of flexion is felt in the posterior cul-de-sac. The uterus is more or less enlarged and tender, depending upon the underlying causes of the displacement. Rectal examination will outline the position of the fundus, and, where necessary, the uterine sound will clearly demonstrate the direction of the uterine canal.

Treatment.—Reposition of the uterus, providing the organ is not firmly adherent, may be effected by bimanual manipulation, the knee-chest position, the sound, or by instruments of support. The first two methods are often combined, and should be persisted in faithfully before resorting to more radical measures. In all cases see to it that the bladder and rectum are empty before attempting reposition.

Bimanual Reposition.—The clothing is loosened about the waist; the semi-prone position is assumed, with the knees well flexed. The index and middle fingers of the left hand are introduced into the vagina behind the cervix. The fingers of the right hand are crowded down in the direction of the sacrum, pressure being made by the left hand immediately above the pubis (Fig. 300). The vaginal fingers are now crowded well up in the cul-de-sac of Douglas, making firm pressure upon the fundus, and at the same time the abdominal fingers are crowded behind the fundus. In this manner the uterus is brought forward against the pubic arch until resistance is met. Now, holding the body of the uterus forward, the vaginal index finger is passed in

front of the cervix, and the latter is pushed upward and backward, thus producing an anteversion. When the patient is fleshy it will be advisable to introduce the finger into the rectum.

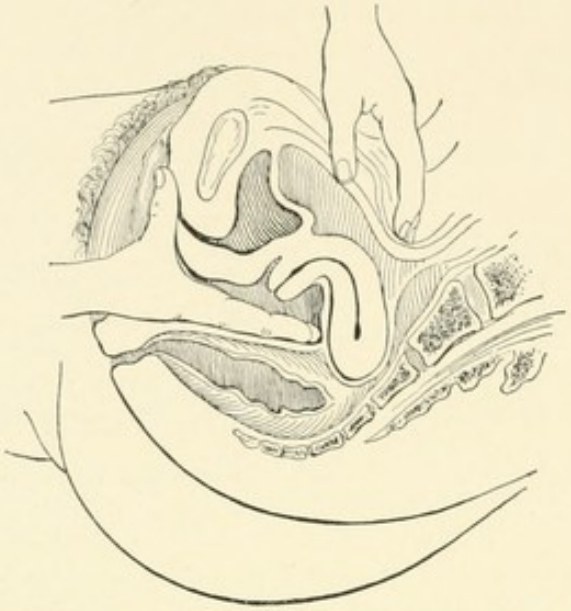


FIG. 300.—Reposition of retroflexed uterus with patient in the dorsal position.

Knee-chest Reposition.—The patient is placed in the knee-chest position; air is allowed to enter the vagina by means of the Sims speculum. The cervix is drawn down by a tenaculum, and if the uterus

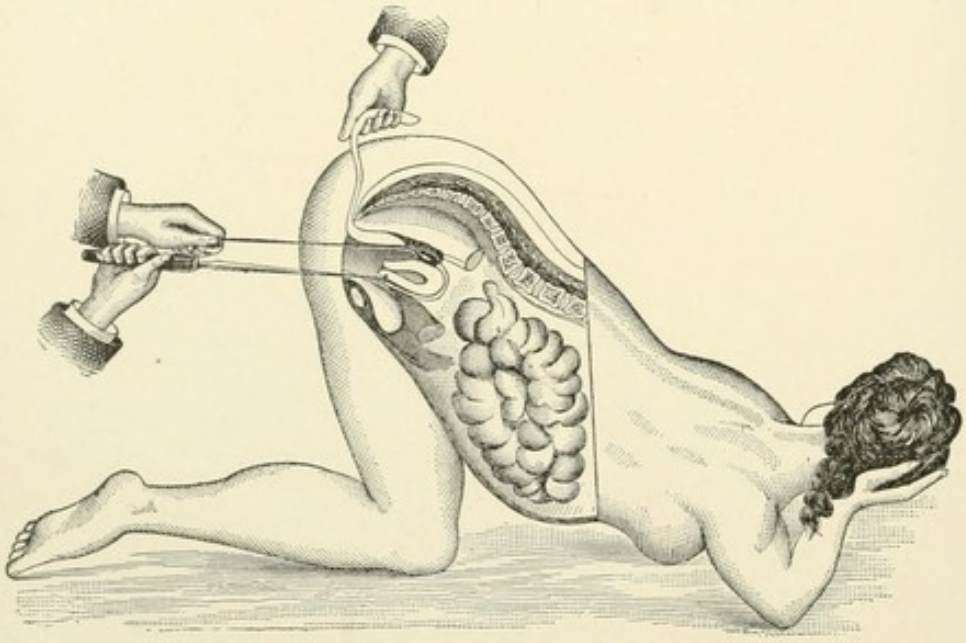


FIG. 301.—Replacement of retro-displaced uterus by means of the uterine repositor, with patient in the knee-chest position (Baldy).

does not fall forward into the natural position, pressure may be applied to the fundus by the finger or repositor (Fig. 301). The uterus may be retained in place by wool tampons placed in front of the cervix. If there are no pus-accumulations in the pelvis and adhesions exist, an

attempt may be made to break up these adhesions by exercising moderate force in bimanual reposition; the attempt may be repeated at intervals of two or three days. A glycerin wool tampon should be introduced after the operation.

The *uterine sound* may be resorted to in case the above methods fail. The operation consists in passing the sound into the uterus, first bending it in the direction of the axis of the canal; the uterus is then brought forward by making a sweep through a half circle (Fig. 302). Great caution must be exercised for fear of injury to the endometrium and puncture of the uterine wall, which has occurred in a number of instances. The operation should be done with strict regard to the rules of surgical cleanliness, and should be reserved as a last resort. The next step in the treatment is to adopt means of supporting the

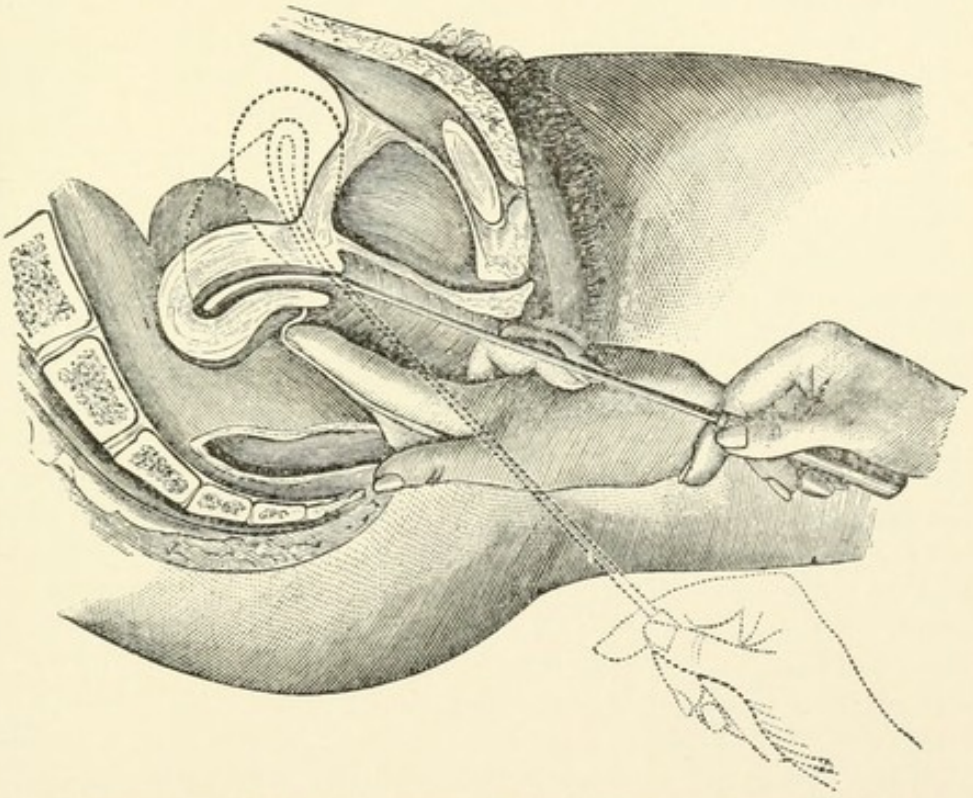


FIG. 302.—Diagnosis and reduction of retroflexion by the sound (Courty).

uterus in the proper position and to restore it to the normal condition in structure and function.

If endometritis exists, the uterus should be curetted. A cotton tampon saturated with boroglycerin or icthyol-glycerin is placed behind the cervix in the cul-de-sac, and the space in front of the cervix is packed with a wool tampon. The glycerin tampons are to be removed in six to eight hours, and vaginal douches of hot water are given three or four times daily. The bowels are to be kept regular; where the perineum is ruptured repair should be made.

Subsequent treatment consists in the repetition of the douches and tamponading in the knee-chest position. As a rule, nothing further is necessary to effect a cure. However, if the uterus does not remain in position, after all signs of inflammation have subsided a pessary may be introduced and worn. Rarely will it be necessary to resort to a

pessary. The contraindications to its use are—1. The possibility of retaining the uterus by the aid of tampons; 2. Existence of inflammation, as salpingitis, metritis, urethritis, vaginitis; 3. Ruptured perineum; 4. Bending of the uterus when the pessary is in place; 5. Pain produced by the pessary. It will thus be seen that the pessary is practically confined to retroflexion in the virgin state; hence its application is limited. The pessary should be removed at least once a month, and daily vaginal douches should be taken.

When a patient trial of tampons and pessaries has proved unavailing, operative measures may be resorted to with the view of permanently curing the retro-displacement. The round ligaments can be shortened so that the fundus uteri is held forward, or the fundus itself may be sutured to the abdominal wall. For shortening the ligaments Alexander's operation is generally employed, and consists in removing a portion of each round ligament. Wylie's operation accomplishes the same purpose in a different way. The abdominal cavity is opened, the fundus uteri is drawn forward, each tube is doubled on itself, and the doubled surfaces are sewed together and to the peritoneal covering of the uterus.

Alexander's Operation.—This operation has a very limited field of usefulness. Before it is indicated the inflammatory lesions of the pelvic organs, such as endometritis, metritis, salpingitis, and pelvic inflammation and adhesions, must be corrected; the perineum must be restored; in short, the uterus must be in a healthy state, but giving rise to symptoms purely referable to the retroflexion, which cannot be corrected by bimanual manipulation, the knee-chest position, or the use of tampons, douches, and pessaries. On the day previous to the operation the uterus is put into the normal position and supported by tampons behind it. This precaution, however, is not necessary; the uterus may be replaced at the time of the operation and retained by tamponading. The skin is prepared as for abdominal section; the incision extends from the spine of the pubis, upward and backward, over the inguinal canal for about two inches. Cutting carefully down to the external ring, the round ligament is sought for with blunt instruments; if necessary, the external ring is incised and the entire inguinal canal exposed to the internal ring. The round ligament will be recognized by its pink, glistening appearance. When found it is secured by forceps, and the fellow-ligament sought for and secured in a similar manner. Tension is then made upon the round ligaments, grasping each with the fingers. The excess in length is cut off—as a rule, this will amount to two inches or more—the ends are united with catgut sutures, and the incision is closed with interrupted sutures. The uterus is supported in position by tampons.

Hysterorrhaphy.—The indication for this procedure is the existence of intra-pelvic lesions, which resist the treatment as advised under Bimanual Manipulation and the Knee-chest Reposition. The field of operation is prepared as in all abdominal sections. The Trendelenburg position will be of great advantage. The incision is short. With the examining finger the existing adhesions are broken up, the adnexa examined, and, if necessary, they are then removed. The uterus is now brought forward, and a silk—or, better still, a silkworm-gut—

suture is passed through the entire abdominal wall on one side; then, passing through the uterine wall at a depth of about one-eighth of an inch, it is again made to penetrate the abdominal wall opposite to the point of entrance (Fig. 303). A second suture is passed about half an inch higher up, and the abdominal incision is then closed with interrupted sutures in the usual manner. The sutures passing through the uterus should be first secured and left long. The remaining sutures are then tied, care being taken to approximate the peritoneal surfaces. It is well, though not necessary, to gently scarify the peritoneal surface of the uterus to favor a plastic exudate. The two sutures passing through the uterus are permitted to remain for two or three weeks, and the uterus is supported with tampons for several weeks or months. Care should be taken not to suture the uterus too high up or too far

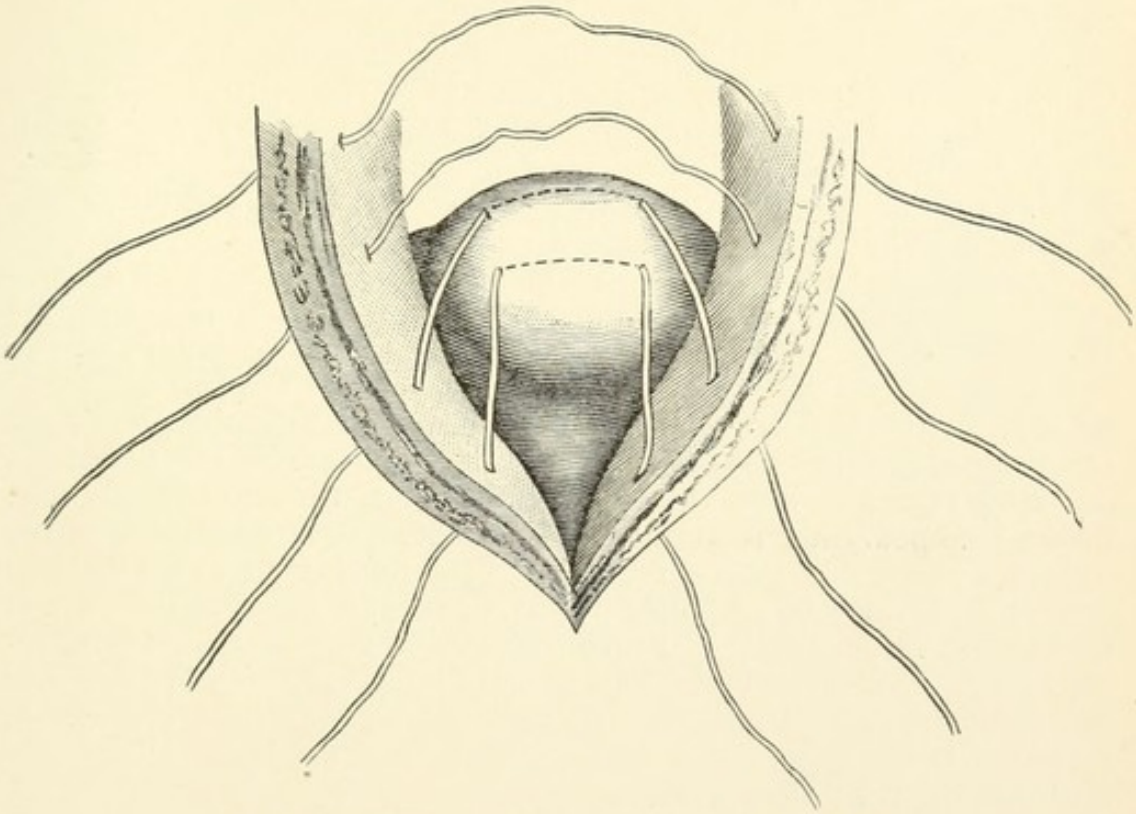


FIG. 303.—Sutures in position in hysterorrhaphy (Baldy).

forward, for fear of subsequent dragging pains and irritability of the bladder.

Prolapsus Uteri.—*Etiology.*—As a rule, prolapsus occurs in multiparæ, though it may occur in primiparæ. It is usually gradual in development, but may be caused suddenly from direct blows, falls from a height, or by lifting. In general the causes are lack of support in the floor of the pelvis from ruptured perineum, relaxation of the uterine ligaments, increased weight of the uterus, and increased intra-abdominal pressure.

All degrees, from a slight descent of the uterus to complete protrusion from the vagina, are found. The vaginal walls are inverted, and the uterus lies within the inverted vagina or may protrude more or less from the vulvar orifice. This position is usually associated with a gen-

eral chronic inflammation of the pelvic organs and tissues. Ulcers of the cervical and vaginal mucous membrane frequently exist. Rectocele and cystocele are developed. Dysuria and constipation follow, and in the effort to evacuate the bowel and bladder the prolapsus is aggravated.

Symptoms.—Occasionally there will be found a complete prolapse of the uterus, yet the patient only suffers from the inconvenience of the protruding body. The usual symptoms are backache, heavy dragging sensation in the pelvis, rectal or vesical tenesmus, constipation, dysuria, and pain radiating down the thighs and to the sacrum.

Pressure upon the urethra may bring about disturbances in the bladder and kidney—namely, cystitis and hydronephrosis. A sound in the urethra will pass in the direction of the tumor for a short distance, and the end of it can be felt by the examining finger in the rectum. Caution should be exercised in sounding the uterus lest pregnancy exist.

Diagnosis.—Inversion is distinguished by a protruding mass surrounded by the external os and the absence of the cervical canal. By recto-abdominal examination the cupped upper extremity may be felt and the absence of the fundus uteri noted. Submucous protruding fibroids and polypi are surrounded by the cervix above, and the fundus uteri is found in the normal position.

Treatment.—The cause, if possible, must be removed. This frequently necessitates perineorrhaphy. When it is impossible to gain the consent of the patient to operate, or where it is not advisable because of feebleness and other contraindications, palliative measures must be adopted for the support of the uterus in its natural position. The use of pessaries is often disappointing and injurious. The cup pessary is the most efficient, and should only be worn throughout the day. Brown's colpeurynter is at times serviceable. It is essential that the uterus, when enlarged, be reduced to its normal size. To do this curettage will afford a happy result when the enlargement is due to inflammatory changes. Foreign growths, as polypi, must be removed. The most efficient and reliable temporary means of retaining the uterus in place is tamponading behind and about the cervix, fairly filling the vagina with wool tampons, the tampons being introduced in the knee-chest position.

Perineorrhaphy and colpo-perineorrhaphy having failed, hysterorrhaphy is the last resort, save vaginal hysterectomy or amputation of the cervix where the latter is hypertrophied.

In acute prolapse, where all the symptoms come on suddenly, the patient is put to bed in the horizontal position, the uterus being gently replaced and held in position by tampons. Ice-bags are applied to the abdomen, and if there are symptoms of internal hemorrhage, the usual precautions are observed. For the technique of plastic operations on the perineum see chapter on Lacerations of the Perineum.

Inversion of the Uterus.—Inversion may be acute or chronic. Acute inversion properly belongs to the field of obstetrics, because of the frequency with which it follows labor. Chronic inversion is almost invariably caused by polypi and submucous fibroids. Multiparæ are most frequently afflicted, though the condition is not unknown in the virgin state.

There is more or less bleeding, sometimes rendering the patient anemic and exhausted; leukorrhea develops; there is a sense of fulness and bearing-down in the pelvis. On examination the inverted fundus is found to occupy part or all of the vagina; the mass is red, firm, and symmetrical. The cervix is seen to closely constrict the mass, sometimes interfering with the circulation and causing sloughing and gangrene. Death is caused by exhaustion from continuous loss of blood, or from sepsis and peritonitis where there are sloughing and gangrene of the inverted uterus.

Diagnosis.—The tumor is firm, smooth, bleeds readily, is constricted by the os externum, and a sound cannot be passed into the cavity. A sound in the bladder and the finger in the rectum can be approximated and the upper limit of the cervix felt. The body of the uterus will be absent. The minute openings of the tube at the sides of the base of the tumor are seen. The above signs will render the diagnosis complete.

Treatment.—The first method to adopt is gradual replacement by gentle, firm taxis. This is best performed under anesthesia. One hand grasps the protruding mass and the other makes counter-pressure over the hypogastrium. By repeated efforts at forcing the fundus upward the inversion may finally be corrected. If taxis fails, then make use of the colpeurynter, which, when placed in the vagina and moderately distended, will produce continuous though not severe pressure. The colpeurynter should be removed part of the day, and gradually more and more distended as the inversion is corrected. The patient must be confined to her bed, the pain controlled by opiates, and the bowels and bladder kept free. When the above methods fail after repeated efforts, vaginal *hysterectomy* should be the next and last resort.

VI. INFLAMMATION OF THE FEMALE GENITALS.

Inflammation of the vulva (**vulvitis**) frequently occurs in infant as well as in adult life. In the infant highly acid urine and oxyurides from the rectum are the exciting causes. Later in life the acrid, irritating discharges from septic and gonorrheal vaginitis and endometritis, from carcinoma of the cervix, from decomposed urine in cystitis, and diabetic urine are found to be the most frequent causes. Want of cleanliness, pruritus, masturbation, and friction, as from locomotion in fleshy women, are occasional etiological factors.

Symptoms and Diagnosis.—In the acute stage there is a sense of fulness and pain on motion and touch; pruritus is an almost constant symptom; urination becomes burning and painful; the surface is red and slightly tumefied; and there is a watery or mucous discharge from the surface. This discharge may become muco-purulent or purulent, with the development of follicular abscesses; one or both of the vulvo-vaginal glands may be infected and an abscess develop or the excretory ducts become occluded, giving rise to the formation of retention-cysts. Ulcers and excoriations of the mucous surface may develop; the sebaceous and piliferous glands may become distended with mucus or muco-pus, causing them to project from the surface of the labia and prepuce as prominent elevations—the so-called *follicular vulvitis.*

Treatment should be directed to the removal of the cause, but certain palliative measures must be adopted for the relief of distressing symptoms. Great benefit will follow vaginal douches of hot water or 1 to 2 per cent. carbolic-acid solution or saturated boric-acid solution. External lotions of lead-water and opium, hot applications of boric-acid solution, or 2 per cent. carbolic acid are useful to relieve the irritation and burning sensation. Carbolic-acid ointment is effective in relieving pruritus.

The infected follicles and abscesses should be incised, washed with an antiseptic solution, and dressed with sterilized or iodoform gauze.

Where the vulvitis becomes chronic, giving rise to dry, thickened, furrowed labia, an application of 20 per cent. silver nitrate will be of service.

Vaginitis.—*Etiology.*—The causes of inflammation of the vagina are similar to those enumerated under the discussion of Vulvitis, in addition to which may be mentioned any condition which causes a congestion of the mucous membrane of the vagina, as pregnancy and fibroids of the uterus. The predisposing causes are constipation, anemia, and general lowered vitality. Any obstacle to the vaginal and uterine secretions whereby the irritating and decomposed fluids are retained in the vagina, as in atresia vaginæ and imperforate hymen, will result in a vaginitis. The wearing of pessaries may set up a local inflammation. Here, as in vulvitis, gonorrhea is the most frequent of all the causes, and acrid, irritating discharges from septic and specific infection, together with decomposed and diabetic urine, are next in point of frequency and clinical importance.

Symptoms and Diagnosis.—The patient may complain of general malaise, headache, backache, and loss of appetite, though frequently there are no general disturbances. There is a sense of heaviness in the pelvis, a burning pain in the vagina, urination is burning and frequent, an intense itching distresses the patient, locomotion and coition are painful, and the vaginal mucous membrane is very sensitive to touch. As a rule, the inflammation does not involve the entire surface, but attacks isolated areas.

The inflamed areas are reddened, tumefied, and extremely sensitive. At first the surface is dry; later there appears a muco-purulent discharge of a white or yellowish appearance. The mucous membrane may become exfoliated and the papillæ infiltrated and prominent, giving to the surface a granulated appearance—granular vaginitis.

Small vesicles may develop on the mucous surface (vesicular vaginitis); the connective-tissue spaces may become distended with gas, giving rise to emphysematous patches (emphysematous vaginitis); and rarely the denuded surfaces may become adherent (adhesive vaginitis). Small ulcers may form on the site of the vesicles and emphysematous patches, and not rarely the mucous membrane of the urethra becomes reddened and tumefied, discharging a yellowish muco-purulent secretion. Where this exists the presence of gonorrhea is highly probable. By pressing upon the urethra from behind forward, a drop of pus will often appear at the meatus; if in this pus the gonococcus is demonstrated by the aid of the microscope, the diagnosis is confirmed. By extension of the inflammation a cystitis may develop; this may be

diagnosticated by the intense pain caused by pressure with the finger against the anterior vaginal wall, and confirmed by an analysis of the urine.

Treatment.—The cause must be sought for and removed where possible. As palliative measures the patient must be at rest, not necessarily in bed, but walking should be proscribed, nor should coition be participated in until all signs of inflammation have disappeared. The patient should use hot vaginal douches of a saturated boric-acid solution, a 1 to 2 per cent. carbolic-acid solution, or simply plain sterile hot water, repeated three times daily while in the recumbent position with the hips elevated upon the douche-pan. Following the douche, glycerin tampons may be inserted or the dry pack introduced. This consists of thoroughly drying the mucous membrane with swabs of cotton after the douche, then packing the vagina with sterilized or medicated gauze or cotton. When the mucous membrane is thoroughly dried the surface may be dusted with a drying powder of boric acid, bismuth, aristol, or iodoform, and the dry gauze or cotton tampon introduced. In the chronic form the mucous surface may be painted once or twice a week with a 2 per cent. solution of silver nitrate or tincture of the chlorid of iron and a glycerin tampon inserted. Douches should be given three times a day. For the relief of pain it may be found necessary to administer either vaginal or rectal suppositories of opium. Where pain, upon the introduction of the speculum or douche-point, is severe, the oleate of cocain should be applied. Lastly, attention should be paid to the general health, and tonics and alteratives given where the condition demands.

Inflammation of the Uterus.—Under the general heading of Inflammation of the Uterus is included cervicitis, endocervicitis, metritis, and endometritis. No distinct boundary-line can be drawn in pathology and symptomatology between these varieties of inflammation of the uterus, two, three, or all four forms blending into one another.

Etiology.—The bacteriological factors in the causation of inflammation of the uterus are in general the pyogenic and specific microorganisms. Most frequently present and most virulent in its effects is the streptococcus pyogenes. The staphylococcus pyogenes albus and aureus are next in point of frequency; the streptococcus erysipelas, the Klebs-Löfler bacillus, and the bacillus coli communis are not infrequently found. Inflammation may rarely be ascribed to auto-infection, and to account for such auto-infection we must assume the presence of one or more of these varieties of germs in the vaginal or cervical mucous membrane, together with a pre-existing trauma or inflammation of the infected tissue.

As predisposing factors may be mentioned congestion of the uterus from suppressed menstruation, flexion, or the presence of tumors, also retained secretions from atresia of the vagina or cervix, imperforate hymen, or stenosis of the cervix. Trauma from coition during the menstrual congestion and the use of non-sterilized sounds and probes are too frequently the cause. By far the most frequent cause of infection arises during labor and abortion. The exanthemata and specific diseases may be complicated with inflammation of the uterus, and, lastly, the inflammation may extend from the vagina and

vulva; and particularly is this true of gonorrheal vaginitis. Constitutional disorders and weakness must be considered as most potent predisposing causes.

Acute Endometritis and Metritis.—*Symptoms.*—There may be no general disturbances, and when present they are of slight consequence, consisting of malaise with loss of appetite and constipation. There is a sense of fulness, often associated with frequent micturition. When the inflammation is more severe the above symptoms become aggravated; there is pain in the pelvis, associated with headache and backache.

Where the inflammation is the result of septic infection during parturition or the puerperal state the attack is usually ushered in with a chill, followed by a rapid rise of temperature from 102° to 105° F. The temperature is variable, recurring at irregular intervals. Where the inflammation involves the tubes, ovaries, and pelvic tissue, or even the abdominal peritoneum, the symptoms referable to these lesions are added to the above.

Physical Signs.—On palpation the uterus may be outlined as somewhat enlarged and tender to manipulation. This is best elicited by bimanual examination. Pressure on the cervix causes pain. The os is patulous and soft and may bleed easily.

On inspection the os externum is seen to be congested, even turgid; the mucous surface may be granulated; the cervical canal is filled with a glassy, viscid, opaque secretion which at times is tinged with blood. Following abortions and labors the discharge may have an offensive odor. The whole cervix is thickened and edematous.

It should be remembered that endometritis may exist in a mild form in the absence of any of the symptoms enumerated. There may be a suppression of the secretions, and this suppression is very significant when occurring shortly after an abortion or labor. The size and position of the uterus should be noted. Malaria may be excluded by the administration of quinin. Cystitis and typhoid fever should also be considered in making a diagnosis.

Treatment.—The patient should be confined to bed during the acute stage, the bowels kept freely open with salines and enemata; hot vaginal douches of plain sterilized water; 1 per cent. to 2 per cent. solution of carbolic acid or bichlorid solution, 1 : 2000, should be repeated every four hours; a light diet should be given. The uterus should be irrigated with a mild antiseptic solution once daily and a gauze drain introduced. A glycerin tampon should be inserted each day, and removed in from four to six hours, followed by a hot vaginal douche. Where there is severe pain a vaginal suppository of opium may be inserted.

Where the inflammation develops from puerperal infection no time should be lost in instituting active treatment. The vagina should be sterilized with soap and water, followed by sterilized water, and lastly a solution of 1 : 2000 bichlorid. The cervix is then dilated in the usual manner if it is not sufficiently patulous to admit a curette. With a sharp curette the uterus is gently but thoroughly scraped; all retained products of conception and a sloughing endometrium are removed; a bichlorid 1 : 2000 douche is given, followed by thoroughly swabbing the

interior of the uterus with tincture of iodin or carbolic acid and packing it with iodoform gauze; lastly, an absorbent sterilized tampon is inserted in the vagina and the patient kept in bed until all symptoms have disappeared. The gauze is removed from the uterus in twenty-four to forty-eight hours. If the symptoms of asepsis have disappeared, no further packing will be necessary, but where the symptoms still indicate the absorption of septic material a second and, if necessary, a third irrigation and packing of the uterus should be done. Hot vaginal douches should be given every four hours; the bowels kept freely open with salines and enemata; if the pulse is rapid, weak, and irregular, stimulation with whiskey, digitalis, nitro-glycerin, and strychnin should be resorted to.

When absolutely necessary pain is relieved by opiates. A strictly milk diet should be enforced while the temperature is elevated.

Endocervicitis and Cervicitis.—Rarely does an acute inflammation of the cervix and cervical mucous membrane remain local. The tendency is to extend upward into the body of the uterus and endometrium; but more frequently chronic cervicitis and endocervicitis remain localized.

Symptoms and Diagnosis.—Where there are no complications all general symptoms are absent. Where hypertrophy of the cervix exists as a result of the inflammation, there may be a sense of weight in the pelvis. A tenacious, glossy secretion, like the white of an egg, is seen in the cervical canal; this may be blood-stained. The os externum is patulous, particularly in a multipara in whom the cervix is lacerated. The cervical mucous membrane is thickened, and bleeds easily when touched with the probe; excoriations and erosions develop upon the mucous surface; the mucous glands may become occluded, forming retention-cysts which stand out prominently upon the mucous membrane, and may go on to the formation of mucous polypi. The os externum, is surrounded by a congested surface which may present an excoriated or granular surface. The entire cervix is thickened to a greater or less extent by the tumefaction and infiltration of its muscular texture.

Treatment of Acute Endocervicitis and Cervicitis.—The cervical mucous membrane should be swabbed with sterilized cotton to remove the secretions, and a 95 per cent. carbolic-acid solution, tincture of iodin, or silver nitrate applied to the mucous surface. Isolated polypi can be excised, first injecting cocain. Where there are cystic degeneration and cicatricial hyperplasia it is well to amputate the cervix, as described under the Treatment for Carcinoma of the Cervix.

Chronic Endometritis and Metritis.—*Symptoms.*—When the inflammation is mild and of short duration, there may be as the only existing symptom a transient leukorrhea, the secretion being transparent or opaque and viscid. If the inflammation involves the deeper structures of the uterus, giving rise to infiltration and hypertrophy of the organ, there will be a sense of weight and bearing-down in the pelvis, pain in the lumbo-sacral region, and the leukorrhea may become abundant, thick, and of a yellowish color. Where the cervix is lacerated and associated with erosions and excoriations about the os externum the secretions are often bloody. When the uterus is ante-

verted there is a frequent desire to urinate, because of the pressure upon the bladder; when retroverted there is constipation as the result of the pressure of the uterus upon the rectum. Menstrual disorders, including dysmenorrhea, menorrhagia, metrorrhagia, and amenorrhea, are brought about as the result of the existing inflammation. Sterility may be mentioned as of not infrequent occurrence. To the above symptoms all the manifestations of hysteria may be added, together with neuralgia of any region of the body.

Physical Examination.—On vaginal examination the touch will reveal a cervix which is no longer conical, as in the virgin, but one which is broader than it is long. The os externum is soft and patulous; lacerations may best be detected by the touch, and in this way also cysts and polypi may be located. By inspection with the aid of the speculum the eroded everted margin of the os externum may be seen and existing lacerations examined. Polypi occasionally protrude through the os externum, and small cysts are not infrequently seen in the inflamed mucous surface. The cervix appears to have lost its original virgin form and to be broadened, and the cervical canal is plugged with viscid mucous secretion.

By bimanual examination the uterus is outlined and its position determined. The organ is uniformly enlarged and tender to the touch; as a rule, it is retroflexed or retroverted and freely movable, so that a change of position of the patient will change the position of the uterus from anteversion to retroversion.

The examination of the uterus may be facilitated by producing traction on the cervix with a volsellum forceps and by rectal palpation. By the introduction of the sound the depth of the uterine cavity and the direction of the long axis of the canal, together with polypi and sensitive points, may be detected; slight and even troublesome bleeding from the endometrium may be caused by the introduction and manipulation of the sound.

Diagnosis.—Chronic metritis must be differentiated from fibroids of the uterus. When the fibroid is subperitoneal or intramural, if not small, the examination will determine the irregularity of outline of the uterus; if submucous, the sound may detect the irregularity; or if the cervix is dilated and the finger introduced, the tumor can be outlined. In fibroids the uterus is harder and more globular than in metritis.

Pregnancy should not be mistaken for metritis. After the eighth week of pregnancy the general and local signs and symptoms will suffice for a correct diagnosis, and before the eighth week the elastic ovoid uterus may be noted. In large, fleshy women the uterus should be palpated per rectum. In fibroids the cervix remains hard, while in pregnancy it is soft and the os at a late period becomes patulous. The use of the sound is never justifiable.

Carcinoma of the cervix and body of the uterus in the early stage may give rise to confusion in differentiating from the hemorrhagic form of endometritis, particularly that variety which occurs about the time of the menopause, the time when carcinoma is most frequent. In carcinoma a profuse watery discharge, tinged with blood and perhaps offensive to smell, is characteristic. Where doubt exists the endometrium should be curetted or a wedge-shaped piece from the cervix re-

moved and subjected to examination under the microscope. The age and family history should be considered, and the emaciation and cachexia so characteristic of carcinoma should be noted.

Treatment.—Where a vaginitis and a urethritis coexist with a chronic metritis and endometritis, these should be treated according to the principles already laid down. Where the cervix is eroded simply painting with Churchill's tincture of iodin may relieve the condition; if not, this process should be preceded by curettement. Cysts in the cervical mucous membrane should be evacuated either by means of the sharp-pointed bistoury or cautery. Where the cervix is thickened and the cervical canal filled with a viscid, glistening secretion, curettement, followed by swabbing the cervical mucous membrane with Churchill's tincture of iodin or carbolic acid, is indicated. It is advised by a few authorities in the above condition to divide the cervix bilaterally, thor-

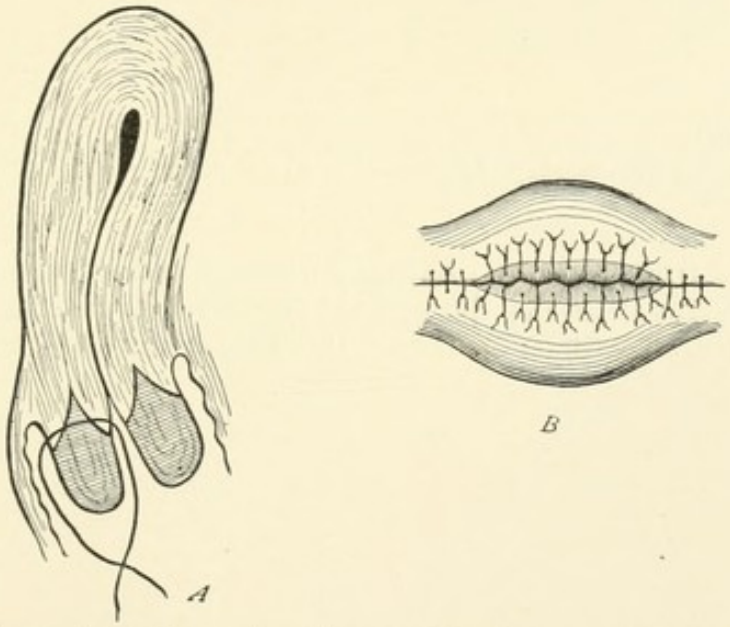


FIG. 304.—Amputation of the cervix with double flaps (Simon): *A*, sectional view showing lines of incision for formation of flaps, and method of suture; *B*, front view of cervix, operation complete.

oughly scrape away the mucous surface, and restore the cervix by catgut sutures. Where the cervix is greatly thickened by induration and the mucous membrane has not become eroded or undergone follicular degeneration, probably the most satisfactory operation is that first advised by Marckwald. This is the so-called *double-flap amputation*, or conical excision of Simon (Fig. 304). This operation consists in making a bilateral incision, followed by taking a V-shaped section from the anterior and posterior flap with the base downward and the apex upward, thus removing the tissue intervening between the two mucous surfaces of the cervix: the two mucous surfaces are sutured with catgut and the lateral commissures united, thus preventing subsequent stenosis from contraction. Where erosions and follicular degeneration exist, this diseased tissue must be removed before the lacerated surfaces are approximated; hence in this condition the amputation of the cervix as introduced by Schroeder (Fig. 305) is the operation *par excel-*

lence. This consists in making bilateral incision, then a transverse incision through the internal mucous membrane, and a curvilinear incision with the convexity downward through the external mucosa; the flap is

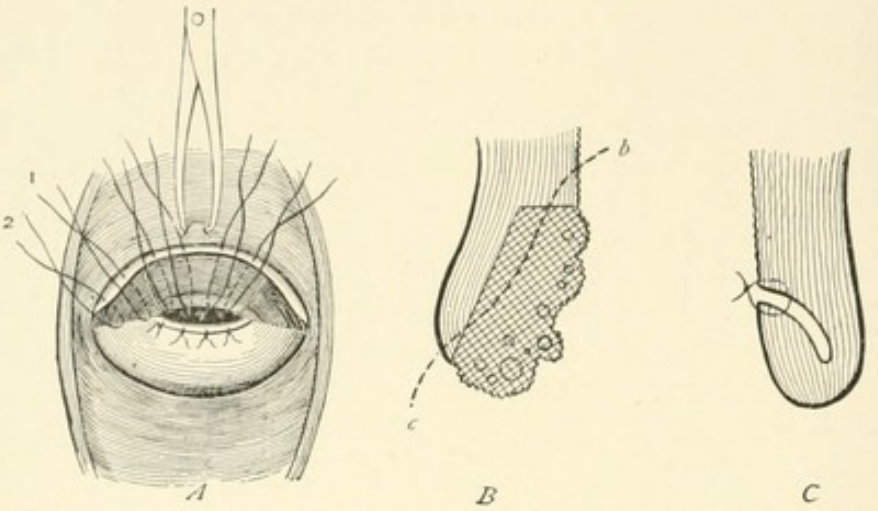


FIG. 305.—Amputation of the cervix by one flap or excision of the mucosa (Schroeder's operation): *A*, showing method of placing the sutures; 1 and 2 are those uniting the commissures; *B*, section showing shape of incisions and (*b*, *c*) line of suture; *C*, shows position of lips after suturing.

then excised from without obliquely upward and inward to the point of the transverse incision; the vaginal and cervical mucous membranes are then sutured with catgut, and the lateral incisions united by the

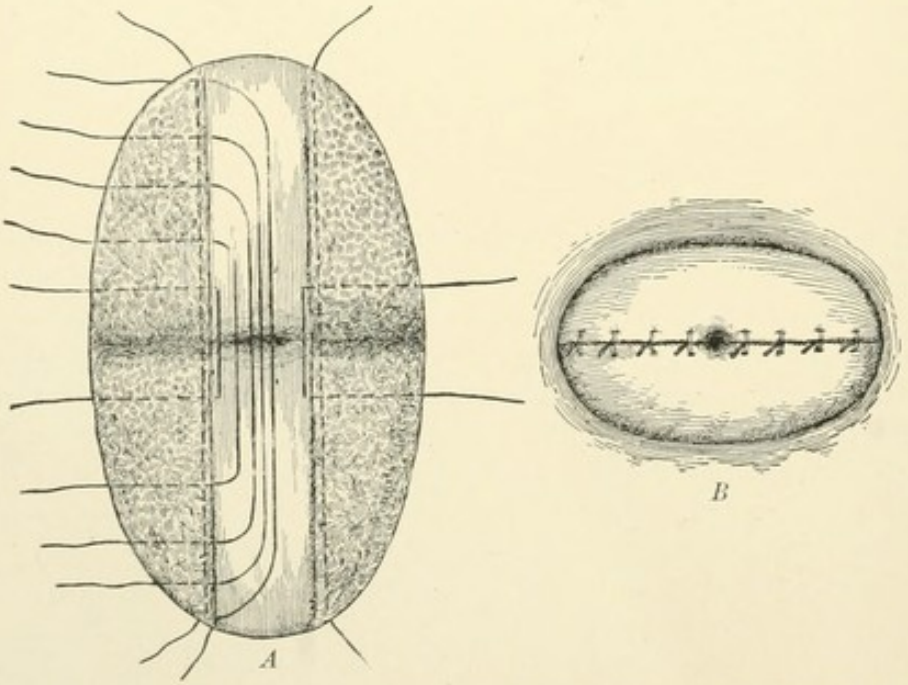


FIG. 306.—*A*, diagram showing area of denudation and arrangement of sutures in Emmet's operation; *B*, appearance of cervix after sutures are tied.

same material. Where there is a laceration associated with a catarrhal endocervicitis without erosions and cystic degeneration the Emmet operation is indicated. This consists in the denudation of the edges

of the flaps either with a bistoury or scissors, care being taken to include the cicatricial tissue at the angle of the laceration. The denuded surfaces are then coapted by catgut interrupted sutures, beginning near the upper angle of the laceration and passing from without inward, including the vaginal mucous membrane and two centimeters of the thickness of the cervix; then passing from within outward at corresponding points in the opposite flap. Each suture should be tied as inserted to ensure perfect coaptation and to control hemorrhage (Fig. 306).

Chronic inflammation of the body of the uterus rarely exists without accompanying inflammation of the cervix, vagina, or Fallopian tubes, and these lesions must not be overlooked in the treatment of the disorder. Curettage heads the list of remedial agents for uterine inflammation. The technique is as follows: The bowels are to be freely opened with salines the previous night, and an enema used in the morning of the day of the operation; a vaginal douche of bichlorid 1 : 2000 should be given; the patient is anesthetized and placed in the lithotomy position, with the legs flexed upon the thighs and supported either by the Clover crutch or by assistants. A Sims speculum is introduced; the posterior lip of the cervix is grasped by volsellum forceps and gentle traction made, while the canal is being slowly and gently dilated by instruments of divulsion (Fig. 307). When the cervical canal is sufficiently dilated a sharp curette is introduced and the entire uterine cavity is scraped till at all points a grating sensation is imparted to the hand and can even be heard, care being taken to curette the angles of the fundus. The uterus is either irrigated with a bichlorid solution 1 : 2000 or swabbed with sterile absorbent cotton applied on a uterine sound. Next the uterus is swabbed with Churchill's tincture of iodin and firmly packed with iodoform gauze. The gauze should be in one long, narrow strip, and should be left protruding from the cervix, where it should remain for six days. The vagina is packed with absorbent cotton, which may be removed in twenty-four to forty-eight hours, and vaginal douches of bichlorid 1 : 2000 given two to four times daily. Curettage will be found to be the most rapid and efficient means of depleting the uterus. The most happy results are thus afforded in the hemorrhagic form of endometritis, and in addition the following remedies have been employed: ergot, digitalis, and hydrastis. Alarming hemorrhage rarely occurs as the result of curettement, and can usually be controlled by tamponading the vagina or the uterus or by

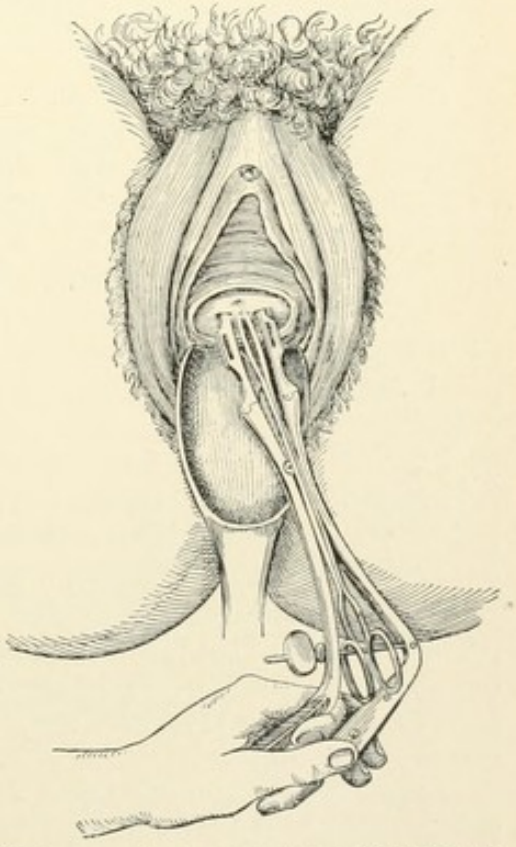


FIG. 307.—Instruments in position for dilatation of the cervix uteri (Baldy).

hot-water irrigation of the latter. If these means fail, it may be found necessary to resort to ligation of the uterine arteries and even to vaginal hysterectomy.

Gymnastics, tonics, and exercise will be found valuable adjuncts to curettement.

Where chronic metritis is painful the indication is to relieve the congestion, and this is best done by scarifying the cervix, painting it with iodin, and inserting glycerin tampons. When chronic metritis with hyperplasia exists in the absence of acute pelvic inflammation, as a last resort the cervix may be amputated. By this method the uterus may be materially reduced in size. Polk advises hysterectomy where the hemorrhage continues after repeated curettements, because of the strong probability of carcinoma and the comparative safety of vaginal hysterectomy. Prompt, heroic action is most imperative in such cases.

VII. PELVIC INFLAMMATION.

With the view of simplifying the study of the various inflammatory lesions of the female pelvic organs and tissues we will include under this heading salpingitis, perimetritis, parametritis, pelvic cellulitis, pelvic peritonitis, and ovaritis, because they do not exist as separate and independent lesions, but are mutually dependent upon the same underlying causes, differing only in the character of the tissue involved, in the extent and intensity of the inflammatory process, and in the stage of the inflammation.

Etiology.—By far the greater number of pelvic inflammations arise from septic infection of puerperal wounds, as in abortions, premature labors, and full-term labors followed by septic infection. Next in point of frequency may be mentioned gonorrhea, which probably causes one-third of all cases. Where gonorrheal infection exists parturition may excite an active inflammation. Traumatisms from venereal excess and the use of unclean instruments, as sounds, tents, and specula, are productive of inflammatory lesions dependent either upon pre-existing pelvic inflammation, as a pyosalpinx, or upon the introduction of septic material on the instruments. Menstrual suppression is often ascribed as a factor, and is operative where there exists latent or incipient pelvic inflammation. Where there is no such pre-existing inflammatory lesion suppressed menstruation brings about a temporary pelvic congestion rarely amounting to a permanent disorder.

Many attacks of pelvic inflammation occur during the menstrual period, at which time the tissues are congested, thus favoring the acute exacerbation of a pre-existing chronic inflammation. Lastly, may be mentioned pelvic tumors, scarlet fever, measles, mumps, and extra-uterine pregnancy.

Diagnosis.—Acute Catarrhal Salpingitis.—The existence of catarrhal salpingitis cannot be diagnosed with certainty without direct inspection of the tube, and even then the microscope may be necessary. The symptoms are marked by the coexisting endometritis; rarely can the tube be palpated, and when palpated no perceptible change is detected. J. Bland Sutton says: "The leading signs of acute salpingitis are not dependent upon the tube itself, but become most strikingly declared

when the disease involves the peritoneum in the immediate vicinity of the tube."

Clinically, the acute form of salpingitis is usually preceded by a vaginitis or leukorrheal discharge, when suddenly the patient complains of pain and tenderness on pressure in the region of one or both iliac fossæ, and on vaginal examination one or both ovaries are found to be somewhat enlarged and tender. This inflammation may slowly develop and result in chronic salpingitis, or it may extend rapidly through the Fallopian tube to the pelvic and general peritoneal cavity, and there set up a peritonitis which may result fatally.

Chronic Salpingitis.—*Symptoms.*—The symptoms pointing to a chronic salpingitis are varied and oftentimes indefinite. In the absence of an acute exacerbation there is no pronounced effect upon the pulse and temperature. Malnutrition may result and neurasthenia be manifest. The menstrual flow is usually prolonged and profuse, and may recur with undue frequency. A chronic salpingitis associated with amenorrhea points to tuberculosis (Sutton).

More or less constant pain is experienced on either one or both sides of the pelvis. Unquestionably, the pain is more severe when the lesion is on the left side, because of the passage of feces and gas within the sigmoid flexure. If both sides are involved, sterility will almost certainly ensue.

Defecation is painful, and in consequence of the associated suffering the patient avoids movements of the bowel as far as possible, and this habit engenders constipation. The same may be said of urination resulting in irritation of the bladder. Recurrent attacks of acute pelvic inflammation, particularly at the time of the menstrual periods, is an almost characteristic occurrence in chronic salpingitis. When pus is suddenly discharged from the uterus, preceded by pain in the iliac fossa, and particularly where the pressure in the region of the tube causes an increased flow of pus, it is safe to infer that the contents of a pyosalpinx have been discharged into the cavity of the uterus.

Diagnosis.—Abdominal palpation may not reveal the existence of the affected tube. There will be a sense of resistance imparted by the abdominal muscles in the iliac fossa of the affected side, and tenderness is universally elicited. By bimanual examination the tube is outlined as an elongated, thickened, tortuous mass, very tender to manipulation, and as a rule fixed; its continuity with the uterus is discerned, and rectal touch may permit of a more thorough examination. Associated with this condition the uterus is often retroflexed. Retroflexion of the uterus has been mistaken for salpingitis, though it is difficult to imagine such an error. Other sources of error in diagnosis are—1. Fecal accumulation; 2. Movable kidney; 3. Small uterine myoma; 4. Tumors of the broad ligament; 5. Pelvic cellulitis.

Hydrosalpinx.—The tumor is more frequently bilateral than in the preceding condition, and is found in the region of the appendages. If no adhesions exist, the tumor will be freely movable, the walls thin, and upon digital manipulation fluctuation will be detected. The contents are usually clear and watery, but may be stained a greenish color by the presence of cholesterin; still more frequently the fluid is of a chocolate color. The ostium abdominalis is closed by inflammatory

adhesions, hence we have to do with an inflammatory cyst. When not greatly distended the tumor is elongated and tortuous, and can be traced from the sides of the pelvis to the uterus in the region of the appendages. When more distended the tumor is oval or rounded. An anesthetic will facilitate the examination. The uterus may or may not be freely movable. It is possible for hydrosalpinx to exist without giving rise to any subjective symptoms. When large the pressure upon the surrounding structures will cause pain. Pain may also be excited by a coexisting local peritonitis. Menstrual disorders, and particularly too frequent and profuse menstruations, are almost invariably present. An intermittent discharge from the tubes into the uterus occasionally occurs, and is a pathognomonic sign of hydrosalpinx, providing there is a simultaneous decrease in the size of the tumor.

Differential Diagnosis.—1. *Ovarian* and *parovarian cysts* are less freely movable, sustain no direct connection with the uterus, tend to assume great proportions, and are not of the sausage shape so characteristic of a distended tube.

2. *Extra-uterine pregnancy* is differentiated from hydrosalpinx by the previous history, the accompanying signs and symptoms, and by watching the progress of the growth.

3. *Hematosalpinx* is almost impossible to differentiate from hydrosalpinx. The history of a previous pregnancy and the tumor being less fluctuating, more or less adherent, and having thickened walls are features which will aid in diagnosis.

Hematosalpinx.—By hematosalpinx we designate a tube distended with blood not due to tubal pregnancy. Nearly all cases of so-called hematosalpinx are pregnancies, and upon careful examination of the contents the remnants of the fetal body will be found. J. Bland Sutton says that, in his practice, a careful examination of tubes dilated and containing blood-clot reveals an embryo, an apoplectic ovum, or chorionic villi in a large majority of the cases; these should not be included as hematosalpinx. In hematosalpinx the ostium abdominalis is usually closed, while in tubal pregnancy and edema of the tube the ostium is usually free and open.

Pyosalpinx.—Where the uterus and abdominal ends of the tube are closed the pus accumulates within the tube, resulting in thinning of the walls from distention, except where they are thickened from infiltration with the inflammatory exudate. The pus may escape from either the uterine or abdominal ostium, or may rupture through the walls of the tube. Preceding the escape of pus from the tube inflammatory adhesions are usually formed, and by virtue of these adhesions the pus-infection is limited, giving rise to circumscribed pelvic abscesses and preventing general infection of the peritoneum and its almost inevitable result—death. Where these adhesions do not exist there is great danger of general suppurative peritonitis. Where adhesions bind the tube to the vagina, the bladder, the rectum, or bowel, the rupture is very apt to take place into these organs. In the smaller tubes the uterine ostium is frequently patent, permitting of a constant or intermittent leakage.

The tube may be straight with a distended distal end, or convoluted and doubled upon itself. When the tube is adherent to the bowel the

pus assumes a fetid odor, due to the transfusion of gases from the intestinal tract. The disease is usually bilateral; rarely is there one tube entirely free from infection. The pus varies greatly in its virulence; that formed from the action of the staphylococcus and streptococcus infection following abortions and labors is the most virulent. Gonorrhea and tuberculosis are less virulent, but more persistent.

Symptoms.—Following the symptoms of endometritis, those of pyosalpinx are ushered in by an elevation of temperature which may suddenly reach 104° F., preceded by a chill, but ordinarily the temperature remains about 100° F. There are increased tenderness and pain in one or both iliac fossæ; the patient becomes restless; creepy sensations are experienced; and there is a gradual loss of flesh. Upon examination the tube can be outlined and found to be enlarged, tender, and adherent; when greatly enlarged fluctuation may be detected.

This condition must be differentiated from—

1. *Extra-uterine pregnancy*, which may be excluded by the history and by noting the progress of the growth. Other signs and symptoms may be similar. The uterus is enlarged in both. The stomach- and gland-symptoms may be alike in both cases, the discharge of the decidual membrane is not a constant occurrence in extra-uterine pregnancy, and the menstrual function is not always suspended.

2. *Cystic tumors* are distinguished from pyosalpinx by the absence of infection, by the thin wall and fluctuation, and by the absence of adhesions in the majority of cases.

3. *Hematosalpinx* is usually unilateral, pyosalpinx is generally bilateral; the previous history will be the distinguishing feature in the differential diagnosis.

4. *Hydrosalpinx* differs in the absence of general symptoms, in the thin walls of the sac and the freedom from adhesions, and in the absence of a history of puerperal or gonorrheal infection.

Pelvic abscesses are not circumscribed as a rule; the mass cannot be traced to the uterus as in pyosalpinx, and it may impart to the examining finger the sensation of a boggy mass filling more or less of the pelvis.

Inflammation of the Ovaries.—**Acute Oöphoritis.**—This condition rarely exists without a previous inflammation of the tube and uterus, the inflammation being an extension from the tube. When ovaritis exists independent of salpingitis, it is either tubercular or due to septic infection conveyed from the uterus to the ovary by means of the lymphatic vessels. In cases of septic infection following abortions and labors, single or multiple, small abscesses may be formed in the substance of the ovary, or the entire ovary may be converted into one large pus-cavity surrounded by the tunica albuginea; adhesions form about the ovary; the abscess may rupture into the surrounding tissue, and be limited by the adhesions giving rise to the formation of pelvic abscesses, or more rarely the adhesions may not exist or fail to limit the pus-infection, and as a result pelvic or general peritonitis occurs with the almost inevitable result—death.

The symptoms differ only in intensity from those of salpingitis. Examination will reveal an enlarged, adherent, very tender, and sometimes fluctuating ovary.

Chronic Oöphoritis.—This condition either follows upon and continues from an acute attack, or less frequently is chronic from the beginning. As with the acute form, it either exists singly, in which case it is usually of a tubercular origin, or, as is almost always the case, it follows upon a salpingitis, which in turn is preceded by endometritis and metritis. Chronic ovarian abscesses are usually the result of acute septic infection. The symptoms differ from pyosalpinx in no way save in intensity. The enlarged adherent tube can be outlined by examination; large abscesses may be detected by fluctuation, and if the abscess approaches the vaginal or abdominal surface, a positive diagnosis of the presence of pus is made by the use of the aspirating needle.

Pelvic Peritonitis.—In this condition we have, as a rule, a direct extension from the preceding forms of inflammation: seldom, if ever, does it exist without cellulitis; hence we do not have independent symptoms of pelvic peritonitis. However, it is to peritonitis that most of the pelvic symptoms are referable where pelvic inflammation exists. Part or all of the pelvic peritoneum is involved: the lymph-exudate organizes and gives rise to adhesions. Abscesses form in these adhesions. They have their origin in the rupture or leakage of a pyosalpinx or ovarian abscess, rarely in direct extension from the uterus, vagina, and rectum, following trauma and ulceration. The presence of adhesions may give rise to the formation of a hard, immovable mass which may occupy part or all of the pelvis. Where a large abscess exists fluctuation may be elicited, but to differentiate this abscess from that of a pyosalpinx or ovarian abscess requires experienced tactile sensation, and at times will be found impossible. The diagnosis of the presence of pus is as near to a diagnosis as we can expect to come.

Cellulitis.—No distinction should be made between cellulitis and peritonitis in the pelvis. It is essentially a septic process. Following abortions and labors, the septic infection travels from the uterus to the pelvic cellular tissue by way of the lymphatics, or indirectly it arises secondary to endometritis and salpingitis plus peritonitis.

Lacerations of the cervix and the vagina may give entrance to septic infection which extends directly to the cellular tissue.

Symptoms.—In the mild aseptic forms the condition may escape notice. When it follows the septic infection of the uterus after abortions and labors there is increased pain and tenderness in one or both iliac fossæ, a slight or a rapid increase in the temperature and pulse-rate, a sense of weight and fulness in the pelvis, and pain in the back.

The above-mentioned symptoms may all be referable to salpingitis, but when the pain and tenderness extend throughout the pelvic cavity and the general symptoms become aggravated, it may be inferred that the inflammation has extended to the pelvic peritoneum and cellular tissue. Where the inflammation follows upon suppressed menstruation the whole pelvis is involved and the general symptoms are pronounced.

Physical Examination.—Vagino-abdominal and rectal examination will reveal the condition. In the mild form nothing but tenderness may be elicited, together with a possible fixation of the uterus, which is also painful on pressure. In the severer form the pelvis is more or less filled with an indurated, hard mass very tender to the touch. The uterus is pushed to one side, or if the mass exist on both sides, the

uterus will be elevated and pushed forward; if there is a mass in the posterior cul-de-sac, the uterine displacement will be simply forward.

Chronic pelvic inflammation, as a rule, follows acute attacks from septic infection incident upon abortions and labors; next in point of frequency comes gonorrhea. The general symptoms are largely referable to the digestive and nervous system; there are neurasthenia, debility, increasing emaciation, indigestion, constipation, and meteorism; the pulse and temperature are not affected. The usual symptoms of endometritis, metritis, and salpingitis are added to the above. Pain in one or both sides of the pelvis is felt more or less constantly, being increased upon urination, defecation, and during menstruation. Coition is painful. Largely as the result of pain caused by the bowel-movements and urination, the patient naturally delays in responding to the calls of nature, with the ultimate result of irritability of the bladder and constipation. Acute exacerbations of pelvic inflammation, especially during the menstrual period, are quite characteristic.

Pain along the course of the sciatic, obturator, and crural nerves indicates pressure upon these nerves, and painful contractions of the psoas and iliac muscles are caused by the pressure of the mass upon them. The menstrual function is quite universally disordered. Dysmenorrhea, amenorrhea, menorrhagia, and metrorrhagia, one or more, are almost constant accompaniments of the affection.

Physical examination will reveal a uterus enlarged, fixed by adhesions, usually retroflexed, and painful to pressure. There will be detected slight resistance or a well-marked mass filling part or all of the pelvis and crowding the uterus in the opposite direction.

Pelvic Abscesses.—The common source of a pelvic abscess is a pyosalpinx from which the pus has either leaked through the ostium abdominalis or has ruptured through the wall of the tube, and has become restricted and circumscribed by adhesions, thus protecting the general peritoneal cavity from invasion. The causes of less frequent occurrence are ovarian abscess, suppurative peritonitis, cellulitis, hematocele, extra-uterine pregnancy, and extension from neighboring organs. The abscess is prone to rupture into the vagina, rectum, bladder, or, if high enough, through the abdominal wall. The great danger lies in the possibility of rupturing into the general peritoneal cavity.

Symptoms.—The symptoms of pelvic abscess follow upon those of metritis, pyosalpinx, ovarian abscess, hematocele, and pelvic inflammation, and are ushered in by a marked effect upon the general and local condition of the patient, the intensity of the symptoms being proportionate to the rapidity of the infection of the peritoneum and cellular tissue and the extent of the area involved. The temperature may be preceded by a chilly sensation or a chill, and may rise suddenly to an alarming degree. The pulse is quickened and weakened in proportion to the intensity of the infection, and is the best guide to the general effect of the local infection. Respiration likewise becomes quickened. When sweating occurs we have a grave indication of general infection. Associated with these symptoms are debility, emaciation, anorexia, and constipation.

The local symptoms pointing to an abscess are—a sense of fulness and weight in the pelvis, pressure upon the iliac and psoas muscles,

causing painful contraction of these muscles, and pressure upon the obturator, crural, and sciatic nerves, causing pain in the area of distribution of these nerves; there will be irritation of the bladder and rectum if the abscess presses upon these organs.

Fluctuation may be elicited when the abscess approaches the abdominal, rectal, or vaginal surface, and at the seat of fluctuation pus may be found by aspiration.

Diagnosis of pelvic inflammation is, as a rule, easy, but to detect coexisting conditions is often a difficult task.

Psoas abscess is differentiated by the presence of signs and symptoms of a lesion of the spine. The frequency with which they coexist should put one on his guard.

Fibroid tumors may be excluded by the use of the aspirating needle and the uterine sound, together with the bistoury.

Hematocele is characterized by its sudden appearance, and a positive diagnosis may be made only by means of an aspirating needle.

Appendicitis.—There is a history of intestinal disturbances. McBurney's tender point is found in the majority of cases. No direct connection can be traced between the mass and the uterus, and there is no history of uterine disturbances at the time of the attack. When the mass is small, it may be possible to outline the tube and ovary distinct from it; rarely can the mass be traced to the cecum. If the pus is aspirated and fecal material found in it, the diagnosis is established, but this procedure must be strongly condemned. A fecal odor is not diagnostic, because any abscess lying in contact with the intestine will absorb gas from the intestinal tract.

Carcinoma.—The history of the case and the symptoms and signs pointing to the organ and tissue originally infected will aid in the diagnosis; the cancerous cachexia and abdominal ascites will also aid in the exclusion of other lesions.

Fecal Impaction.—This condition should never mislead one; catharsis will eliminate the possibility.

Prognosis.—In the mild forms there may be complete re-establishment of function and the disappearance of all pathological lesions. The graver forms tend to become chronic, and invalidism from adhesions and abscesses is the almost inevitable result. Death may occur from peritonitis. Subsequent acute exacerbation is the rule. Treatment may result in a cure, and in nearly every case will favorably modify the condition.

Treatment of Pelvic Inflammation.—**Prophylaxis.**—This consists in the treatment of vaginitis and endometritis before the inflammation has extended to the tubes and pelvic tissue, in all the means of prevention of childbed fever and its timely treatment when the infection has already occurred, in strict cleanliness during all operations and examinations about the genital tract, and, lastly, in the prevention of exposure during the menstrual period.

Curative treatment may be considered under the head of *palliative* and *operative*.

Palliative treatment in acute pelvic inflammation may be briefly summarized as rest in bed till all acute symptoms have passed away; hot applications (preferably a hot-water bag) to the abdomen, hot water or

1 : 5000 bichlorid-of-mercury-solution douches of not less than one gallon in quantity and repeated every four hours during the acute stage, and thereafter once or twice a day for at least six months; pelvic congestion will be greatly relieved by saline cathartics. It will be well to have two or more free watery stools during the first twenty-four or forty-eight hours, and subsequent daily movements of the bowel. By means of cathartics much of the pain will be relieved, and only in extreme cases will it be necessary to resort to opiates. Glycerin tampons should be inserted in the vagina daily during the active stage of the inflammation. They should be allowed to remain no longer than eight hours; then they are to be removed and a prolonged hot vaginal douche given. The diet should be light; rest in bed should not be strictly enforced after the acute symptoms have disappeared. The existing endometritis and metritis are to be treated according to the principles suggested in their respective chapters. During the entire inflammatory stage sexual rest must be enjoined, as it is of the highest importance that all causes of pelvic congestion be avoided. Scarification of the cervix by a number of punctures will result in free bleeding and may do much in depleting the pelvis. When a chronic inflammation follows upon an acute attack, the hot douches should be continued once or twice daily, the bowels kept freely open, sexual intercourse proscribed, and a moderate amount of exercise should be taken. Some benefit may be derived from painting the vault of the vagina with iodin or ichthyol. The application may be followed by the introduction of a glycerin tampon. Pressure-symptoms from retroflexion of the uterus are best relieved by the introduction of wool tampons, placing them in the posterior cul-de-sac when the patient is in the knee-chest position. The tampon should be removed every three to five days. The tampons will also serve the purpose of preventing sexual excess. Absorbent cotton should not be used, because of the tendency to contract and become very hard. Pessaries should never be used when any inflammation exists. General massage and galvanism are at times beneficial. When pus exists it should be evacuated without delay.

We shall not attempt to enter into a discussion of the comparative merits of abdominal and vaginal operations in pelvic inflammation, but shall simply present the claims of either side and briefly express our preference. In favor of the abdominal route may be argued the improved methods in abdominal surgery and the advantage gained by bringing the field of operation into view and being able to palpate clearly the pelvic viscera and thus avoid injuring neighboring structures. Against the choice of the abdominal route may be argued—First, that the barrier of adhesions which protects the general peritoneal cavity from the pelvic inflammation is broken down; second, where drainage is indicated it will be necessary to drain against gravity; third, the increased liability of shock when the peritoneal cavity is exposed.

Montgomery thus enumerates the advantages of the vaginal route:

1. It permits us to explore, treat, and preserve organs which would otherwise be sacrificed.

2. It promotes drainage from the most dependent portions of the pelvis and enables the large peritoneum to be protected by plastic barriers.

3. It enables us to remove the uterus and its appendages with less danger and much more subsequent comfort than if the abdominal incision had been practised.

4. The adhesions which Nature has provided to protect the vital organs are undisturbed, and consequently the patient is less liable to have subsequent obstructive symptoms.

5. Convalescence is shorter, and the patient avoids such agonizing sequelæ as abdominal sinuses, painful cicatrix, weakened ventrum, and ventral hernia.

Against the vaginal route may be argued—1. Danger of vesical and rectal fistulæ; 2. Increased danger of injuring the ureter; 3. Inability to see the field of operation, thus relying much upon the sense of touch.

Where the septic infection so debilitates the patient as to lower her resistance to shock, vaginal drainage is indicated. Where the pelvic abscess is extra-peritoneal, lying as it often does between the layers of the broad ligament, vaginal drainage should be employed. A transverse incision is made at the junction of the cervix and vaginal vault; then with a blunt-pointed instrument the abscess-cavity is opened, irrigated, and packed with iodoform gauze.

Vaginal hysterectomy has been advised where both tubes are distended with pus. The technique consists in making an incision completely around the cervix at the junction with the vaginal mucous membrane, and a bilateral incision on either side of the cervix parallel to the posterior surface of the broad ligament about 2 cm. long. With a blunt instrument the tissues are dissected up to the peritoneum, hugging close to the uterus; the peritoneum is opened; the finger is passed over the fundus of the uterus and carried along the tubes on either side, gently separating the adhesions. The remaining portions of the broad ligament are clamped, and the uterus removed by severing the broad ligament close to the uterus. The wound is closely inspected for bleeding points, and the cavity is packed with iodoform gauze, care being taken to cover the ends of the forceps with gauze to prevent pressure-atrophy. At the end of forty-eight hours the forceps are removed, and twelve hours later the gauze, and the wound irrigated daily until all discharge ceases.

Abdominal Operation.—The usual technique is observed in opening the peritoneal cavity. If the omentum and intestines are found adherent to the parietal peritoneum, the adhesions should be gently separated with the fingers. If the omentum is so adherent as to render it impossible or dangerous to separate it from the structures to which it is attached, it is best to ligate and remove it in sections. Adhesions of the structures should be gently separated by the fingers, and the separated surfaces examined for injury. Immediate repair of the injured bowel or bladder is imperative. The Trendelenburg position greatly facilitates the operation. The uterus is then outlined and the examining finger worked well down behind it; then by a careful sawing motion the adhesions are gently separated till the tube and ovary are freed on either side, always beginning at the lowest point and working upward. The ovary and tube are then brought through the abdominal incision; a double ligature is passed through the broad ligament immediately beneath the uterine end of the tube; the loop is

caught and the staff is withdrawn; two ligatures are made by cutting through the loop; these are so twisted that by tying the broad ligament and half the tube with one ligature, and the tube and half the broad ligament with the other, a sort of figure-of-8 ligature is made. Care should be taken not to include the round ligament, as it increases the danger of slipping. If the tube is cut by the ligature, part of the uterine tissue should be included in its grasp. The stump of the tube should be cauterized by a Paquelin cautery or carbolic acid. Care should be taken to remove a distended tube without rupturing. If pus escapes, the pelvic cavity should be irrigated and swabbed dry with sterilized gauze. Carefully inspect the pelvis for bleeding points before closing the abdominal cavity. Drainage with a rubber or glass tube is employed where pus has ruptured into the pelvic or abdominal cavity or where many adhesions have been separated; also where there is danger of having injured the bladder and bowel. Close the abdominal wound as is customary in abdominal surgery. Here, as in all surgery, the axiom should prevail, "Save what can be saved." Never sacrifice a healthy tube or ovary. If the tube is diseased and the ovary healthy, leave the ovary and remove the tube. Do not neglect to treat the endometritis which nearly always exists. The majority of uteri should be curetted during convalescence from an abdominal section for pelvic inflammation.

VIII. TUBERCULOSIS OF THE FEMALE GENITAL TRACT.

Tuberculosis may involve one or all parts of the female genital tract: the tubes are attacked most frequently; next in point of frequency, in the order named, are the uterus, ovaries, vagina, and vulva. As a rule, genital tuberculosis is secondary to primary tuberculosis of the lungs or peritoneum, less frequently of any other portion of the body. That primary tuberculosis exists in the female genitalia there can be no question.

Vulva.—Tuberculosis of the vulva may be an expression of general tuberculosis or secondary to tuberculosis elsewhere in the body, but the vulva is more frequently the seat of primary tuberculosis than any portion of the genital tract, because of the ease with which abrasions and excoriations of the skin can be infected with the tubercle bacillus. The typical lesion is an ulcer with slightly elevated margins which are irregular and sharply defined. About the margins are numerous miliary tubercles. The ulcer is shallow; the base is studded with minute granulations and may have a viscid secretion. The ulcer extends very slowly and shows a tendency to recur.

Vagina.—The vagina is usually infected by the leukorrheal discharge of tubercular endometritis, and hence it is the upper posterior wall that is most frequently involved. It is rarely primary, and may arise by extension from the bladder and rectum, and in this way recto-vaginal and vesico-vaginal fistulæ are sometimes formed. It begins as small gray or yellowish tubercles, which may coalesce, break down, and form ulcers.

Uterus.—Tuberculosis of the uterus may be primary, but is generally secondary to tuberculosis in distant parts of the body or neighbor-

ing structures, particularly the tubes and vagina. The infection is at first limited to the endometrium, but later extends to the deeper structures of the uterus. Beginning as a diffused miliary tuberculosis, it later develops either into a diffused caseous degeneration of the endometrium or ulceration ensues. The caseous débris may become locked up in the uterus, giving rise to pyometra. Interstitial hyperplasia of the uterine tissue may result from the chronic tubercular endometritis. The cervix is rarely, if ever, the seat of primary tuberculosis. As a secondary lesion it becomes either studded with tubercles or ulcerated.

Tubes.—In nearly all cases of tuberculosis of the female genital tract the tubes are involved. Undoubtedly, they may be the seat of primary tuberculosis, but more frequently the disease is an extension from either the uterus or the peritoneum, and rarely exists without tuberculosis elsewhere in the body, particularly the lungs. The pathological lesions usually found are—miliary tubercles scattered over the mucous surface; diffuse caseous degeneration of the mucous membrane; tubercular ulcers, involving the mucous and submucous tissues; and chronic interstitial hyperplasia of the tube-wall. The tube when distended contains the typical caseous débris giving rise to the so-called "caseous pus-tube."

Ovary.—The ovary may be the only portion of the genital tract affected, but rarely does it exist as a primary focus, being almost invariably a complication of phthisis or peritonitis.

Tuberculosis of the female genital tract occurs at all ages from childhood to adolescence. When in the extremes of life it is usually a secondary infection, while occurring in the age of sexual activity it may be primary or secondary.

Symptoms and Diagnosis.—When of secondary origin the symptoms are usually marked by those of the primary lesion. The condition in the vulva and vagina is recognized by the peculiarities of the ulcers and granulations above referred to, by the aid of the microscope, by the slow progress in the development of the lesions, by their ready response to treatment, and by their tendency to recur. The presence of tuberculosis elsewhere in the body is strongly suggestive of the tubercular character of the lesion. The miliary form is to be distinguished from *granular vaginitis* by its comparative rarity, by the association of *granular vaginitis* with pregnancy and gonorrhea, and by the aid of the microscope.

Hard and soft chancre and *syphilitic ulcers* are differentiated by the history, by the microscopic examination, and by the effect of antisyphilitic treatment.

Tuberculosis of the cervix and body of the uterus may be confused with *carcinoma*. A microscopic examination of the product of curettement or of a small portion excised from the cervix, and the inoculation of guinea-pigs with the secretions, will determine the nature of the lesion. The tubercle bacillus may be detected in the leukorrheal discharge by the same method as pursued in the examination of sputum. Edebohls says: "The coexistence of a tubal tumor or tumors with plaque-like thickenings of the subperitoneal tissues points with the greatest distinctness to tuberculosis. The tuberculosis under these conditions may fairly be assumed to be primary in the tube or tubes if no other deep-

seated tumors can be palpated in the abdominal cavity." The following words from Paul Petit are appended: "The tubercular nature of endometritis may be absolutely determined if scrapings of the débris present the following characteristics: interstitial cells which are necrosed or atrophied in a diffused manner or in well-defined lines; giant-cells in greater or less numbers; embryonal nodules detached from the stroma and apparently developed around the vessels, whose lumina may or may not be preserved; numerous flexible and dilated glands lined with epithelial cells which are either considerably elongated or have undergone an epithelioid transformation. In order to clear the diagnosis we should always perform an exploratory curettement, which will prevent confusion with carcinoma of the body of the uterus."

In tubercular salpingitis the nodular character of the uterine end of the tubes has been held as pathognomonic, but this is not true. Rarely, on the posterior surface of the uterus and broad ligament are found little granulations; however, their presence is so rarely detected that little reliance is placed on their discovery. Salpingitis in a virgin prior to puberty is seldom anything other than tubercular. The association of distended tubes with tubercular peritonitis is suggestive of tubercular salpingitis.

Treatment.—Prophylaxis is essential. Cleanliness in examinations and operations upon the genitalia should always be observed. The undoubted conveyance of the infection from the tubercular genitals of the male should emphasize the importance of guarding against such a possibility.

Curative.—Ulcers of the vulva and vagina will readily respond to treatment with the tincture of iodin, iodoform, Paquelin cautery, or excision with subsequent suturing.

Tubercular endometritis demands a thorough curettement, followed by swabbing with the tincture of iodin and packing with iodoform gauze. If the results are not satisfactory, vaginal hysterectomy is justifiable. Tuberculosis of the tubes and ovaries demands their removal except in cases seriously complicated with tuberculosis elsewhere. The uterus may be curetted as suggested above, or a total hysterectomy be done.

IX. LACERATION OF THE CERVIX UTERI.

The usual cause of laceration of the cervix is parturition. The conditions favoring laceration are—1, forceps delivery; 2, hastening the process of labor by ergot; 3, dystocia from maternal causes, as from a relatively large presenting body or abnormal presentation; 4, diseased cervix. The laceration may be partial or complete. In partial laceration the entire thickness of the cervix is not involved, while in complete laceration the tissues are severed throughout their entire thickness, and the rent extends to a variable distance.

Lacerations may be—1. *Unilateral*, involving one or the other side of the median line—more of the left side because of the relative frequency of the left occipito-anterior presentation. 2. *Bilateral.*—The most frequent variety is a laceration on either side of the median line, the one on the left being, as a rule, the more extensive; rarely,

the cervix is completely divided into an anterior and posterior flap. 3. *Stellate.*—This form consists of three or more lacerations; it is comparatively rare, and is seldom extensive.

Nature rarely repairs these injuries, but occasionally healing will take place on the vaginal surface, leaving a gaping wound communicating with the cervical canal.

As a result of the laceration, involution of the uterus may be interfered with; endometritis and endocervicitis may result, accompanied by a leukorrheal discharge; retention-cysts may develop in the mucous membrane of the cervix from the occlusion of the cervical glands; granulations cover the lacerated surface, and connective tissue is increased, rendering the cervix markedly hyperplastic.

Pelvic inflammation is not the direct result of the laceration, but of the accompanying endometritis, and sterility may, and often does, result from the endometritis and the plugging of the cervical canal with mucus. Abortions not infrequently arise from the accompanying endometritic lacerated cervix.

Ruptured perineum and subinvolution being frequent complications, we often find displacements of the uterus.

Carcinoma of the cervix often follows a laceration.

Symptoms and Diagnosis.—The symptoms are, as a rule, referable to resulting complications. There is tenderness of the cervix during coitus and on digital touch; the cervix bleeds easily upon manipulation as a consequence of endometritis. There may be a leukorrheal discharge; pains and functional disturbances may be excited by the laceration where subinvolution and displacements are present; there is also a sensation of weight and bearing-down in the pelvis, referable not to the laceration, but to the enlarged and displaced uterus.

The diagnosis is best made by digital examination. If the laceration is incomplete, the cervix may be patulous to the index finger to a variable degree; if complete, the lacerated surface is felt to be rough and granular or velvety. A linear cicatrix may be felt, the remains of a previous laceration which has undergone partial or complete healing. Inspection by the aid of the Sims or bivalve speculum will confirm the diagnosis; the lacerated os externum will appear eroded, everted, and granular; by the aid of two tenacula the eroded everted surfaces are approximated and the granulated surface disappears; the cervical glands will be seen to be distended, giving the granular appearance. This is the condition commonly known as ulcer of the cervix.

Treatment may be immediate or secondary.

Immediate Treatment.—Where the laceration is extensive and the hemorrhage profuse the immediate operation may be done, though with great difficulty in recognizing the relations of the relaxed parts. Continuous catgut sutures may be used and the wound left to Nature.

Secondary Operation.—The most favorable time for the repair of the cervix is at the end of the puerperium, when involution has progressed to a considerable degree and before the various complications have arisen, as endometritis, subinvolution, cicatrix, and hyperplasia of the cervix. If done at this time, no cutting is necessary beyond simply freshening the raw surfaces by the curette and uniting them by the

interrupted suture. In the vast majority of cases the laceration is not recognized until late, when the complications arise and an examination is made. The indication for the repair of the cervix is in no way governed by the extent of the laceration. Some of the most extensive lacerations have given rise to little or no inconvenience, while a slight and apparently insignificant tear may be productive of the most pronounced disturbances, and give the most satisfactory results when treated by operation.

The presence of acute pelvic inflammation or of pus within the pelvis would preclude the operation; on the other hand, chronic non-suppurative inflammation within the pelvis is no contraindication, provided care be taken to avoid traction upon the cervix, which would disturb the pelvic organs. When endometritis is present, a preliminary dilating of the cervix and curettement of the uterus are advisable, to be immediately followed by the repair of the cervix.

A preliminary treatment of the granular surface may at times be necessary; this consists of opening the retention-cysts. For the operation the patient is either placed in the dorsal or Sims position, resting on a Kelly pad. If the patient can endure the pain and the laceration

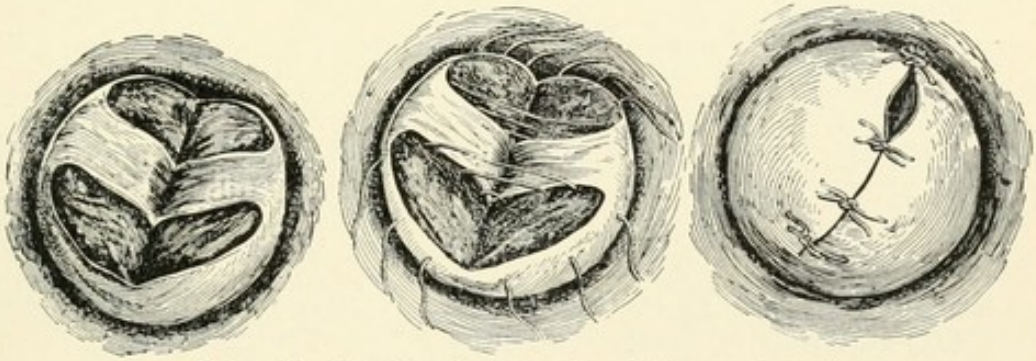


FIG. 308.—Operation for laceration of the cervix uteri.

is not too extensive, no anesthetic need be given. A 4 per cent. solution of cocain may be injected into the cervix at various points, and the operation be done with very little pain; it is best, however, to have the patient under complete anesthesia.

The Sims speculum is introduced and the vagina irrigated with 1 : 2000 bichlorid solution, and then made dry by mopping with sterile sponges.

The anterior lip is seized by a tenaculum and the lacerated surface denuded with scissors or a knife; the posterior lip is treated in a similar manner, care being taken to remove all the cicatricial tissue, including that at the apex of the laceration (Fig. 308). Sufficient cervical mucous membrane should be left to form a cervical canal. The incision should not extend higher up than necessary, for fear of too much tension on the stitches when the uterus is replaced. Bleeding may be free, and is controlled by sponges, continuous warm irrigation, forceps, or ligature.

When the surfaces are denuded and the hemorrhage controlled, the sutures are passed, beginning a little below the upper angle on the left side, entering the vaginal surface, and including the entire thickness of the cervix, passing out through the cervical mucous membrane, then

returning at corresponding points in the opposite side, passing from within outward.

The second stitch is taken in the middle of the flap, and the third near the os externum, both being placed in the same way as the first. As a rule, three sutures will suffice, but a fourth, and even a fifth, may be necessary. The ends of the sutures are caught with a pair of hemostatic forceps, and the right side is sutured in exactly the same manner, except the sutures are reversed in direction. The sutures on both sides are tied from above downward. Superficial stitches may be used to coapt the surface. The vagina is packed with iodoform gauze. If catgut is used, the wound is not disturbed; if silkworm gut or silk, the stitches are removed in seven to ten days. The patient is kept in bed for two weeks, though this is not absolutely necessary. When one lip, usually the anterior, is much larger than the other, it is either amputated or reduced in size by removing a V-shaped piece and then approximating the surfaces. In stellate lacerations, where one lip is small it may be excised and the flap on either side coapted. If the laceration is incomplete, it should be made into a complete laceration by cutting entirely through the cervix and then repairing as in ordinary complete laceration.

X. FIBROID TUMORS OF THE UTERUS.

Fibroid tumors of the uterus have essentially the same histological structure as the uterus itself. Various synonyms have been applied, as Myoma, Hysteroma, Fibro-myoma, Fibroid, and Fibroid myoma.

What the exciting and essential causes may be is not determined. According to Bayle, one-fifth of all women over thirty-five years of age have fibroid tumors of the uterus. It is essentially a growth of adult life, and occurs most frequently in the African race.

Of the recognized varieties, we will consider—1. Polypoid or pedunculated fibroids; 2. Submucous fibroids; 3. Interstitial fibroids; 4. Subperitoneal fibroids: (*a*) Pedunculated; (*b*) Sessile and free; (*c*) Intraligamentous, pelvic, and abdominal.

1. **Polypoid or Pedunculated Fibroids.**—These growths lie within the uterine cavity, and are connected with the uterine wall by a pedicle. They are covered with endometrium, which becomes hypertrophied and perhaps gangrenous and ulcerated. During the menstrual period the cervix becomes dilated by the protruding polypus, and this is the most favorable time for their detection by simple inspection. At other times it usually becomes necessary to dilate the cervix and make a digital exploration of the uterine cavity. Where the polypus protrudes through the cervical canal into the vagina, a digital examination will generally suffice to determine its relations to the surrounding structures and differentiate it from a polypus of the cervix.

Inversion of the uterus may be mistaken for a fibroid tumor, and especially when the inversion is due to the presence of a fibroid; but the inverted uterine tissue will be found more sensitive than a neoplasm. The inverted uterus can be outlined by recto-abdominal palpation, and the diagnosis further established by the aid of the uterine sound.

2. **Submucous Fibroids.**—These growths lie immediately beneath the endometrium and project into the uterine cavity. The hypertrophied mucous membrane covering them may become gangrenous and slough. Through the expelling influence of the uterine contractions the tumor may project more and more into the uterine cavity, either giving rise to the formation of a polypus or extruding it entirely from the uterus—the so-called "*spontaneous enucleation.*"

By bimanual examination the uterus will be found to be uniformly enlarged; the uterine sound will detect the presence of one or more rounded tumors bulging into the cavity, and the cavity itself will be found to be increased in depth. This condition, when associated with a hemorrhage more or less profuse and continuous, points to the existence of a submucous fibroid. The diagnosis is best made at the time of hemorrhage, when the cervix is dilated. It may be necessary to dilate the cervix to a greater degree in order to permit of the introduction of the examining finger, which should make the diagnosis with absolute certainty. The submucous fibroid is felt as a protruding body having a broad rounded base; the surface is even and covered with hypertrophied mucous membrane. Where the mucous membrane is gangrenous and sloughing, and particularly where there are cachexia and a putrid, offensive discharge, the presence of a carcinoma may be suspected, but the age, family history, personal history, and the examination of the product of curettement should exclude all doubt.

3. **Interstitial Fibroids.**—The tumor lies imbedded in the uterine tissue. When it does not project upon the peritoneal or mucous surface, the diagnosis becomes very difficult, and must be based upon the hemorrhagic discharge and the increase in depth of the uterine cavity. Nothing short of the discovery of the tumor will suffice for a diagnosis.

Incomplete abortion is excluded by the history and the product of curettement.

Early pregnancy may be excluded by the history, by the persistence of the menstrual flow, and by observing the progress in development.

Carcinoma of the uterus may be distinguished by the age, history, fetid discharge, cachexia, and the examination of the product of curettement.

Diseased adnexa may be diagnosed usually by a careful bimanual examination with the patient under the influence of an anesthetic. The uterus is not increased in size, metrorrhagia does not exist, and the development is more rapid.

Displacements of the uterus are recognized by bimanual examination and the uterine sound. It is not uncommon to find displacement and fibroids coexisting.

4. **Subperitoneal Fibroids.**—No hemorrhage accompanies this condition, and the uterine cavity is not enlarged. By bimanual, vagino-abdominal, and rectal examination the tumor or tumors are outlined and their location and relations to surrounding structures determined. They may usually be distinguished from ovarian cysts by their density and by the absence of fluctuation, yet fluctuation is not always elicited in ovarian cysts, particularly fibro-cysts. A second point in the differentiation is the rapidity of growth of ovarian cysts.

Floating kidney is distinguished by its form and by replacing it in its natural position.

In the *intra-ligamentous fibromata* the tumors grow and wedge themselves between the layers of the broad ligament, crowding into the iliac fossæ, and are closely connected with the uterus. They are to be differentiated from *parovarian cysts*, which have no direct communication with the uterus and which fluctuate.

A *tube distended with pus*, *blood*, or *serous fluid*, when closely adherent to the uterus, may give rise to confusion, but doubt may be dispelled by a carefully-taken history and by the aid of the sound. These tumors usually increase slowly up to the time of the meno-

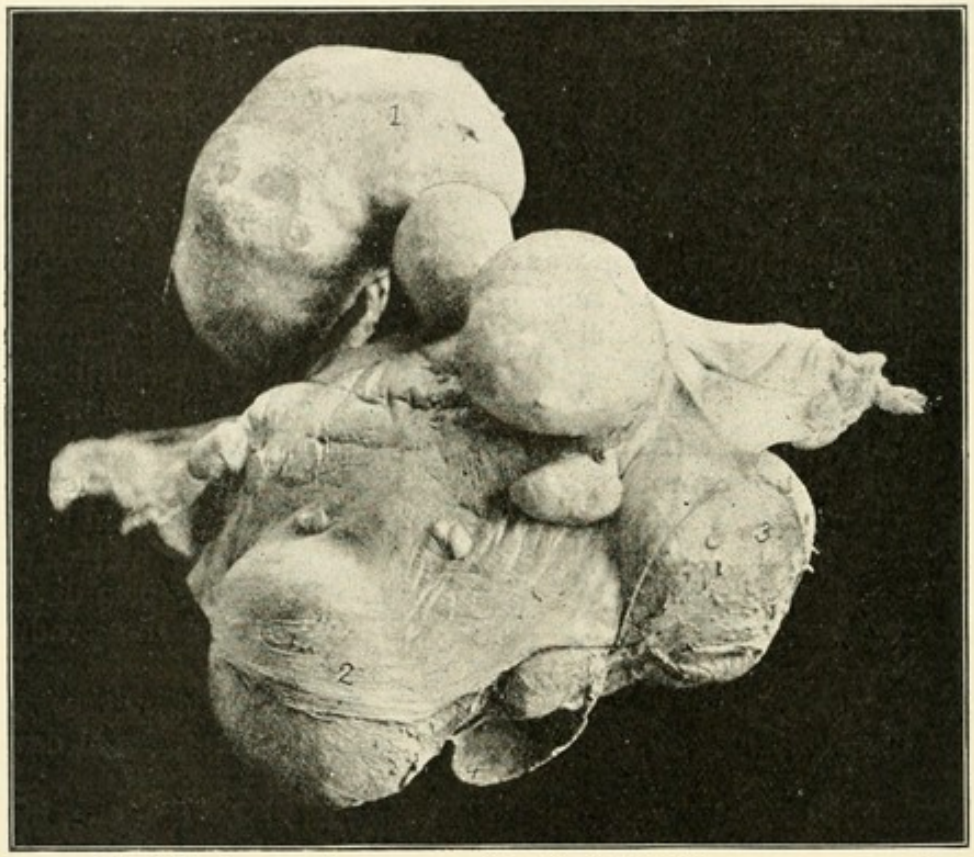


FIG. 309.—Multiple fibroma of uterus complicated with triplet pregnancy: 1, pedunculated subserous fibroid (myoma), diameter 6 inches; 2, myoma, diameter 4½ inches; 3, myoma, diameter 4 inches; 4, dilated cervix at seat of amputation (from a photograph in the collection of Dr. Jepson, Sioux City).

pause, when retardation in their growth generally takes place. Interstitial tumors are of slow growth. When multiple, they may crowd upon each other and interfere with their own nutrition, first making a rapid increase in the size of the uterus. Spontaneous enucleation and expulsion may take place in either the submucous or subserous variety; gangrenous degeneration may precede the expulsion of the tumor. When a subperitoneal fibroid is expelled into the peritoneal cavity, it becomes either absorbed or mummified; in rare instances it may suppurate or become calcified. Death may result from peritonitis or from the anemia consequent upon the frequent hemorrhage. Less frequent causes of death are malnutrition from pressure, uremia, septicemia, and heart-complications.

Pregnancy coexisting with fibroid tumors presents a very serious complication and renders diagnosis difficult. By a strange coincidence these tumors grow with increased rapidity during gestation. In Fig. 309 are represented the uterus pregnant with triplets and numerous fibroids, twelve of which measured an inch and more in diameter. Hysterectomy at the third month was followed by recovery. The triplets contained in the uterus are represented in Fig. 310. When the tumors are subserous, and especially if pedunculated, they can sometimes be pushed upward out of the true pelvis or they spontaneously take this position, and thus interfere with natural labor to only a slight extent. If serious interference with delivery is inevitable, operative



FIG. 310.—Triplets removed with uterus and fibroid tumors (from a photograph in the collection of Dr. Jepson, Sioux City).

procedures must be considered with the view of saving, if possible, both mother and child. Cesarian section, immediately followed by removal of the tumor, is in many cases the operation of choice. In others Porro's operation is the most suitable, especially if the tumors are confined to the lower portions of the uterus.

Treatment.—Alterative treatment has no remedial effect, and should be condemned as irrational and injurious to the patient.

Ergot in carefully selected cases is of service in controlling hemorrhage, in stimulating uterine contractions, thus aiding in the expulsion of polypoid and submucous fibroids, less frequently interstitial fibroids. It may serve to tide the patient over to the menopause, and sometimes promotes atrophy of interstitial and subserous growths.

Curettage, followed by uterine tamponade, will check the hemorrhage for a considerable time and will retard the growth of the tumor. By this means time may be gained and the patient sustained till the menopause brings about retrogressive processes.

Electricity tends to contract the uterus, to lessen hemorrhage, and to decrease the size of submucous and interstitial fibroids. The intra-uterine positive electrode causes atrophy, but only affects the immediate vicinity which it touches. The negative electrode liquefies the tumor superficially. Superitoneal tumors are but little affected. The use and abuse of electricity are responsible for the development of firm adhesions which seriously complicate subsequent operative procedures.

Surgical Treatment.—1. *Removal of the uterine appendages* will bring about the usual changes of the menopause, and has been advocated for all varieties of uterine fibroids. Small interstitial tumors are markedly affected, but the operation has very little influence, if any, upon large tumors. The best results are obtained in medium-sized hard fibroids where hemorrhage is severe.

2. *Ligation of the Uterine Arteries.*—The technique consists in preparing the vagina as in all vaginal operations. A transverse incision is made in the cul-de-sac of Douglas. The finger is introduced into the incision and the uterine artery located; a strong ligature is then passed through the lower portion of the broad ligament above the uterine artery and tightly tied. This method is of no service in large tumors or in the subserous variety.

3. *Morcellation.*—In submucous tumors or in the interstitial variety which has been forced to protrude into the cavity of the uterus, complete enucleation should be done if the size of the growth is sufficient to permit of its extraction through the dilated or incised cervix. If the tumor cannot be extracted *en masse*, the cervix should be dilated to the extreme degree, and, if this does not suffice, lateral incisions are made in the cervix. Much advantage is gained by administering ergot for some days prior to the removal of the growth. By this means the cervix will be more efficiently dilated by the protruding mass. The tumor is grasped with a volsellum forceps and traction made. With the knife or scissors a section is taken from the tumor, and this process is continued until the entire growth is removed. Hemorrhage is controlled by packing with iodoform gauze.

4. *Vaginal hysterectomy* is indicated where enucleation and morcellation cannot be performed and hemorrhage is severe. The tumor must not exceed, in size, the fetal head. The technique will be described under Vaginal Hysterectomy for Carcinoma of the Cervix.

5. *Myomectomy* is indicated in subserous growths and in interstitial tumors where the uterine cavity is not entered. The abdominal cavity is opened in the usual manner, the tumor is delivered through the abdominal incision, the capsule is incised, and the growth enucleated. The wound is then closed with sutures. The abdominal wound is closed without drainage (Fig. 311).

6. *Abdominal Hysterectomy.*—The incision should be made large enough to deliver the tumor. Adhesions when existing are broken by the finger. The broad ligaments are tied off on each side—two and

possibly three ligatures will be required for each broad ligament; the last should be made to include the uterine artery, and the first should

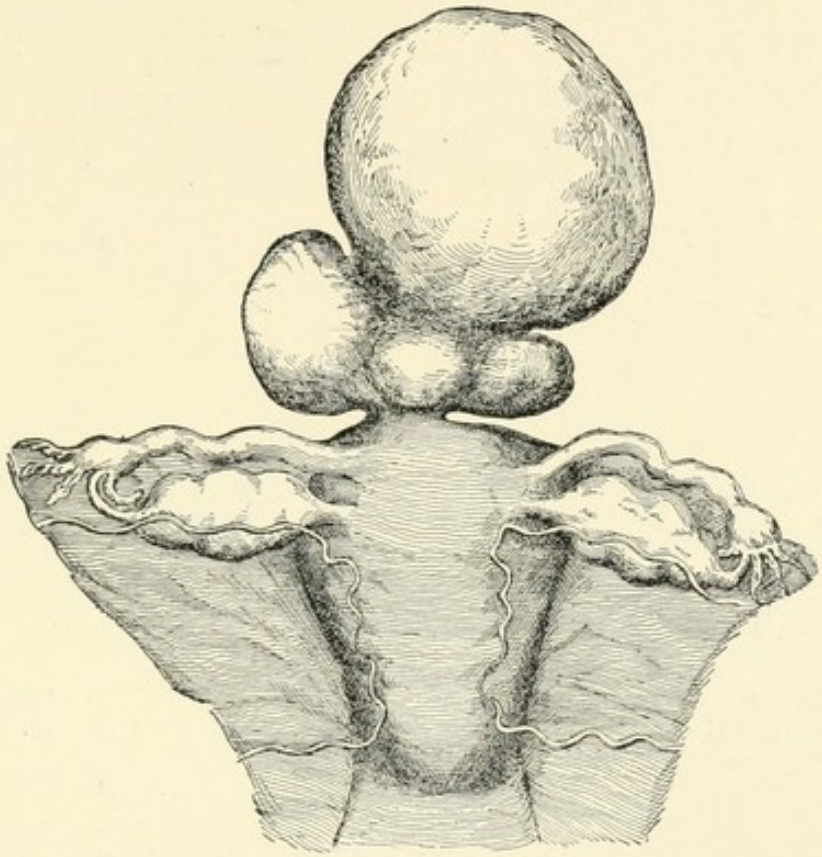


FIG. 311.—Subperitoneal nodular fibroid tumor of the uterus (Baldy).

include the ovarian artery (Fig. 312). The broad ligament should be severed close to the uterus as far as the reflection of the peritoneum to

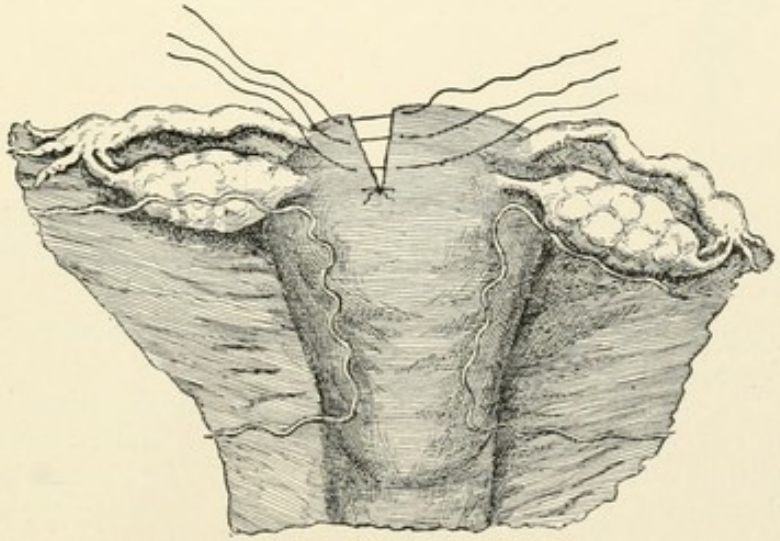


FIG. 312.—Method of removal of a subserous uterine fibroid: stitches in place ready for tying (Baldy).

the bladder. A circular incision through the peritoneum is then made at this point, passing completely around the cervix. A V-shaped wedge with the base upward is taken from the cervix and the mass

removed. The stump of the cervix is closed by buried catgut sutures, and the peritoneal cuff stitched over the stump by separate interrupted or continuous sutures; thus the stump becomes extra-peritoneal. The Trendelenburg position is almost indispensable. The patient is slowly lowered to the horizontal position before closing the abdominal cavity, and all bleeding points are controlled. If no great oozing occurs from breaking up adhesions and pus does not escape into the peritoneal cavity, the abdomen is closed without drainage.

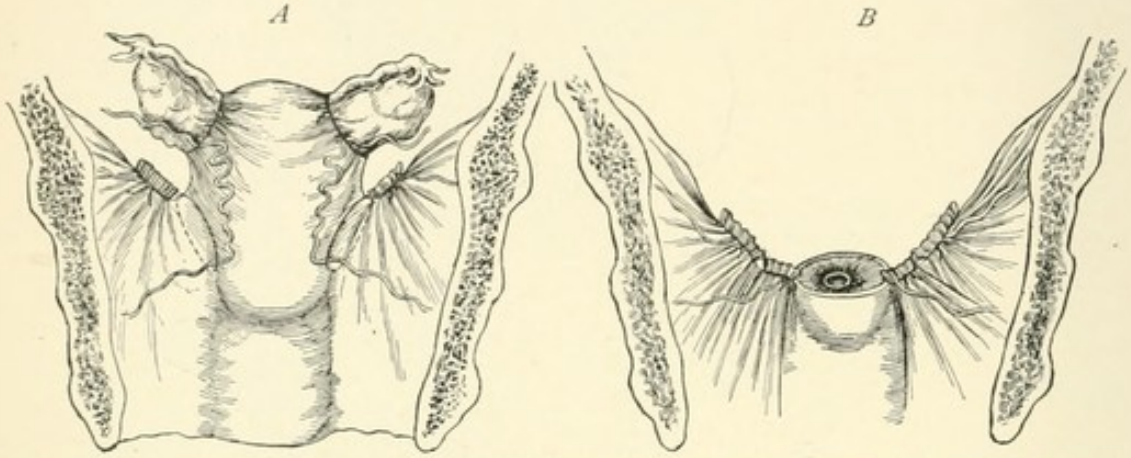


FIG. 313.—Supravaginal amputation of the uterus: *A*, first step, position of second ligature shown; *B*, cervix amputated by wedge-shaped incision (Baldy).

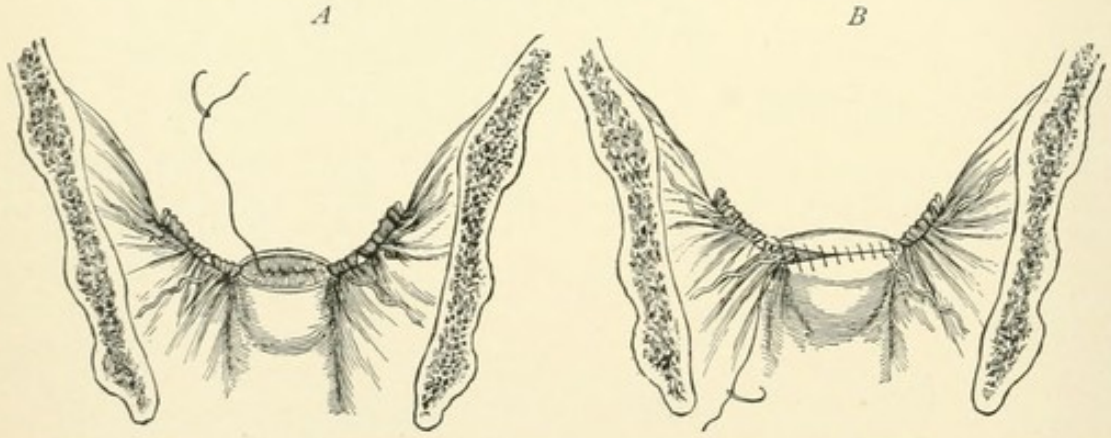


FIG. 314.—Supravaginal amputation of the uterus: *A*, cervical canal being closed by sutures which are buried by subsequent sutures; *B*, peritoneal edges of the stump in process of being whipped together, the lower stump being buried under the peritoneum (Baldy).

The operation of supravaginal hysterectomy, as described by Dr. Baer, is as follows:

"After the required abdominal incision is made all existing adhesions of omentum, intestines, etc. are separated in the usual way, and the tumor lifted out of the abdominal cavity. If the incision has been an unusually lengthy one, several sutures are then placed at its upper end for the better protection of the intestines. The patient may now be elevated to the Trendelenburg posture if deemed best, and the parts thoroughly studied, so that a clear idea as to the character and location of the tumors and pedicle may be obtained before the ligation and separation are begun. The first step in the operation is the passing of a single silk ligature through the broad ligament near the cervix. This

ligature is again made to transfix the broad ligament near the outer edge, to prevent slipping; it is then tied. A stout pedicle-forceps is next placed under the Fallopian tube and ovary and made to grasp the broad ligament for the purpose of preventing reflux from the uterus (Figs. 313, 314). The ligament is now severed just below the forceps, the incision being carried close to the tissues of the tumor. If deemed necessary another ligature is now passed through the broad ligament farther down along the side of the cervix. This ligation and cutting are now repeated on the opposite side. The knife is then run lightly around the tumor an inch or two above the peritoneal reflection of the bladder in front, probably a little lower behind, and the severed edge of the peritoneum stripped down with the handle of the scalpel for the purpose of making peritoneal flaps. The next step is a most important one: it is the ligation of the uterine arteries. This is done in the broad ligaments, outside of, but close to, the cervix. Care must be taken to avoid the ureter on the one hand and the cervical tissue on the other. The ligature may either be placed within the folds of the severed ligaments, or, which is preferable, made to encircle the double fold of the ligament and artery in one sweep; action here will depend upon the size of the pedicle and the consequent separation of these folds. The constant traction which is made upon the pedicle by the assistant who is holding the tumor serves to draw out and elongate the cervix after the peritoneal covering has been incised, and thereby to permit deeper incision into the neck, which is next amputated with the knife by a wedge-shaped incision. The stump is now grasped with a small volsella forceps, and further trimmed and reduced, if necessary, so that the entire supravaginal portion is removed before it is dropped back into the pelvis. The cervix being now released, it immediately recedes, and by the retractive and elastic properties of the vagina is drawn deeply into the pelvis, where it is buried out of sight by the peritoneal flaps covering it. These flaps have been rendered so taut by the ligatures which have been placed that usually as the cervix recedes into the pelvis they close over it like elastic bands. The cervix is now in its natural position and without a ligature or suture in its tissues. The operation is finished by infolding the edges of the peritoneal flaps, which may be secured by Lembert sutures if necessary. I have not found this necessary if the ligatures which secured the uterine arteries had also grasped the severed folds of the broad ligaments, for this so tightens them that the sides are brought forcibly together when the cervix is drawn under. The bladder and surrounding tissues aid also in closing the pelvic cavity. Nothing whatever is done to the cervical canal. The portion of the broad ligament embraced in the first ligature is the same structure that forms the ordinary ovarian pedicle, minus the Fallopian tube. The other ligatures close the opened broad ligament, as a rule. If any other vessels are found spurting, they are of course ligated. I have not found it necessary to employ the temporary elastic ligature. The steps of the operation vary somewhat to suit the complications which may be present in the individual case, but the general direction and conclusion are practically the same in all cases."

Extra-peritoneal Treatment of the Stump.—This method should be selected only when great haste is demanded because of the patient's

condition. The same steps are followed as in the intra-peritoneal treatment of the stump to the point of amputating through the supravaginal portion of the cervix. After the broad ligaments have been ligated and cut from their attachment to the body of the uterus on either side, and the uterus and tumor delivered through the abdominal incision, a ligature or Koeberle's clamp is applied about the cervix immediately above the vesical fold of peritoneum. Transfixion-needles are placed at right angles just above the ligature, and the amputation is made about three-fourths of an inch above the needles. The parietal peritoneum is stitched to the stump, and the abdominal incision closed tightly about it. The pins rest upon the abdominal wall, pressure being avoided by rolls of sterilized gauze. The stump is covered with boric acid or iodoform powder, and the wound dressed with a sterilized absorbent dressing. If the clamp is used, it should be tightened each day as occasion demands.

Total Abdominal Hysterectomy.—The vagina is prepared as for a vaginal hysterectomy. If a rapid operation is demanded because of the condition of the patient, time will be gained by first proceeding, as in vaginal hysterectomy, by making an incision around the cervix at its junction with the vaginal mucous membrane, and ligating the broad ligaments as high as possible. The patient is then placed in the Trendelenburg position, the abdomen opened in the usual manner, the tumor delivered, and the broad ligaments ligated and incised. Thus the uterus, including the cervix, can be removed entire, and the vaginal opening closed by buried catgut sutures. The usual method is to open the cul-de-sac from above by making a free incision about the cervix at the internal os and stripping down the peritoneal covering with a blunt instrument till the cervix is freed from its attachments.

Drainage is rarely indicated, and when it is it should be made through the vagina by pieces of gauze. The vagina is packed with iodoform gauze previous to the operation. To avoid injury to the bladder, it is well to partly fill it with a mild sterilized solution. The opening from the vagina is either closed with catgut or the vagina is packed from above with iodoform gauze.

XI. UTERINE POLYPI.

Polypi of the cervix are either granular or fibroid, the latter being less common. They are usually single, but may be multiple; rarely do they attain any considerable size. The pedicle is constricted and long, oftentimes permitting the protrusion of the polypi through the external os. A catarrhal glandular endocervicitis is an almost universal accompaniment, and the secretion is at times offensive in odor and profuse. Spontaneous enucleation is not infrequent.

Polypi of the Uterus.—No sharp line of distinction can be drawn between submucous fibroids and fibroid polypi, the submucous fibroid often being transformed into a fibroid polypus by the contracting uterus forcing the tumor into its lumen—an attempt at spontaneous enucleation. The pedicle may be long enough to permit the tumor to protrude into the vagina.

Suppurative endometritis is a frequent complication, and chronic

metritis invariably exists. Thus the uterus is generally enlarged and its cavity deepened.

Symptoms.—These do not vary from those of chronic endometritis and metritis, save possibly in the severity and frequency of uterine hemorrhage and the profuse leukorrheal discharge. Uterine contractions (cramps), profuse leukorrhea, increased menstruation, weight and bearing-down sensation in the pelvis, and backache go to make up the clinical picture. The hemorrhage may be continuous and oozing, or profuse and alarming.

Treatment.—A polypus of the cervix when the pedicle is slender is best removed by torsion, followed by the usual treatment for endocervicitis. Where the base is broad it may be necessary to excise the growth and close the resulting wound with sutures.

Polypi of the uterus are also removed by torsion, followed by curettage and packing of the uterus with gauze, as advised for the treatment of endometritis. Where the growth is large it may be necessary to remove it piecemeal until the pedicle can be reached and excised.

XII. MALIGNANT DISEASES OF THE FEMALE GENITAL ORGANS.

Under malignant diseases will be classed sarcoma, epithelioma, and carcinoma, which may be primary or secondary degeneration of benign growths, notably fibroids.

External Genitals.—Malignant diseases of the external genitals are of rare occurrence. By far the most frequent is

Epithelioma, which develops as a small whitish or grayish nodule with uneven surface, painless and hard, located usually upon the inner surface of the labia majora. The progress of the disease is slow, and may not attract attention until the growth becomes stimulated by external irritation or by some unknown cause. The blood-supply to the growth is then increased; the tumor rapidly infiltrates neighboring structures, and there is formed an ulcer which spreads slowly but surely, with an advancing margin which is hard, raised, and of a bluish color. The induration advances rapidly, a disagreeable fetid odor arises from an ichorous purulent secretion, and the ulcer steadily advances more and more rapidly along the mucous surface of the labium. Through the irritating influence of the secretions papillary excrescences often spring from the margin and bed of the ulcer, and at times assume enormous proportions. The tendency of the ulcer and indurated margin is to extend inward, involving the labia minora and clitoris, then the vaginal wall; rarely does it spread over the skin-surface. Externally, late in the process, the destruction may extend to the perineum and inner side of the thigh. The inguinal glands become involved after ulceration has fully developed; they may break down into a caseous mass, or, becoming secondarily infected with pus-organisms, an abscess develops which discharges externally. Pruritus is of almost constant occurrence, and is thought by some authorities to be a cause and not an effect of epithelioma. When ulceration begins, pain is experienced, increasing in intensity proportionate to the size of the ulceration. Cachexia develops, but not to so marked a degree as in carcinoma. The patient gradually loses flesh,

the secretion becomes very offensive, hemorrhage is infrequent, and death will occur in about two years after ulceration begins, though the primary nodule may exist for years and even escape notice.

Treatment consists in immediate and free excision of the growth, including the neighboring tissue. Where the ulceration has advanced beyond control the treatment resolves itself into palliative measures; the surface is kept clean by frequent washing with antiseptic solutions and the application of absorbent sterilized dressings.

Sarcoma of the external genitals is exceedingly rare, and is usually located in the labia majora, starting as a hard nodule beneath the mucous surface and rapidly spreading to the skin. Ulceration soon takes place, and an abundant secretion is discharged from a deep, ragged ulcer. The further progress is rapid and of short duration; all the symptoms of epithelioma are exaggerated; the pain is severe, the leukorrhea profuse and very offensive; hemorrhage may even threaten life and emaciation and cachexia are soon followed by death. The inguinal lymphatics are early involved, and metastatic growths develop in distant parts of the body.

Treatment.—Early and free excision. When seen late in the development of the disease only palliative measures may be of service.

Sarcoma of the uterus may be primary or secondary; when secondary it is usually a malignant degeneration of fibroids or fibromyxomatous tumors.

The most usual form is that of fibro-sarcoma. This resembles in gross structure and location the various forms of uterine fibroids—that is, the submucous, interstitial, and subperitoneal varieties. Histologically, it is either the round- or spindle-celled variety, the former being the most frequent. Rarely do the sarcoma-cells infiltrate the uterine tissue in a diffused manner. The cervix is seldom involved, as in carcinoma. The submucous tumors form polypoid excrescences, are usually of the round-cell variety, and to the naked eye give the appearance of brain-tissue. The surrounding structures are rapidly invaded, and adhesions form which bind the uterus to the abdominal wall.

Etiology.—Nulliparæ are specially predisposed, and the menopause seems to be the selected time, though sarcomata have been known to occur prior to puberty.

Myo-fibromata are prone to degenerate into sarcomata.

Symptoms.—The first symptom to be noticed in the majority of cases is menorrhagia, and later metrorrhagia. Pain when present is due either to the contraction of the uterus in the attempt to expel the tumor, and hence simulates labor-pains, or is due to the pressure of the growth upon neighboring nerves and muscles, causing pain radiating down the thigh and painful contractions of the psoas and iliacus muscles. A watery discharge, which later assumes a disagreeable odor, is a frequent event. The body of the uterus is increased in size and the cavity increased in depth. In the submucous variety the cervix may be patulous to the examining finger, and the tumor may be palpated as a soft, projecting mass. Sometimes the growth protrudes through the cervical canal into the vagina, and in some instances spontaneous expulsion has occurred. Sloughing of the tumor, accompanied by a disagreeable odor, occurs late in the submucous, and

less frequently in the subserous, variety. The effect upon the general health is pronounced and rapid; there is a rapidly-developed cachexia; loss of strength and flesh is marked in a short time, and death occurs from septicemia, peritonitis, exhaustion, or metastasis. Metastatic growths first occur in the lymphatics and surrounding pelvic tissue; later, in the lung and liver.

Diagnosis.—The diagnosis can only be made by the aid of the microscope, but the rapidity of the growth, the rapid and pronounced effect upon the general health, the occurrence of the menopause, the occurrence of hemorrhage after menstruation has long ceased, the intense pain and foul watery discharge, the presence of a fibroid tumor, which after existing for a long time with no great discomfort suddenly begins to grow rapidly and to bleed, and, lastly, the soft sensation upon palpating the growth, are characteristics which point to sarcoma.

Fungous endometritis may simulate sarcoma, but this condition is rarely found after the menopause. There is no pain, no increase in size of the uterus, no watery foul discharge, no cachexia and loss of flesh; the os is not patulous, and no soft circumscribed growth can be palpated. The microscopic examination of the product of curettement will settle the diagnosis, though repeated examinations may be necessary.

Uterine fibroids may at times grow rapidly, and the question of their benign or malignant character may arise. In uterine fibroids the growth is never so rapid, the effect upon the general health is not as great. They seldom increase in size after the menopause. They are seldom associated with a watery discharge, metastatic growths never occur, and the tumor never returns after complete removal. The microscope will relieve all doubt.

Carcinoma is differentiated from sarcoma by the microscope. It is possible to remove the entire growth with more certainty in sarcoma than in carcinoma, because the lymphatics are late to be involved. The tumor is early recognized as compared with sarcoma.

Treatment.—Operative.—Total hysterectomy when the surrounding tissue is not involved.

Palliative.—Where it is impossible to remove the entire growth palliative measures must be adopted. These consist in relieving pain with opiates, controlling hemorrhage by curettage, followed by cauterizing with the Paquelin thermo-cautery or with chromic acid, zinc chlorid, or nitric acid, and correcting the disagreeable odor with disinfectant and deodorizing solutions. Supporting treatment must be given and the bowels regulated. Opiates for the relief of pain should not be withheld.

Carcinoma of the Cervix.—*Etiology.*—Carcinoma of the cervix occurs most frequently between the ages of thirty and fifty. Multiparæ are more susceptible than primiparæ. Lacerations of the cervix with everted, eroded lips are fruitful sources for the development of carcinoma of the cervix; coition and locomotion, causing irritation of such surfaces, are exciting causes.

Catarrhal inflammation is an undoubted predisposing cause, particularly when associated with erosions and excoriations. It has long been observed that carcinoma selects the site where two kinds of epithelial

cells meet, as in the rectum, the lips, and external os of the cervix. It is found more frequently in the white race than in the negro, and in the lower more often than in the upper classes of society. Heredity plays an important part in the causation. Carcinoma of the cervix is found as a cauliflower growth springing from the vaginal portion of the cervix and protruding into the vagina. Nodular growths may spring from the cervical mucous membrane, and finally ulcerate and invade the surrounding structures. Superficial infiltration, rapidly followed by extending ulceration, progressively involving adjacent tissues, is one of the earliest of the recognized forms of carcinoma of the cervix.

Symptoms.—Hemorrhage is the most prominent symptom, and, as a rule, it first directs the patient's attention to her condition. If occurring before the menopause, the menstrual flow is increased, and later hemorrhage occurs in the intervals between menstrual periods. Hemorrhage occurs earliest in the superficial ulcerative type. It may be so severe as to be dangerous, and anemia may develop to an alarming degree. When ulceration has developed the discharge acquires a sickening odor and is of a dark color. Pain may not be experienced until the growth is beyond operative interference. It is the result of the involvement of the pelvic connective tissue, and is directly proportionate to the extent of the infiltration and area of ulceration. The pain is lancinating or burning, and, infrequently, colicky. Where the neighboring organs become invaded numerous symptoms arise which are referable to the region involved. Chronic peritonitis develops and gives rise to the drawing, sharp, shooting pains occasioned by the presence of adhesions. Vesical tenesmus and dysuria are occasioned by the invasion of the bladder. The ureters may become occluded, giving rise to hydronephrosis. When ulceration ensues vesico-vaginal fistula may be developed. When the rectum becomes involved there are rectal tenesmus, bloody, offensive stools, possibly stricture, and late in the process recto-vaginal fistula from ulceration.

The effect upon the general health is characteristic: cachexia, rapid loss of flesh and strength, constipation alternating with diarrhea, later constant diarrhea, and, lastly, uremic symptoms from partial or complete closure of one or both ureters, give the familiar clinical picture. Death occurs from uremia and from exhaustion brought on by the repeated hemorrhages, vomiting, loss of appetite, diarrhea, profuse and foul-smelling discharge, and the severe pain. Peritonitis may be the cause of death.

Where a fibroid is gangrenous and sloughing the fetid discharge, frequent hemorrhages, general emaciation, and cachexia, all point to the existence of a carcinoma. The os externum is tightly stretched so as to form a thin diaphragm; the examining finger is introduced between it and the sloughing mass.

The *diagnosis* should always be made by the aid of the microscope. The nodular variety may be distinguished from fibroids by the more rapid growth, softer consistency, healthy surrounding tissue, and on cross-section the growth is soft like marrow, while the fibroid cuts with considerable resistance. The mucous membrane is not as adherent to the fibroid as to the carcinoma. The microscopic examination will be conclusive.

Catarrhal inflammation may be roughly distinguished from the superficial ulcerative form by its resisting the examining finger, while carcinoma readily breaks down. The absence of ulceration speaks strongly against carcinoma, and the presence of numerous distended follicles with a discharge of pure mucus is characteristic of catarrhal inflammation.

In the early development the microscope alone will decide; when ulceration has advanced to an extreme degree, no trouble will be experienced in making a diagnosis.

Where we are forced to wait, the subsequent course of the disease will usually make the case clear. Where the papillomata present a polypoid form they may be confused with benign polypi, in which case the cancerous nodules may be seen and felt, but the diagnosis must rest with the microscope.

The extent to which the tissues are invaded is a most important question to decide. Vagino-abdominal and rectal examination, with traction upon the cervix, will usually bring the indurated mass within reach of the examining finger.

The average *duration* of the disease is difficult to estimate, because the growth is rarely recognized till late in its development. The probable duration is one year and a half to two years. Only when confined to the cervix is there hope of permanent removal of the growth.

Treatment.—Palliative treatment must be resorted to when total extirpation of the infected tissue cannot be accomplished, and is to be directed to relieving distressing symptoms. Unfortunately, the large majority of cases which are observed by the surgeon for the first time are beyond the possibility of a radical operation. The onset is so insidious that the broad ligaments and pelvic connective tissue are usually involved before the patient is warned of her danger. Occurring at the time when menstrual disorders are not unexpected, no alarm arises at the appearance of hemorrhage, and not until the discharge becomes profuse and offensive does the patient seek medical aid. In these hopeless cases the treatment is to be directed toward the control of the hemorrhage, altering the offensive discharge, affording relief from pain, and in all possible ways rendering the patient more comfortable.

The hemorrhage is best controlled by the use of the curette, followed by the Paquelin cautery and tamponing the vagina with iodoform gauze. By this method, together with hot vaginal douches, life may be prolonged and the hemorrhage controlled for many months. A number of chemicals are used for the same purpose, but with less beneficial effect. Of these may be simply mentioned Monsel's solution, chlorid of zinc, nitric acid, and chromic acid. Where the hemorrhage threatens life it may be controlled by hot vaginal douches and by tamponing the vagina with iodoform gauze.

The fetid discharge is best altered by douches of permanganate of potash and hydrogen peroxid. The patient's strength should be supported by the use of tonics, the bowels should be regulated, and pain must be controlled by opiates.

Radical treatment rarely stops short of total hysterectomy. When seen very early it may be possible to eradicate the growth by amputating the cervix, although it is doubtful if one can ever be assured

that the invasion has not gone beyond the point of excision. Even a partial amputation of the cervix is advised.

The operation is as follows: The vagina is prepared as in vaginal hysterectomy. By perineal and side retractors the cervix is brought into view and is firmly grasped by double volsellum forceps. By forcible traction upon the cervix the uterus is brought well down; a circular incision is made completely around the cervix at a point well above the carcinomatous growth; the cervix is amputated at this point by extending the incision into the cervical canal. The hemorrhage may be controlled by passing two or more sutures before the cervix is completely severed. The ends of these sutures are left long, so that traction may be made upon them after the cervix is removed; the vaginal and cervical mucous membrane are next coapted by interrupted catgut sutures.

Schröder's supravaginal amputation should be selected where vaginal hysterectomy is not attempted. The technique, as described in *The American Text-Book of Gynecology*, is as follows:

"The vagina, vaginal portion, and external genitals are cleansed by scrubbing with a solution of soft soap and washing in ether, alcohol, and bichlorid-of-mercury solution 1 : 2000. The instruments required are to be sterilized by boiling them for ten minutes or longer in soda solution, and are then placed upon a table at a convenient distance from the operator in the tray in which they have been boiled. The buttocks, thighs, and mons veneris are guarded by a broad strip of antiseptic gauze having a slit corresponding to the vulvar orifice. The cervix is exposed by a perineal retractor and the labia held apart by assistants. The cervix is then seized in the grasp of a double tenaculum or volsellum forceps and traction applied, the womb being drawn down as far as the elasticity of the uterine ligaments will permit. A circular incision is made from one-half to one centimeter beyond the margin of the diseased vaginal mucous membrane. There may be considerable hemorrhage from the divided vaginal arteries which will require the application of hemostats and ligatures. After the hemorrhage has been controlled it is easy with the finger to separate the cervix from the tissues front and back, traction being made upon the cervix all the while. The connective tissue here contains no large vessels and is easily separated. The cervix is then drawn strongly to one side, rendering tense the parametric connective tissue on the opposite side, which contains the uterine vessels. This tense tissue, being easily recognized by the touch, is surrounded by a ligature, as in the operation for total extirpation. The maneuver is best carried out by a half-blunt staphylorrhaphy or aneurysm needle. After tightly tying the ligature the included tissue is divided with scissors between the ligature and the cervix. This ligation should include the uterine artery. A ligature is similarly placed on the opposite side, and the tissues divided between it and the cervix. Frequently the tightly-stretched sacro-uterine ligaments interfere with the drawing down of the uterus. They may be included in a ligature and severed, when the uterus will readily descend. The ligatures should be applied as far from the cervix laterally as possible, so that the division of the tissues does not occur close to the cervix. The cervix is now transversely separated from the body

of the uterus anteriorly as far as the cervical canal, and a stitch passed through the vaginal wall, the connective tissue, and the divided cervical wall and brought out in the cervical canal. This, being tightly tied, provides the means for safely holding down the stump after complete separation of the cervix. Should there be any hemorrhage at this stage, it may be controlled by several similar sutures. The posterior wall of the cervix is now cut through, and sutures passed as before around its circumference, uniting the mucous membrane of the vagina to that of the womb. As the upper end of the opened vaginal tube is much larger than that of the womb, the vaginal mucous membrane is thrown into folds by the sutures. On either side are openings in which the ligature strands lie; these require each a stitch to effect closure. If the ligatures include the uterine vessels and are tightly tied, there should be very little bleeding in this operation. The lower segment of the womb may be removed by this method if desired. Douglas's cul-de-sac is frequently opened; the author has opened it several times, but this misadventure did not increase the danger of the operation. The wound in Douglas's pouch should be immediately closed by a continued suture of fine silk or catgut. The vagina is to be carefully cleansed with boiled water and tamponed with iodoform gauze. The tampons are removed and renewed, and the vagina douched at intervals of twenty-four hours. In from five to eight days the tampons may be discontinued, but the daily douches are persisted in. On the tenth or twelfth day the patient may leave her bed. The early removal of the stitches is a matter of no importance, and the longer they remain the easier is their removal. Usually they are removed on the eighth day. If catgut be used throughout, there is no need of paying any attention to them whatever, as the loop is absorbed and the knot then falls off."

Carcinoma of the Body of the Uterus.—Cancer of the body of the uterus presents itself either in the form of a diffuse infiltration or as polypoid excrescences. The origin in either case is the endometrium. Necrosis follows upon infiltration, surrounding structures become involved, particularly the rectum, bladder, and peritoneum, adhesions about the uterus are formed, and metastasis involves the distant organs and tissues.

Symptoms.—A watery, fetid, and blood-tinged secretion is the characteristic symptom, though the blood and the odor are not constant.

Pain is not a constant, but is a characteristic, symptom. It is referable to the uterine contractions in their effort to expel the contents of the uterus, and hence are of a colicky nature, or to the peritoneum, where a chronic peritonitis is set up, giving rise to the sharp, lancinating pains. The pains may recur at certain intervals and at certain hours. In this respect they are characteristic. Bimanual palpation will reveal a uterus more or less enlarged, possibly adherent, and tender to the touch. If the os is patulous or dilated, carcinomatous nodules and infiltration may be detected by the examining finger.

The general effect upon the health is often not pronounced until late in the course of the disease.

Diagnosis.—When hemorrhages recur frequently after the menopause, and the usual causes, such as polypi, are excluded, and when the discharge becomes fetid, it is highly suspicious of carcinoma. Little

doubt can remain if the body of the uterus is found enlarged, adherent, and nodular growths are felt on its surfaces. The uterine sound will aid in detecting the sloughing, irregular surface. A positive diagnosis is made by examining the product of curettement by the microscope.

Treatment.—Operative treatment can only be undertaken when the infiltration has not advanced beyond the uterine tissues. Nothing short of a total extirpation will suffice, either by the abdominal or vaginal route. Statistics show that hysterectomy done for carcinoma of the uterus is successful as to immediate and remote results in 33 to 50 per cent. of cases—a showing far superior to that of carcinoma in any other portion of the body. Hence the injunction is imperative to operate at the earliest possible moment before surrounding structures are involved, and in all cases to remove the entire uterus, tubes, and ovaries. Where the size of the uterus will permit the vaginal route should be selected, and only in the rare cases where the body of the uterus is too large to be removed through the vagina should the abdominal route be selected.

Technique of Vaginal Hysterectomy.—Many American gynecologists prefer to secure the broad ligament by clamps because of the ease and rapidity with which it is done. The use of clamps is open to a number of serious objections: 1. The danger of clamping a ureter; 2. Serious hemorrhage from slipping of the clamps; 3. Pressure of the forceps upon the bladder and rectum; 4. Interference with the operative procedures by crowding the space; 5. Preventing the closure of the peritoneal cavity, and thus permitting adhesions of the gut to the raw surface and free access of infection to the peritoneal cavity.

The preparatory treatment consists in evacuating the bowels and sterilizing the field of operation in the usual manner.

Where the cervix is completely degenerated, so that traction cannot be made with forceps, the mass is curetted or dissected away with scissors, the vaginal mucous membrane grasped with volsellum forceps immediately in front of the cervix and incised at a safe distance. The bladder is then carefully dissected up till a sufficient portion of the cervix is exposed to afford a firm grasp with the forceps. The cul-de-sac of Douglas is then incised and the peritoneal fold stitched to the vaginal mucous membrane. With the index finger as a guide, a ligature on a staff is passed through the base of the broad ligament on either side, the ligature including the uterine artery (Fig. 315). The ligated portion of the broad ligament is severed and the uterus drawn farther into the vagina. The bladder is readily stripped from the uterus, and the anterior cut margin of the vagina is stitched to the vesico-uterine fold of the peritoneum by a continuous catgut suture. The broad ligament is then ligated in section, step by step, on either side until the uterus is free (Fig. 316). The tubes and ovaries are to be removed together with the uterus. Each ligature is passed through the anterior vaginal mucous membrane for the purpose of preventing slipping of the ligatures and to bring the stumps of the broad ligament outside the peritoneal cavity. Finally a ligature is passed through all the stumps of the broad ligament and out through the anterior vaginal mucous membrane; next the opening in the vagina is closed with sutures and packed with iodoform gauze. The above technique is essentially that advised by Herman J. Boldt.

In place of ligatures, clamps may be used in dealing with the broad ligaments. The steps of the operation are the same, except the base

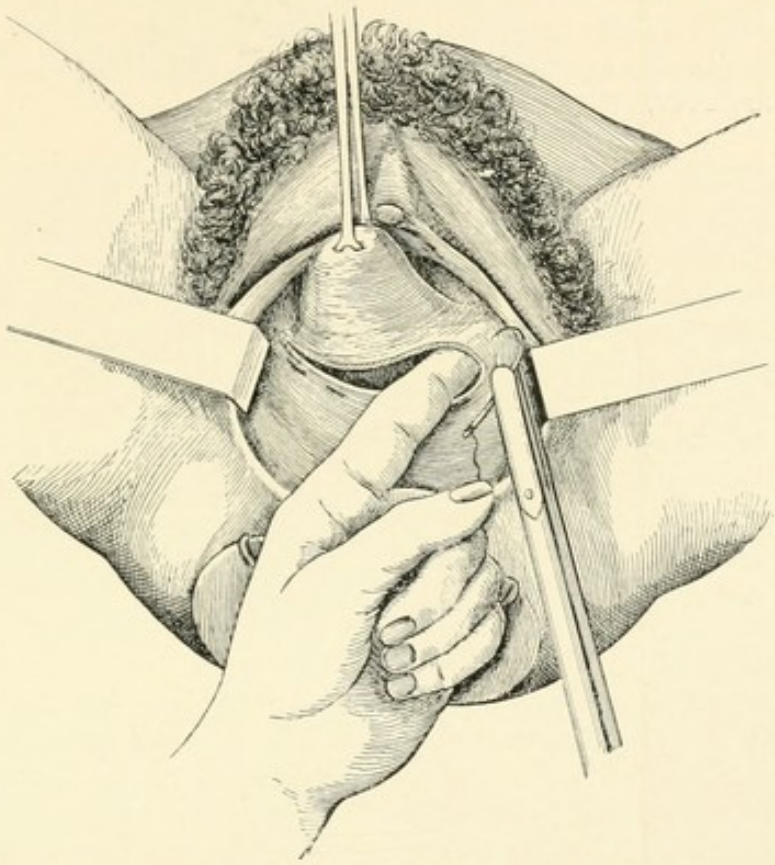


FIG. 315.—Vaginal hysterectomy: opening the posterior cul-de-sac, and suturing the peritoneum and the mucous membrane together to control bleeding (Martin).

of the broad ligament is clamped on either side and the ligament cut inside the clamp. The uterus is then drawn down and a second clamp

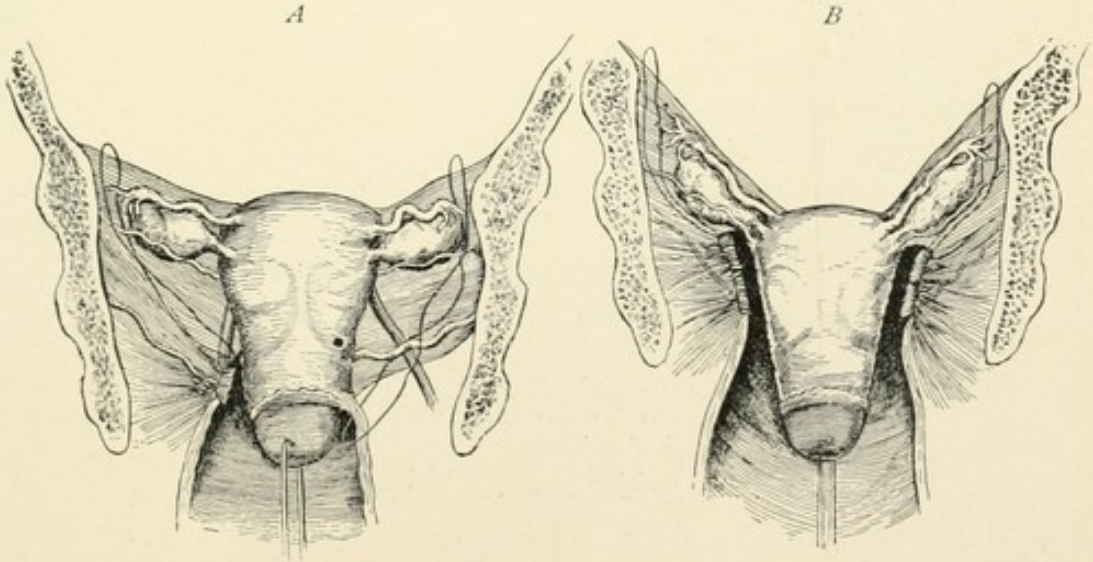


FIG. 316.—Vaginal hysterectomy with the ligature: *A*, first step; *B*, second step (Baldy).

placed higher up, and a third which includes the remaining portion of the ligament. The uterus is removed, the handles of the clamps are

securely tied with silk to prevent slipping, and the vagina is packed with iodoform gauze. In twenty-four to forty-eight hours the clamps are removed and the openings again loosely packed. This method is not only reliable, but rapid, and where there is much pelvic induration, involving the broad ligaments, it may be impossible to ligate. Convalescence, however, is more protracted.

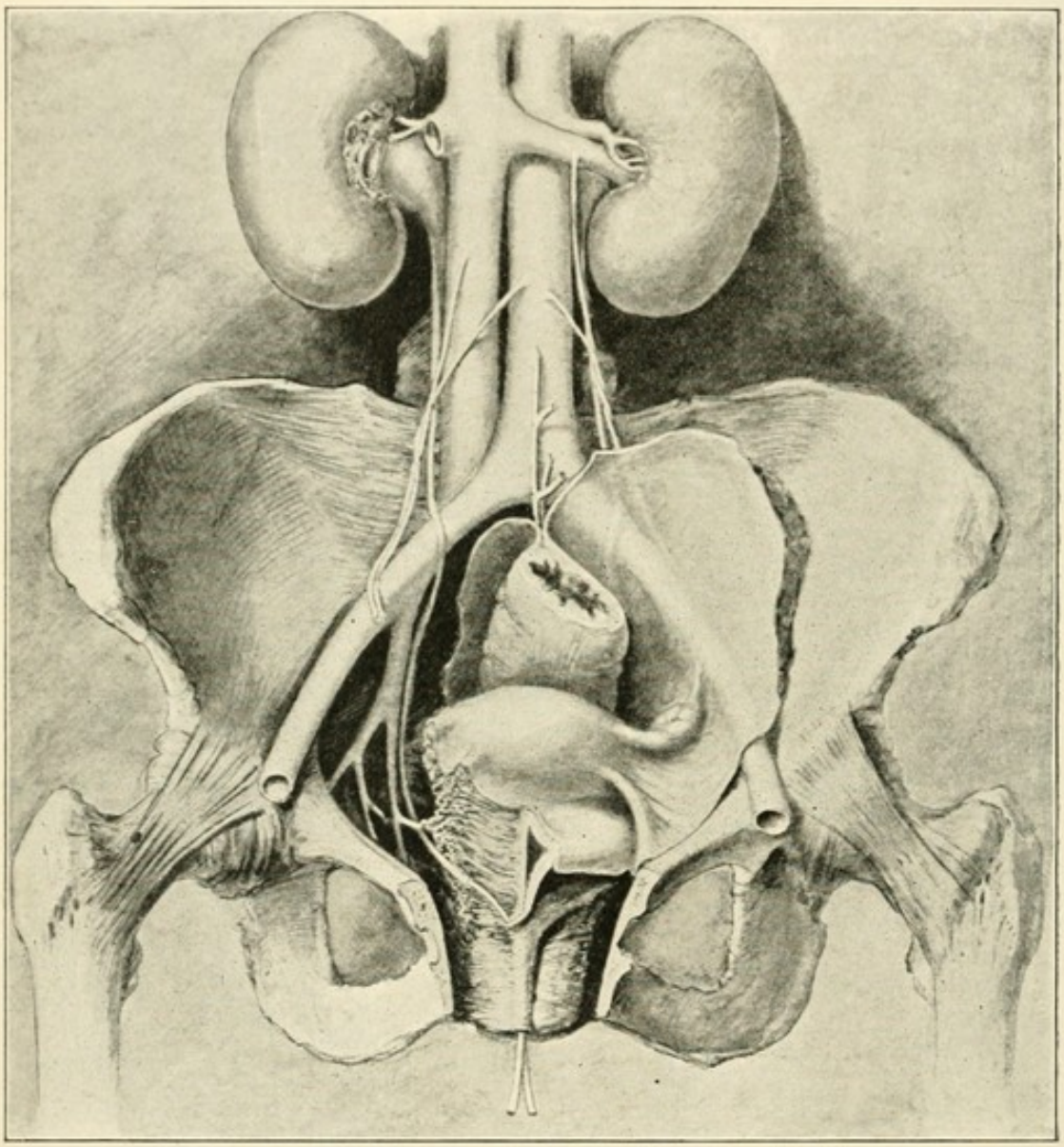


FIG. 317.—Hysterectomy for cancer of the uterus (Clark).

Abdominal Hysterectomy with Removal of a Considerable Portion of the Broad Ligament.—Dr. J. G. Clark of Baltimore suggests a method of extirpating the uterus and a great part of the broad ligament without injury to the ureters. Under cocain anesthesia he first passes bougies into the ureters, causing them to bulge out like thick cords, as seen in Fig. 317. The patient is then anesthetized and a free abdominal incision made. Next the upper portions of the broad ligaments, with the ovarian ligaments, are ligated. The bladder is separated, the uterine arteries exposed and dissected out an inch beyond the vaginal branches,

and here they are tied. The next step is to dissect the ureters free, and to tie the remainder of the broad ligament at a point close to the iliac

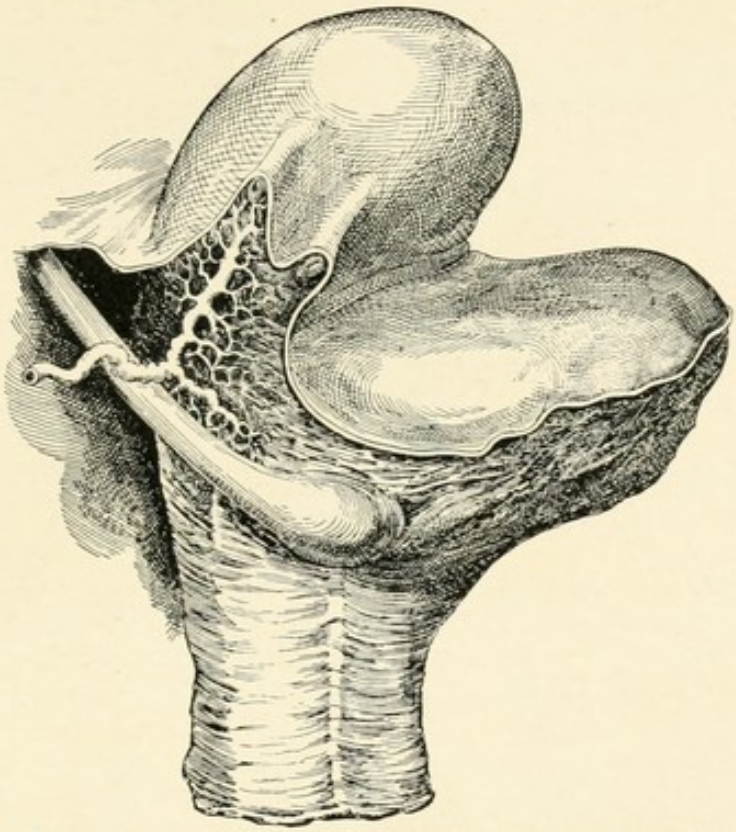


FIG. 318.—Hysterectomy for cancer of the uterus (Clark).

vessels; it is then divided at its pelvic attachment well below the cancerous area. The vagina is perforated with scissors, tied in seg-

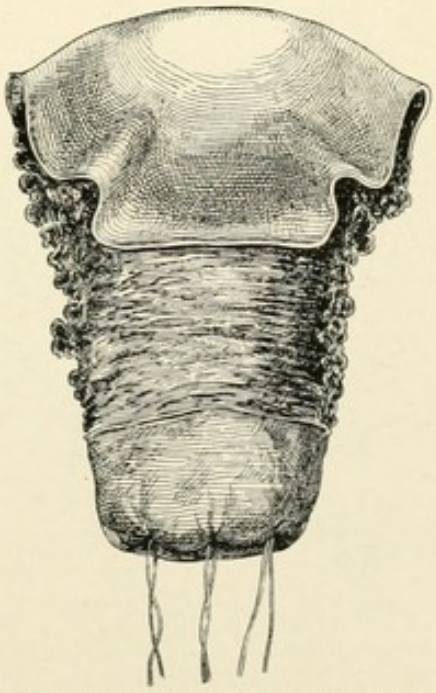


FIG. 319.—The uterus after vaginal hysterectomy (Clark).

ments, and divided. A strip of gauze is passed down into the vagina, and the peritoneal flaps are sutured over the raw surface The pelvic

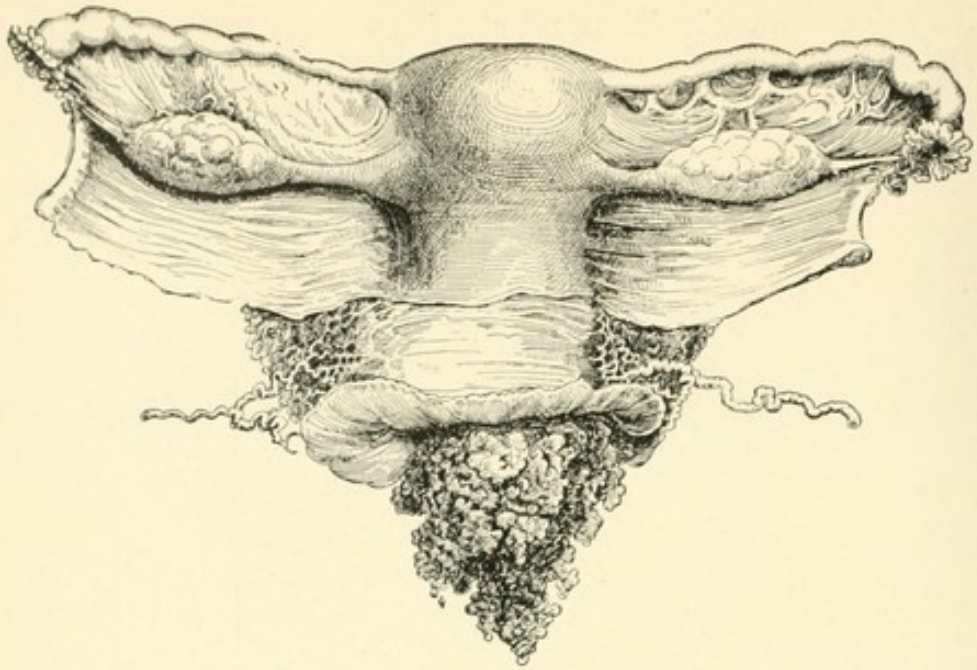


FIG. 320.—Uterus, broad ligaments, and part of vagina removed *en masse* (Clark).

cavity is irrigated and the abdominal cavity closed without drainage. Fig. 318 shows the peritoneum dissected off, affording a lateral view

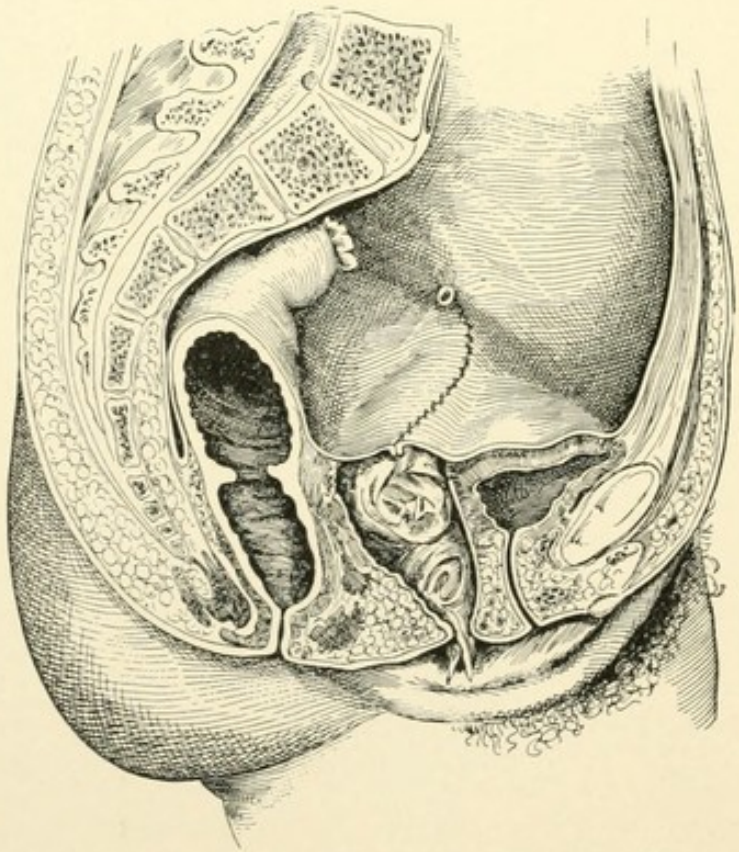


FIG. 321.—Hysterectomy for cancer of the uterus (Clark).

of the uterus and bladder, with their relations to the uterine artery and ureter, and the latter vessels to each other. In Fig. 319 is shown the condition of the uterus after vaginal hysterectomy. No part of the broad

ligaments or vagina is excised with the uterus. The advantages of Clark's method are shown in Fig. 320, which represents the uterine artery dissected out before the broad ligaments were freed from their pelvic attachments. Observe that the greater part of the broad ligament and a considerable cuff of the vagina have been excised with the uterus *en masse*. Fig. 321 represents the operation as completed. The space left by the removal of the uterus is filled with gauze from above, after which the vesical and rectal peritoneum are closed with a continuous suture.[1]

XIII. NEW GROWTHS OF THE TUBES, OVARIES, AND BROAD LIGAMENTS.

New growths of the tubes are of very infrequent occurrence, and rarely attain any considerable size. As with all new growths, these neoplasms are classed as benign and malignant.

Benign tumors are, in order of their frequency, adenomata, fibro-myomata, cysts, and lipomata.

Adenomata spring from the glandular structures of the tube, and form a papillomatous mass which occludes the lumen of the tubes. Histologically, they are composed of true gland-structures.

Fibro-myomata are usually subserous and sessile or pedunculated. They never attain any considerable size. They are identical with the fibromata of the uterus, though with a predominance of muscle-fibers.

Cysts.—These are either subserous or interstitial, never grow beyond the size of a hen's egg, and are usually much smaller.

Lipomata are subserous and have been found in rare instances.

Malignant Growths.—*Carcinomata.*—Cancer of the tube may be primary or secondary, either from metastasis or direct extension from the endometrium; less frequently, indeed almost never, from the ovary.

Medullary carcinomata have been described, but the usual form is epithelioma, similar to that of the endometrium.

Sarcomata.—The sarcomata may be primary, but in almost every instance are secondary, and rarely composed of sarcomatous cells alone, the usual form being a fibro-sarcoma and myxo-sarcoma.

The symptoms do not suffice to make a diagnosis, and nothing but an exploratory incision will reveal the condition.

Benign growths are harmless, with the exception of adenomata. The malignant growths are almost invariably fatal, because, as a rule, they denote the extension of the growth from the uterus to the surrounding structures.

Treatment.—There is no indication for the removal of benign growths. Malignant growths, together with the uterus, should be extirpated, provided the infiltration is limited.

New Growths of the Ovaries.—**Benign.**—*Fibromata* are of infrequent occurrence, and still more rarely exist without more or less muscle-fibers. In gross and minute appearances they are identical with the subserous fibromata of the uterus, and may attain enormous proportions. They are sharply circumscribed, smooth, and lobulated.

[1] *Johns Hopkins Hospital Bulletin*, cited in *Annual of the Medical Sciences*, 1896.

The secondary degenerations are myxomatous, calcareous, fatty, and cystic. At any stage of their development sarcomatous tissue may appear. The tumor may suppurate or become gangrenous, and hemorrhages may occur in the substance of the growth. Fibro-cystic tumors develop from the distention of the lymph-channels by a clear lymph fluid, which may be tinged with blood or become purulent from secondary infection with pyogenic organisms.

Malignant tumors of the ovary are, in point of frequency—

(*a*) *Sarcomata*, which are relatively frequent in childhood, and are of the spindle-cell variety, though the small round-cell sarcoma is occasionally seen. Rarely is the growth composed of sarcomatous cells alone, the usual combination being fibro-sarcoma. The medullary sarcoma may be confused with carcinoma and require a microscopic examination. The degenerative changes are fatty, hemorrhagic, cystic, and calcareous. The growth may attain the size of a fully-developed fetal head, and is peculiar in frequently appearing simultaneously in both ovaries. This fact, together with the age, which is usually early womanhood, the effect upon the general system, and the rapidity of the growth, will suffice to make the diagnosis highly probable.

(*b*) *Carcinomata* may be primary or secondary, either by direct extension from the uterus and tubes or as a metastatic growth from the breast or elsewhere. Cystic tumors of the ovary are prone to become cancerous. They appear in both ovaries less frequently than do sarcomata. The usual form is the medullary, which must be differentiated from sarcomata by the microscope. As a rule, they appear later in life than sarcomata. The usual forms of degeneration are fatty, cystic, myxomatous, and colloid. Extension to neighboring structures occurs early, and metastasis rapidly takes place; conversely, cancer of the breast may result in metastatic deposits in the ovary; less frequently the disease comes from other portions of the body.

Ovarian Cysts.—Cysts of the ovary are usually classed as unilocular, multilocular, and dermoid (Fig. 322). The unilocular cysts are in reality simple retention-cysts formed by the distention of the Graafian follicle with a clear serous fluid. Rarely do they exceed in size a walnut, rarely do they assume a size sufficient to indicate surgical interference, and the rupture of their contents into the peritoneal cavity is harmless.

Multilocular cysts are varied in their composition, and possibly in their origin, though their exact mode of formation is still under debate. Probably the simpler varieties arise as the result of an oöphoritis; the follicles, becoming more and more distended with fluid, and the walls, becoming thinned from pressure-atrophy, finally give way, and two or more follicles are combined to form a large one. In this manner the ovary assumes the size of an orange, rarely as large as an adult head, and is composed of numerous spaces distended with fluid. The more complex cysts probably arise in the same manner, differing only in the additional involvement of the connective-tissue framework and gland-tissue. The gland-tissue proliferates as does the interstitial tissue; in this manner papillary and adenomatous excrescences project into the cyst-cavities, forming great cauliflower growths. Many authors emphasize the importance of a microscopic examination of the cyst-con-

tents—the elements being a few blood- and pus-cells, cholesterin plates, degenerate epithelium, and the "ovarian granular cells" of Drysdale, which are not pathognomonic of ovarian cysts, but in reality are epithelium which has undergone partial fatty degeneration.

Papillomatous cysts rarely attain any considerable size. Without entering into a discussion of their origin and pathology, suffice it to say they present the same external appearance as the former cysts, unless the cyst-wall has been penetrated by the papillomatous growths. Within the cyst-wall are numerous dendritic growths varying in size

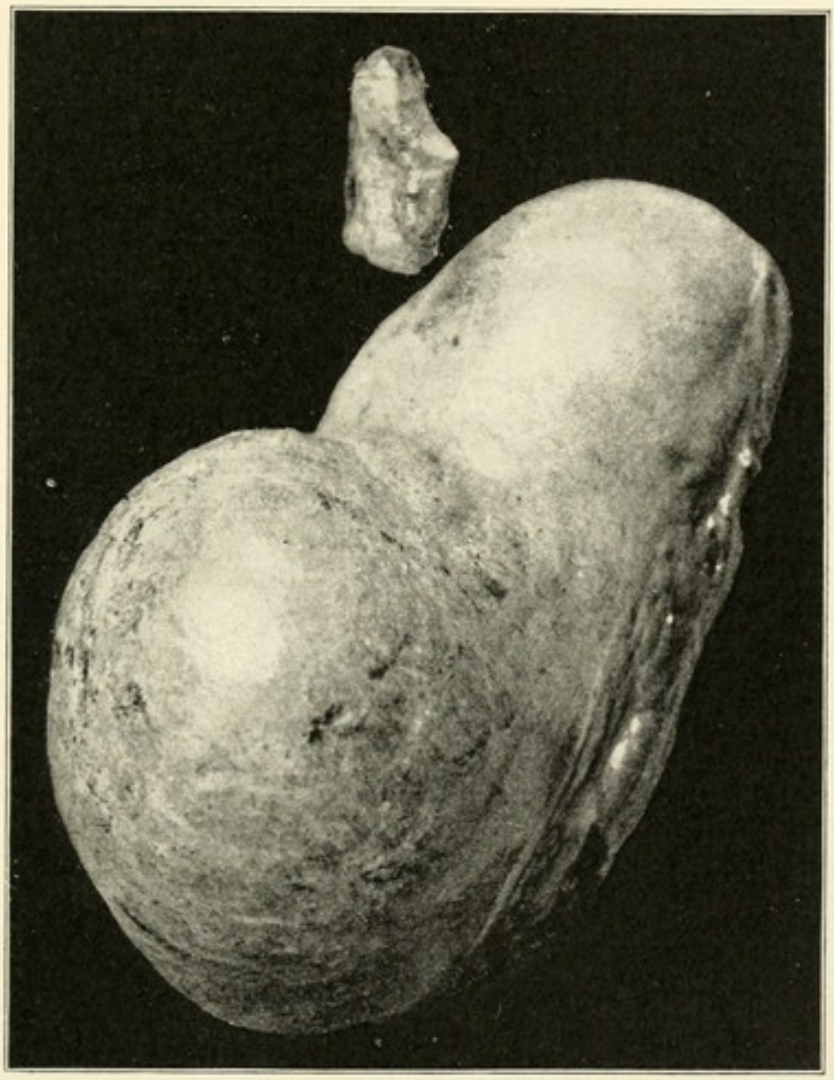


FIG. 322.—Multilocular cyst (from a photograph in the collection of Dr. Andrews, Mankato, Minn.).

up to that of an orange; the fluid within the cysts is clear and watery, varying but little from that of the simple ovarian cysts. These growths are prone to cancerous degeneration—a clinical fact so often observed as to suggest the probability of all being malignant: this is not borne out by pathological investigation.

Tubo-ovarian cysts probably arise from the catarrhal salpingitis resulting in adhesions of the fimbriated extremity of the tube to the ovary; the tube fills with fluid; the wall between a distended Graafian follicle and the lumen of the tube gives way, and the two are simul-

taneously distended. The cyst is characteristic in shape; the tube broadens toward the fimbriated extremity and ends in a bulbous sac. It is rarely large, yet has been known to contain as much as a quart of fluid. It is usually bilateral.

Dermoid Cysts.—According to Johnstone, dermoid cysts arise from the Graafian follicle through the faulty development of the ovum. They occur at all ages from infancy to adolescence; many attain the size of an adult head. They are usually unilateral; their development is slow, and oftentimes they cease to grow for a long period of time.

Ovarian cysts in the infant are almost invariably dermoid. In three-fourths of the cases they are unilateral. Adhesions bind them to adjacent structures and degenerative changes are of frequent occurrence. The external wall of the cyst is of darker color than the simple ovarian cysts, and yellowish patches of fat are seen here and there through the cyst-wall. The contents consist of hair, teeth, bones, cartilage, nerve, muscle, and nails; even well-formed organs, such as the mammæ, are occasionally found. The contents of the cysts vary from an oily liquid to a thick caseous substance; they are always unilocular.

Symptoms of Ovarian Tumors.—Ovarian tumors may attain a considerable size before the attention of the patient is attracted to their growth.

Pain in the region of the ovary occurs in a limited number of cases, and is in no way directly proportionate to the size of the growth, being more the result of the accompanying peritonitis. Associated with ovarian tumors there is usually endometritis; hence menorrhagia is an almost constant symptom. Amenorrhea is not frequent, and points to the existence of a tumor in each ovary when occurring early in the development of the condition. Later it follows as the result of exhaustion and depletion. Sterility is due to the involvement of both ovaries or to some complication, as endometritis: pregnancy not infrequently complicates ovarian tumors. Pressure-symptoms soon develop if the growth remains in the pelvis, but if it rises in the abdomen the growth may assume immense proportions before causing discomfort. These pressure-symptoms are constipation, tenesmus, frequent urination, dysuria, pain in the regions supplied by the sacral and sciatic nerves, backache, heavy sensation in the pelvis, edema of the vulva and lower extremities, and hemorrhoids. When the tumor has ascended into the abdominal cavity and developed to an enormous size the distress from pressure and weight is pitiful.

Dyspnea becomes extreme; the stomach is unable to retain food; the heart's action is embarrassed; jaundice may supervene from pressure upon the bile-ducts; the skin becomes dry; emaciation becomes extreme, and the urine scanty and high-colored. Death from exhaustion ends the patient's suffering unless some complication supervenes.

Diagnosis of Ovarian Tumors.—A small cyst is frequently discovered by bimanual examination when no suspicion of its existence had been entertained. It will be recognized as a smooth, globular, elastic, movable tumor, lying to one side or behind, very rarely in front of, the uterus. If lying between the layers of the broad ligament, the growth will be more fixed. In all cases it can be outlined

separately from the uterus. When the cyst has grown to the size of a fetal head fluctuation is elicited, providing the contents are fluid. If gelatinous, the peculiar sensation to touch will be elicited. This fluctuation may be masked by thickening of the cyst-wall from inflammatory adhesions. Anesthesia will facilitate the examination in such cases.

An exploratory puncture with an aspirating needle may be made, providing the tumor is found in the cul-de-sac or bulges into the vagina. The contents aspirated may be serous, bloody, or purulent, and, if purulent, vaginal incision and drainage may be made at once. When the tumor has grown to the size of an adult head, lying largely within the abdominal cavity, it will be recognized on palpation by its smooth, circumscribed, peculiar tense, elastic sensation. Fluctuation may not be detected, and too much stress must not be placed upon this sign. The tumor is more or less movable when manipulated, and may also move with the change of the position of the patient. The percussion-note over the tumor is dull or flat, and this area of dulness does not change to the most dependent portion of the abdominal cavity when the patient lies on one or the other side. The position and size of the uterus should be outlined by vaginal examination; the organ will be found to be displaced by the tumor—possibly drawn upward by the adhesions, but usually pushed to one side. The uterus will not be increased in size. When the tumor is large inspection will aid much in the diagnosis. The abdomen will not be symmetrically distended, being more prominent in the region of the tumor. The degree of distention may be estimated by measuring the distance from the umbilicus to either anterior superior spine of the ilium. If the distention is great, the superficial veins will be prominent on that side, and the linea albicantia may appear as in pregnancy. Above, the limit of the tumor may be outlined, but below, it is lost in the pelvis. In extreme cases the upper border may be lost behind the arch of the thorax; the ribs bulge and the abdominal viscera are displaced. In determining the variety of the cyst—that is, whether it is unilocular, multilocular, colloid, or dermoid—the following general points may be of service:

In unilocular cysts the surface is smooth; even fluctuation is discerned at all points with equal facility, and the growth compared with the multilocular cysts is limited in size.

Multilocular cysts attain enormous proportions, are irregular in outline, resistance is not uniform, fluctuation may be limited to a portion of the tumor.

A dermoid cyst may be suspected when the tumor appears early in life, when it is of slow growth, accompanied with pain and exacerbations of peritonitis. On palpation it imparts a doughy sensation. Of course when portions of the cyst, as teeth, bone, and hair, are discharged through a fistulous communication, the diagnosis is established. Very rarely, indeed, are portions of the tumor palpated and recognized as teeth and bone.

Differential Diagnosis.—Tympanites often leads to a misapprehension as to the existence of a tumor. In tympanitis the distention is symmetrical and not constant, being aggravated shortly after meals, and is associated with flatulence, passage of gas, and rumbling in the bowel. The percussion-note is uniformly tympanitic; no circum-

scribed mass can be palpated, and auscultation will reveal gurgling sounds at all points.

Phantom tumors in hysterical subjects are often misleading. Anesthesia will clear up the mystery. *Thick, fat abdominal walls* are distinguished by the great fat folds so prominent in the sitting posture; by the peculiar doughy feel, so different from the tense, elastic resistance of an ovarian cyst; by the deep resonance. The "fat-thrill" of Godell may simulate the cyst-thrill in percussion, but may be muffled by laying the hand of an assistant upon the surface between the examiner's hands.

Ascites.—Here the history and the presence of a cause in the heart, lung, or liver will facilitate the diagnosis of ascites. The abdomen is distended symmetrically, bulging at the sides, and more flattened in front than is the case when a cyst is present. Fluctuation is not confined to the bulging area, which is dull on percussion at the dependent portion, and changes with the position of the patient. This is not true of a cyst. Above the line of dulness is tympany. Vaginal examination is negative; the uterus is not displaced and no tumor is felt. Circumscribed collections of fluid due to peritonitis are difficult to distinguish from cysts, but there is usually a history of peritonitis, and the tumor is more often in the middle line than to one side.

In the presence of a large accumulation of ascitic fluid small cysts are not often discovered. When suspicion of their presence exists, it would be well to tap the abdomen to draw off the ascitic fluid, and then make a careful examination for the cyst. The examination of the fluid will aid in the diagnosis. Ascitic fluid coagulates by heating; it may contain some blood-cells; the cell-elements of cystic fluid are rarely present; and the fluid lacks the viscidity of cystic fluid. The specific gravity is about 1014, and the color is green and yellow.

Pyosalpinx and Pelvic Abscesses.—The history will often clear up the diagnosis. Such collections of pus are usually associated with a history of septic infection following labor and abortion or a gonorrheal infection. They are generally accompanied with chills, pain, fever, and sweating. Physical examination will elicit tenderness and a mass which is fixed and does not give the firm, elastic resistance of a cyst. Rarely do they attain any considerable size. If bulging into the vagina, the exploring needle will settle the diagnosis.

Hydrosalpinx will usually be readily distinguished by its elongated, tortuous shape.

Pelvic hematocele, as a rule, is associated with a history of possible pregnancy. It is recognized by its peculiar doughy feeling, by the mass being fixed and not circumscribed; fluctuation is indistinct, and the aspirating needle withdraws blood.

Ectopic gestation must be thought of. Before the rupture there will be a growing tumor to one side or behind the uterus; it will be boggy to the touch and other evidences of pregnancy will be found. After rupture there will be a history of sudden pain, collapse, and the appearance of a hematocele, as described above.

Uterine fibroids are usually distinguished by their greater degree of resistance.

Pancreatic cysts are usually found in the median line of the epigas-

trium; the fluid is alkaline, of low specific gravity, and contains fat-droplets. The epithelial cells found in ovarian cysts are absent. The stomach is displaced forward.

Displacement of the kidney may be detected by the shape of the organ, by the ability to replace it, and by its consistency.

Tumors of the kidney are usually found in the young. They are retroperitoneal, as demonstrated by inflating the colon over them. A history of hematuria, pyuria, and renal colic is often given, and the lessening in size of the tumor simultaneously with the appearance of pus or increased amount of water in the urine. Catheterization of the pelvis of the kidney will be valuable in the diagnosis of pyonephrosis and hydronephrosis.

Enlarged spleen from malaria, tumors, or leukemia is recognized by its tendency to grow downward and inward, by its peculiar shape, by the detection of the notch upon the inner margin, by the examination of the blood, and by the history relating to the case.

A distended bladder should not be mistaken for a cyst. Inquire into the frequency and time of urination, the amount of urine voided; and the use of the catheter will prevent possible errors.

Impacted feces will be excluded by the use of enemata and cathartics; the tumor thus caused will be dull on percussion and doughy on pressure, the indentation remaining persistent after the finger is removed.

Treatment of Ovarian Tumors.—Medical treatment, tapping, electricity, injections with iodin and astringents, will only be mentioned to condemn them. It cannot be too strongly emphasized that the only justifiable treatment is surgical interference. Tapping may be the only resort when the patient suffers from pressure-symptoms and a surgical operation is contraindicated.

Ovariotomy may be said to be indicated wherever there exists a tumor of the ovary. The usual preparations for an abdominal section are made. The Trendelenburg position will be found most advantageous. The incision should be in the median line above the pubis, and should be long enough to admit of ready manipulation and delivery of the tumor after it has been emptied. The adhesions binding the tumor to the parietal peritoneum are broken up with the fingers; the omentum when adherent is freed in a similar manner, or, if too strongly attached, by amputating the adherent portion. Great care should be exercised in separating adhesions to the intestines; the adherent gut should be brought plainly to view, with the sac well exposed. A trocar is plunged into the cyst-cavity and the fluid allowed to escape. The peritoneal cavity is protected by sponges. As the cyst empties the sac is grasped with the cyst-forceps and traction made. Thus the cyst is drawn out of the wound. The trocar is then removed and the opening in the sac enlarged. The contents are allowed to escape, and the hand is introduced inside the cyst. Secondary cysts may be broken into and discharge their contents into the large cyst-cavity. Traction upon the cyst is continued until it is drawn outside the abdominal cavity. The pedicle is then ligated and removed close to the uterus.

The stump is either cauterized with a Paquelin cautery or with car-

bolic acid. If the contents of the cyst are not purulent, there is no indication for irrigation. If there is suppuration, irrigation and drainage should be employed. Where the adhesions are extensive and there is considerable oozing a drainage-tube should be inserted. Serous and bloody fluid should be removed from the peritoneal cavity by sterilized sponges. The wound is closed in the usual manner.

Occasionally it will be found impossible to remove the cyst *en masse*. Such is sometimes the case when the adhesions are too firm, the bleeding and shock too severe, or the collapse of the patient renders a hasty operation imperative. In such a case the cyst is drawn out as far as possible and the extruded portion excised. The margins of the remaining portion of the cyst are stitched to the abdominal incision, and the cavity drained by iodoform gauze or a glass drainage-tube.

XIV. EXTRA-UTERINE PREGNANCY.

Tubal Pregnancy.—The normal site of impregnation is in the uterus, but sometimes it occurs in the tube.

Etiology.—Little is known concerning the cause of tubal pregnancy. Most frequently it occurs after a long period of sterility, though it has been known to happen as early as the age of twenty, and after repeated normal pregnancies or closely following upon an abortion, miscarriage, or labor at full term. Desquamative salpingitis is thought by many to be the pathological condition most frequently responsible.

As a result of tubal pregnancy the tube becomes thickened, owing to congestion and hypertrophy of the essential cell-elements. At times there is a general or localized thinning of the walls of the tube. The ovum becomes adherent to the mucous membrane by a new-formed chorionic membrane; later the greater portion of the villi become atrophied while the remaining villi form the placenta. When this fetal body is separated from its attachments hemorrhage into the chorionic villi is a universal result, and there is developed from the product of conception what is generally known as an apoplectic ovum or fleshy mole. Early, it is seen as a dark coagulum of blood which in a few days becomes of a yellow color, due to a deposit of fibrin upon the surface. In the center is a cavity lined with a smooth amniotic membrane containing a clear amniotic straw-colored fluid, and at times the remains of an embryo. The presence of an embryo is proof positive of the character of the clot, and the existence of chorionic villi, as demonstrated by the microscope, is the next most essential point in diagnosis.

Rupture of the tube is an almost inevitable result, though in rare instances the fetus is destroyed early in its development and remains quiescent. Rupture of the tube may be primary or secondary, and may be intra-peritoneal or extra-peritoneal.

Primary rupture is the term employed when the accident occurs prior to the development of the placenta at the twelfth week. When rupture takes place into the peritoneal cavity there is grave danger of fatal hemorrhage, the danger being proportionate to the degree of the development of the ovum. Peritonitis is of rare occurrence. The blood tends to collect in the cul-de-sac of Douglas and to

become walled off in the pelvis by the adherent omentum and intestines above. Secondary hemorrhages may follow. Primary rupture of the tube between the layers of the broad ligament, known as extra-peritoneal rupture of the tubes, is of less serious consequence, because the extra-ligamentous pressure soon checks the hemorrhage. The ovum may become destroyed and no subsequent injury ensue, but it may go on to development between the layers of the broad ligament, and is then called "intra-ligamentous gestation" or "broad-ligament pregnancy."

Tubal abortion is a term applied to those cases in which impregnation develops in the outer third of the tube, and, the ostium abdominalis not being closed, the ovum is expelled through it into the abdominal cavity. The danger of such an event is directly proportionate to the proximity of the ovum to the ampulla and to the patency of the ostium abdominalis, which should close not later than the sixth or eighth week. After the eighth week tubal abortion does not take place, but the tube ruptures because of the closure of the ostium abdominalis.

Together with tubal abortion there is more or less hemorrhage into the peritoneal cavity. This may be so abundant as to result in profound shock and death or peritonitis may develop. Thus the vast majority of hematoceles are occasioned. Coincident with the development of the ovum in the tube is the development of a uterine decidua, which is expelled accompanied by hemorrhage. When occurring early the ovum is often not detected in the blood-clot.

Tubal Gestation.—The placenta is formed almost exclusively from fetal tissue, the tubal mucous membrane entering but little into its structure; hence there is little or no thickening of the tube, but, on the contrary, the walls become thinned and finally rupture. The decidua forms in the uterine cavity and around the ovum, and is usually discharged during pregnancy, with symptoms of miscarriage. Occasionally it is expelled in fragments and unnoticed. The menstrual membrane of membranous dysmenorrhea must not be mistaken for the decidual membrane. The decidual membrane is larger, thickened, and presents a shaggy external surface, and at its three angles are the openings corresponding to the Fallopian tubes and the internal os. The internal surface is dotted with the orifices of the uterine glands. When the fetus lies above the placenta in the tube the placenta is crowded down between the layers of the broad ligament, and when the fetus lies below the attachment of the placenta the latter is crowded high into the abdomen. These remarkable displacements not only result in alteration of the placental structure and function, but have a jeopardizing effect upon the life and health of the mother and fetus. The danger to the mother is hemorrhage from the placental site into the peritoneal cavity or gestation-sac. The fetus is usually ill-formed or under-sized; club-foot, spina bifida, hydrocephalus, and like deformities are frequently present. Rarely does the fetus live, but even after its death the placenta may continue to grow and attain enormous proportions. A dead fetus may become *mummified;* in other cases it becomes partially converted into a *lithopedion* by a deposit of lime salts in the superficial structures. The fetal body and placenta may become

gangrenous or suppurate, and death ensue from septic infection or peritonitis.

Secondary rupture of the gestation-sac may occur at any time after the formation of the placenta at the twelfth week. If the placenta lies above the fetus, crowding it into the pelvis, there is great danger of rupture of the placenta with fatal intra-peritoneal hemorrhage. When the fetus lies above the placenta, the latter may finally rupture into the peritoneal cavity without dangerous hemorrhage, and the fetus continue to live and accommodate itself to its environments. Not always does the sac rupture. Spurious labor may occur at the expected time, the amniotic liquor become absorbed, and the fetus mummifies, only to be accidentally discovered years afterward.

J. Bland Sutton says: "There is not such a thing as primary peritoneal pregnancy. *All forms of extra-uterine pregnancy pass their primary stages in the Fallopian tube.*"

Tubo-uterine pregnancy, or **interstitial pregnancy,** as it is sometimes called, is a term applied to the condition in which the fetus develops in that portion of the Fallopian tube lying in the uterine wall. In consequence of the structures of the walls the sac does not become thinned, but greatly hypertrophied, just as does the uterus; hence rupture does not occur so early as in the other forms, and the rupture may be intra-peritoneal or intra-uterine. Tubal pregnancy must not be confused with pregnancy in a rudimentary horn of the uterus. In tubal pregnancy the decidua is intra-uterine, and in pregnancy of a rudimentary cornu the decidua lies within the cornu. A few cases are on record in which there existed simultaneously an intra-uterine and an extra-uterine fetus.

Symptoms of Tubal Pregnancy.—The usual signs of early pregnancy are not always present, but when discernible are valuable diagnostic points. The breasts may not undergo the usual development, and there may be no amenorrhea. In such cases the diagnosis must depend upon a physical exploration. The woman herself may not be aware that she is pregnant.

Rupture of the tube manifests itself by a sudden pain or sense of something having given way in that region; then follow other symptoms referable to internal hemorrhage. If the rupture has occurred through the placental site into the peritoneal cavity, the loss of blood may be enormous; the patient becomes faint, pallor rapidly develops, the respiration becomes sighing, the pulse weak and rapid, the extremities cold, and the temperature subnormal. Death may follow in two or more hours. If the rupture occurs between the layers of the broad ligament, the extra-vascular soon equalizes the intra-vascular pressure, and hemorrhage is checked without serious effect upon the patient. Coincident with the rupture there are frequently hemorrhage from the uterus through the vagina and the expulsion of the decidua *en masse* or in shreds.

After the third month tubal pregnancy gives the following signs and symptoms:

1. The breasts are usually enlarged as in normal pregnancy, though this is not a constant sign.

2. Amenorrhea is not constant. Hemorrhage from the uterus may

recur at irregular intervals, and, when accompanied by the expulsion of shreds of decidua, is a most characteristic symptom.

3. The uterus enlarges as in normal pregnancy up to about the third month, and the os is soft and patulous.

4. When pregnancy has been suspected and symptoms of internal hemorrhage suddenly develop, it is altogether probable that the gestation-sac has ruptured. The fetus may be palpated as a soft, irregular mass lying to one side and behind the uterus. When the fetus has become developed it is sometimes possible to recognize the head and extremities by palpation.

5. The pre-existence of salpingitis and a long period of sterility is strongly indicative of ectopic gestation. In the experience of Dr. Joseph Price rupture of ectopic gestation-cysts occurs with much greater frequency during the summer months than during any other period of the year, and with noteworthy frequency in women in whom lactation is prolonged either for the purpose of averting pregnancy or from other cause.

Ectopic gestation at term is manifested by characteristic labor-pains, dilatation of the os, hemorrhage from the uterus, and often expulsion of the decidual membrane. These pains may continue for several days, and the breasts may secrete milk for two or three weeks. All these symptoms may disappear and the tumor gradually diminish in size from the absorption of the liquor amnii and mummification of the fetus. Again, the fetus may macerate, suppurate, or become gangrenous, and either cause general peritonitis, or its remains may be discharged through the groin, vagina, bladder, or rectum.

Diagnosis.—Prior to the rupture of the pregnant tube there is often nothing to suggest pregnancy. However, a diagnosis is sometimes arrived at through an examination made because of the suspicion of pregnancy on the part of the patient or because of pain in the iliac fossæ. When the tube is found distended and boggy we should always think of the possibility of ectopic gestation, and where there are irregular symptoms of pregnancy, with the uterus slightly enlarged and the cervix soft, the presence of a distended tube is highly suspicious of tubal pregnancy.

The expulsion of the decidua, accompanied by hemorrhage, is an important symptom, and must be differentiated from an early uterine abortion and from membranous dysmenorrhea. The diagnosis of rupture of the tubal sac may be made where the previous history of amenorrhea and more or less definite signs of pregnancy are followed by the appearance of a sudden pain in the region of the tube, followed by collapse. The diagnosis subsequent to the rupture will be made by the above history, plus finding a pelvic hematocele or hematoma.

Differential Diagnosis.—Pelvic hematocele or *hematoma* due to ectopic gestation, and that due to other causes, cannot be differentiated unless the history points directly to this cause or the fetal remains can be found in the blood-mass. So frequently is ectopic gestation the cause of hematosalpinx that we are quite justified in ascribing it as the cause where no other can be found.

Tubal pregnancy must be differentiated from a *tube distended with pus and serum.* Prior to the rupture the symptoms and physical signs

may be identical, as they also are at the time of the rupture. Here the history of previous symptoms of pregnancy will often suffice to make a diagnosis. After the effects of the rupture have subsided the subsequent course differs more widely.

In ruptured tubal pregnancy the temperature is at first subnormal, and then slowly rises, while in ruptured *pyosalpinx* the temperature rises rapidly. In the former condition there are symptoms of internal hemorrhage, the pain is of limited duration, and the general symptoms of sepsis are not marked. In ruptured pyosalpinx there are no signs of internal hemorrhage, the pain is prolonged, the pulse becomes rapid and weak, and general symptoms of sepsis ensue.

Ovarian tumors are to be excluded by the menstrual history and the signs of pregnancy.

Subserous fibroids of the uterus are sometimes mistaken for a gestation-sac. The previous history of increased menstruation, the slow development, the absence of signs of pregnancy, and the firm consistency and close connection of the growth with the uterus will aid in making a diagnosis.

Treatment.—Electricity has been recommended as a means of destroying the life of the fetus before the tube has ruptured, with the expectation that the fetus will be absorbed. This procedure must be condemned. Nothing short of the removal of the gestation-sac is indicated. At the time of rupture of the sac, unless there is every evidence of extra-peritoneal hemorrhage, the indication is imperative for immediate abdominal section.

After the gestation-sac has ruptured and the symptoms of shock and internal hemorrhage have subsided the patient may survive and the condition be palliated for days, weeks, and months without surgical interference. The indication, however, is to operate on all intra-peritoneal cases at the earliest possible moment by abdominal section, removing all blood-clots, irrigating, removing the gestation-sac, and draining.

Where the sac has ruptured between the broad ligaments the mass is to be removed by way of the vagina; the pelvic cavity is irrigated and drained. This, however, can only be done in the early period of gestation; after the third month the abdominal route must be selected. As late as the fourth month the embryo, tube, ovary, placenta, and adjacent portions of the broad ligament can be removed *in toto*, but later than the fourth month the placenta has assumed such proportions and has become so firmly adherent to its point of attachment that it must be dealt with separately from the gestation-sac. In the treatment of the gestation-sac no attempt should be made to extirpate it, because of the danger of bleeding and the injury to the bowel and ureters, which are often firmly adherent. The sac should be opened and emptied of its contents, then stitched to the abdominal incision, and packed with gauze. J. Bland Sutton formulates the treatment of the placenta as follows:

1. "When the placenta is situated above the fetus it is good practice to attempt its removal with the fetus.

2. "In some instances the placenta becomes detached in the course of the operation and leaves no choice.

3. "When the placenta is below the fetus it may be left.

4. "Should the placenta be left, the sac closed, and symptoms of suppuration occur, then the wound must be reopened and the placenta removed.

5. "If the fetus dies before the operation is attempted, the placenta can be removed without risk of hemorrhage."

It is thus seen that the operation for tubal pregnancy after the fourth month is fraught with great dangers. This emphasizes the importance of early operative interference. No time should be lost in waiting for the period of viability in case the child continues to live after the rupture of the gestation-sac. The added hazards to the life of the mother are too great to justify the almost hopeless endeavor to save the life of the child. The indication is for immediate operative interference as soon as the condition is recognized.

CHAPTER XVII.

THE *X*- (OR RÖNTGEN) RAYS IN SURGICAL DIAGNOSIS.

A NEW chapter in surgery was begun when, on the 8th day of December, 1895, Prof. Röntgen of Wurzburg, Germany, announced his discovery that certain rays of light could be made to pass through objects hitherto considered opaque. For want of a name, he let *x* represent this unknown quantity, this new manifestation of energy, and to the present time it is known as the *x*- or Röntgen ray. The scientific world was startled and amazed when photographs of the human hand showed that light penetrated the soft parts, throwing only a faint shadow, while the bones, resisting the passage of these mysterious rays, stood out clear and definite, a perfect image of the bony skeleton. Metallic substances were shown to be impervious to the rays, and when it happened that bullets, needles, or buckshot were lodged in the tissues, the photograph—or skiagraph, as it came to be called—showed the dark shadow of the object and revealed its position with perfect accuracy.

Like many other important discoveries, skiagraphy was arrived at step by step. The first step was taken by Maxwell when he propounded his theory regarding light. The ether is the name applied to the subtle fluid which pervades all bodies, liquid or solid, and occupies the boundless space between the stars. Maxwell's theory is that waves of light are identical with electro-magnetic disturbances in ether.

In 1879, William Crookes published the results of his wonderful experiments upon what he called the radiant or fourth state of matter. Three states of matter were familiar to every one—namely, solid, liquid, and gaseous, but this fourth state was something new. Michael Faraday had worked in the same direction, and had expressed his belief that there existed a state of matter in which the molecules were relatively as far apart as compared with those of a gas as the molecules of a gas were as compared with those of a liquid. What Faraday

suggested, Crookes demonstrated by the aid of his now world-renowned tubes.

The terms *anode* and *cathode* were employed by Faraday to designate the conductor terminals by which a current enters and leaves an electrolytic cell—that is to say, a cell in which chemical changes in the fluid are produced by the passage through it of an electric current. The element from which the current passed into the electrolyte was designated anode, while cathode was the name applied to the element to which the current passed from the electrolyte. The effect of electric discharges through rarefied gases was also studied by him, and Geissler, following up his researches, was at last able to produce from the Geissler tubes the startling and beautiful effects now familiar to all. The results observed at the anode in rarefied gases differed from those seen at the cathode. At the cathode appeared a beautiful bluish light, while the balance of the tube, including the space about the anode, presented a general and diffusive glow. One of the effects of the cathode was the production of fluorescence or phosphorescence, and it was even further noticed that the influence from the cathode moved in straight lines; thus the term *cathodic rays* came into use and the cathode became a central point of interest (Morton and Hammer).

Crookes came to the conclusion that electrified particles were projected in straight lines from the cathode. In the air of the tube exhausted to one-millionth of an atmosphere, and thus reduced to the radiant or fourth state of matter, the molecules were so far apart that these electrified particles were capable of passing with great speed in a straight line, and bombarded the opposite side of the tube. At the same time the glass became fluorescent.

Hertz took the next step by proving that electro-magnetic disturbances in ether possessed many of the properties of light, as refraction, reflection, dispersion, and polarization. He took a Crookes tube —which is nothing more or less than a glass tube of any shape from which the air has been exhausted—and found that the cathode rays in passing through the tube were capable also of passing through opaque substances *within the tube*. This was in 1891, and shortly afterward Hertz died. Paul Lenard took up the investigation where Hertz, his preceptor, laid it down, and two years afterward discovered that the rays passed through opaque objects *after leaving the tube*, and in 1893 made the remarkable announcement that he had obtained photographs through opaque substances by means of these rays. Strange to say, his statement received little attention. The final step was taken when Röntgen, on the 8th of November, 1895, while experimenting with a Crookes tube covered with a shield of black cardboard, noticed that a piece of barium-platinum-cyanide became phosphorescent. He worked on, and found that the rays affected photographic plates in the same way as light does, but, unlike light, these rays cannot be reflected, concentrated, or refracted outside the tube in which they have their origin.

In December, 1895, Röntgen laid his remarkable communication before the Wurzburg Physico-medical Society in the following terms:

"1. If we pass the discharge from a large Ruhmkorff coil through a Hittorf or a sufficiently exhausted Lenard, Crookes, or similar apparatus, and cover the tube with a somewhat closely fitting mantle of thin

black cardboard, we observe in a perfectly darkened room that a paper screen washed with barium-platinum-cyanide lights up brilliantly, and fluoresces equally well whether the treated side or the other be turned toward the discharge-tube. Fluorescence is still observable two meters away from the apparatus. It is easy to convince one's self that the cause of the fluorescence is the discharge apparatus and nothing else.

"2. The most striking feature of this phenomenon is that an influence (Agens) capable of exciting brilliant fluorescence is able to pass through the black cardboard cover, which transmits none of the ultra-violent rays of the sun or of the electric arc; and one immediately inquires whether other bodies possess this property. It is soon discovered that all bodies are transparent to this influence, but in very different degrees. A few examples will suffice: Paper is very transparent; the fluorescent screen held behind a bound volume of 1000 pages still lighted up brightly; the printer's ink offered no perceptible obstacle. Fluorescence was also noted behind two packs of cards; a few cards held between apparatus and screen made no perceptible difference. A single sheet of tin-foil is scarcely noticeable; only after several layers have been laid on top of each other is a shadow clearly visible on the screen. Thick blocks of wood are also transparent; fir planks from 2 cm. to 3 cm. thick are but very slightly opaque. A film of aluminum about 15 mm. thick weakens the effect very considerably, though it does not entirely destroy the fluorescence. Several centimeters of vulcanized India rubber let the rays through. Glass plates of the same thickness behave in a different way according as they contain lead (flint glass) or not; the former are much less transparent than the latter. If the hand is held between the discharge-tube and the screen, the dark shadow of the bones is visible within the slightly dark shadow of the hand. Water, bisulphid of carbon, and various other liquids behave in this respect as if they were very transparent. I was not able to determine whether water was more transparent than air. Behind plates of copper, silver, lead, gold, platinum, fluorescence is still clearly visible, but only when the plates are not too thick. Platinum 0.2 mm. thick is transparent; silver and copper sheets may be decidedly thicker. Lead 1.5 thick is as good as opaque, and was on this account often made use of. A wooden rod 20 by 20 mm. cross-section, painted white with lead paint on one side, behaves in a peculiar manner. When it is interposed between apparatus and screen, it has almost no effect when the *x*-rays go through the rod parallel to the painted side, but it throws a dark shadow if the rays have to traverse the paint. Very similar to the metals themselves are their salts, whether solid or in solution.

"3. These experimental results and others lead to the conclusion that the transparency of different substances of the same thickness is mainly conditioned by their density; no other property is in the least comparable with this.

"The following experiments, however, show that density is not altogether alone in its influence: I experimented on the transparency of nearly the same thickness of glass, aluminum, calc-spar, and quartz. The density of these substances is nearly the same, and yet it was quite evident that the spar was decidedly less transparent than the other bodies, which were very much like each other in their behavior.

I have not observed calc-spar fluoresce in a manner comparable with glass.

"4. With increasing thickness all bodies become less transparent. In order to find a law connecting transparency with thickness I made some photographic observations, the photographic plate being partly covered with an increasing number of sheets of tin-foil.

* * * * * *

"6. The fluorescence of barium-platino-cyanide is not the only recognizable phenomenon due to *x*-rays. It may be observed, first of all, that other bodies fluoresce—for example, phosphorus, calcium compounds, uranium glass, ordinary glass, calc-spar, rock salt, etc.

"Of especial interest in many ways is the fact that photographic dry plates show themselves susceptible to *x*-rays. We are thus in a position to corroborate many phenomena in which mistakes are easy, and I have, whenever possible, controlled each important occular observation on fluorescence by means of photography. Owing to the property possessed by the rays of passing almost without any absorption through thin sheets of wood, paper, or tin-foil, we take the impression on the photographic plate inside the camera or paper cover whilst in a well-lit room. In former days this property of the ray only showed itself in the necessity under which we lay of not keeping undeveloped plates, wrapped in the usual paper and board, for any length of time in the vicinity of discharge-tubes. It is still open to question whether the chemical effect on the silver salts of photographic plates is exercised directly by the *x*-rays. It is possible that this effect is due to the fluorescent light, which, as mentioned above, may be generated on the glass plate or perhaps on the layer of gelatin. 'Films' may be used just as well as glass plates.

"I have not as yet experimentally proved that the *x*-rays are able to cause thermal effects, but we may very well take their existence as probable, since it is proved that the fluorescent phenomenon alters the properties of *x*-rays, and it is certain that all the incident *x*-rays do not leave the bodies as such.

"The retina of the eye is not susceptible to these rays. An eye brought close up to the discharge apparatus perceives nothing, although, according to experiments made, the media contained in the eye are fairly transparent.

"7. As soon as I had determined the transparency of different substances of various thicknesses, I hastened to ascertain how the *x*-rays behaved when passed through a prism—whether they were refracted or not. Water and carbon disulphide in prisms of about 30° refractive angle showed neither with the fluorescing screen nor with the photographic plates any sign of refraction. For purposes of comparison the refraction of light-rays was observed under the same conditions; the refracted images on the plate were respectively about 10 mm. and 20 mm. from the non-refracted one. With an aluminum and a vulcanized rubber prism of 30° angle I have obtained images on photographic plates in which one may perhaps see refraction. But the matter is very uncertain, and even if refraction exists it is so small that the refractive index of the *x*-ray for the above materials can only be, at the highest, 1.05. Using the fluorescent screen, I was unable to discover

any refraction at all in the case of the aluminum and the rubber prism.

"Researches with prisms of denser metals have yielded, up to now, no certain results, on account of the small transparency, and consequently lessened intensity, of the transmitted ray.

"In view of this state of things, and the importance of the question whether *x*-rays are refracted on passing from one medium to another, it is very satisfactory that this question can be attacked in another way than by means of prisms. Finely powdered substances in sufficient thicknesses only allow a very little of the incident light to pass through, and that is dispersed by refraction and reflection. Now, powdered substances are quite as transparent to *x*-rays as are solid bodies of equal mass. Hence it is proved that refraction and regular reflection do not exist to a noticeable degree. The experiments were carried out with finely-powdered rock salt, with pulverulent electrolytic silver, and with the zinc powder much used in chemical work. In no case was any difference observed between the transparency of the powdered and solid substance either when using the fluorescent screen or the photographic plate.

"It follows from what has been said that the *x*-rays cannot be concentrated by lenses; a large vulcanized rubber and glass lens were without influence. The shadow of a round rod is darker in the middle than at the edge; that of a tube filled with any substance more transparent than the material of the tube is lighter in the middle than at the edge.

"8. The question of the reflection of the *x*-rays is settled in one's mind by the preceding paragraphs, and no appreciable regular reflection of the rays from the substances experimented with need be looked for. Other investigations, which I will describe here, lead to the same result. Nevertheless, an observation must be mentioned which at first sight appears to contradict the above statement. I exposed a photographic plate to the *x*-rays, protected against light rays by black paper, the glass side being directed toward the discharge-tube. The sensitive layer was nearly covered, star-fashion, with blanks of platinum, lead, zinc, and aluminum. On developing the negative it was clearly noticeable that the blackening under the platinum, lead, and especially under the zinc, was greater than in other places. The aluminum had exercised hardly any effect. It appeared, therefore, that the three above-mentioned metals had reflected the rays. Nevertheless, other causes for the greater blackening were thinkable, and in order to make sure I made a second experiment, and laid a piece of thin aluminum, which is opaque to ultra-violent rays, though very transparent to *x*-rays, between the sensitive layers and the metal blanks. As again much the same result was found, a reflection of *x*-rays by the above-mentioned metals was demonstrated. But if we connect these facts with the observation that powders are quite as transparent as solid bodies, and that, moreover, bodies with rough surfaces are, in regard to the transmission of *x*-rays, as well as in the experiment just described, the same as polished bodies, one comes to the conclusion that regular reflection, as already stated, does not exist, but that the bodies behaved to the *x*-rays as muddy media do to light.

"Again, as I could discover no refraction at the point of passage from one medium to another, it would seem as if the *x*-rays went through all substances at the same speed, and that in a medium which is everywhere, and in which the material particles are imbedded; the particles obstructing the propagation of the *x*-rays in proportion to the density of the bodies.

"9. Hence it may be that the arrangement of the particles in the bodies influences the transparency—that, for example, equal thicknesses of calc-spar would exhibit different transparencies according as the rays were in the direction of the axis or at right angles to it. Researches with calc-spar and quartz have yielded a negative result.

"10. It is well known that Lenard, in his beautiful investigation on Hittorf cathode rays passed through thin aluminum-foil, came to the conclusion that these rays were actions in the ether and that they passed diffusely through all bodies. I have been able to say the same about my rays.

"In his last work Lenard has determined the absorption coefficient of various bodies for cathode rays, and among other things for air, atmospheric pressure at 4.1, 3.4, 3.1, per centimeter, and found it connected with the exhaustion of the gas contained in the discharge apparatus. In order to estimate the discharge pressure by the spark-gap method, I used in my researches almost always the same exhaustion. I succeeded with a Weber photometer (I do not possess a better one) in comparing the intensity of the light of my fluorescing screen at distances of about 100 mm. and 200 mm. from the discharge apparatus, and found in the case of three tests agreeing well with one another that it varied very nearly inversely as the square of the distance of the screen from the discharge apparatus. Hence the air absorbs a very much smaller fraction of the *x*-rays than of the cathode rays. This result is also quite in agreement with the result previously mentioned, that the fluorescing light was still observable at a distance of two meters from the discharge apparatus.

"Other bodies behave generally like air—that is to say, they are more transparent for *x*-rays than for cathode rays.

"11. A further noteworthy difference in the behavior of cathode rays and *x*-rays consists in the fact that, in spite of many attempts, I have not succeeded, even with very strong magnetic fields, in deflecting *x*-rays by a magnet. The magnetic deflection has been up to now a characteristic mark of the cathode rays: it was, indeed, noticed by Hertz and Lenard that there were different kinds of cathode rays, 'distinguishable from one another by their phosphorescing powers, absorption, and magnetic deflection,' but a considerable deflection was nevertheless observed in all cases, and I do not think this characteristic will be given up without overwhelming evidence.

"12. After experiments bearing specially upon this question it is certain that the spot on the wall of the discharge apparatus which fluoresces most decidedly must be regarded as the principal point of the radiation of the *x*-rays in all directions. The *x*-rays thus start from the point at which, according to the researches of different investigators, the cathode rays impinge upon the wall of the glass tube. If one deflects the cathode rays within the apparatus by a magnet, it is

found that the *x*-rays are emitted from another spot—that is to say, from the new termination of the cathode stream.

"On this account, also, the *x*-rays, which are not deflected, cannot merely be unaltered cathode rays passing through the glass wall. The greater density of the glass outside the discharge-tube cannot, according to Lenard, be made responsible for the great difference in the 'deflectability.'

"I therefore come to the conclusion that the *x*-rays are not identical with the cathode rays, but that they are generated by the cathode rays at the glass wall of the discharge apparatus.

"13. This excitation does not only take place in glass, but also in aluminum, as I was able to ascertain with an apparatus closed by a sheet of aluminum 2 mm. thick. Other substances will be studied later on.

"14. The justification for giving the name of 'rays' to the influence emanating from the wall of the discharge apparatus depends partly on the very regular shadows which they form when one interposes more or less transparent bodies between the apparatus and the fluorescing screen or photographic plate. Many such shadow pictures, the formation of which possesses a special charm, I have observed—some photographically. For example, I possess photographs of the shadow of the profile of the door separating the room in which was the discharge apparatus from the room in which was the photographic plate; also photographs of the shadows of the bones of the hand, of the shadow of a wire wound on a wooden spool, of a weight enclosed in a small box, of a compass in which the magnetic needle is completely surrounded by metal, of a piece of metal the lack of homogeneity of which was brought out by the *x*-rays, etc.

"To show the rectilinear propagation of the *x*-rays there is a pin-hole photograph which I was able to take by means of the discharge apparatus covered with black paper. The image is weak, but unmistakably correct.

"15. I looked very carefully for interference phenomena with *x*-rays, but, unfortunately, perhaps only on account of the small intensity of the rays, without success.

"16. Researches to determine whether electrostatic forces affect *x*-rays in any way have been begun, but are not completed.

"17. If we ask what *x*-rays, which certainly cannot be cathode rays, really are, we are led at first sight, owing to their powerful fluorescing and chemical properties, to think of ultra-violet light. But we immediately encounter serious objections. If *x*-rays be in reality ultra-violet light, this light must possess the following characteristics:

"(*a*) It must show no perceptible refraction on passing from air into water, bisulphid of carbon, aluminum, rock salt, glass, zinc, etc.

"(*b*) It must not be regularly reflected to any appreciable extent from the above bodies.

"(*c*) It must not be polarizable by the usual means.

"(*d*) Its absorption must not be influenced by any of the properties of substances to the same extent as it is by their density.

"In other words, we must assume that these ultra-violet rays behave in quite a different manner to any infra-red visible or ultra-violent rays

hitherto known. I could not bring myself to this conclusion, and I have therefore sought another explanation.

"There seems at least some connection between the new rays and light-rays in the shadow pictures and in the fluorescing and chemical activity of both kind of rays. Now, it has been long known that, besides the transverse light vibrations, longitudinal vibrations might take place in the ether, and, according to the view of the different physicists, must take place. Certainly their existence has not, up till now, been made evident, and their properties have not on that account been experimentally investigated.

"May not the new rays be due to longitudinal vibrations in the ether? I must admit that I have put more and more faith in this idea in the course of my research, and it behooves me, therefore, to announce my suspicion, although I know well that this explanation requires further corroboration."

Apparatus required for *x*-Ray Work.

The apparatus as at present employed consists of four parts:

1. The battery or electric machine. To supply the required electric current any of the following may be utilized: (*a*) Static electrical machines; (*b*) induction coils whose primary circuits are supplied either with continuous or alternating electrical currents; (*c*) Telsa transformers, utilizing oscillatory electrical currents.
2. The Crookes tube.
3. The fluoroscope.

Any person possessing a Holtz machine can easily connect it with a Crookes tube at small expense and obtain satisfactory results in *x*-ray work. The positive and negative poles must first be determined in the following manner: Operate the machine in the dark and observe the "combs" or "collectors" on each side of the revolving glass disks. At those combs opposite one of the prime conductors a brilliant "brush-light" discharge will be observed extending from the combs along the surface of the glass. This "brush-discharge" is *positive*. The discharge at the negative combs appears as bright star-like points of light. That prime conductor which is an extension of the positive combs will be, by induction, a negative pole, while the other prime conductor will be, by induction, a positive pole.

Having determined these polarities, the next thing is to connect to each prime conductor a small condenser in the form of a Leyden jar. The small jars are the best, as the larger ones are likely to crack the glass of the Crookes tube.

The Leyden jars are connected to the prime conductors by the internal armatures. The external armatures are connected to the Crookes tube. The positive prime conductor, as previously determined, being connected to the internal armature of one Leyden jar, will induce a negative charge in the external armature of the same jar. This, therefore, becomes a negative pole or cathode, and the source of the cathodic stream from which are produced the *x*-rays. The external armature of the other jar becomes the anode or positive pole.[1]

[1] Morton and Hammer: *The x-Ray*, pp. 80, 81.

Fig. 323 illustrates the manner of connecting a Crookes tube to a Holtz machine.

By means of Tesla transformers *x*-rays of great power may be obtained, and by the more elaborate apparatus the photographic plate has been affected at a distance of forty feet.

Up to the present time the formula of Tesla is the best that has been introduced, and follows the principle that the highest efficacy of the rays depends upon the three following factors: high voltage, low ampèrage, and frequent oscillations. Dr. Trouton has estimated that the duration of *x*-radiation at each spark ranges from $\frac{1}{10000}$ to $\frac{1}{800}$ of a second. Spark coils or Holtz machines are objectionable as ray-producers, since the period of the spark is much longer than the period of radiation. In the apparatus constructed upon Telsa's formula by the consumption of about three ampères and 110 volts a voltage of about 3,000,000 can be obtained, and a frequency of about 400,000 a

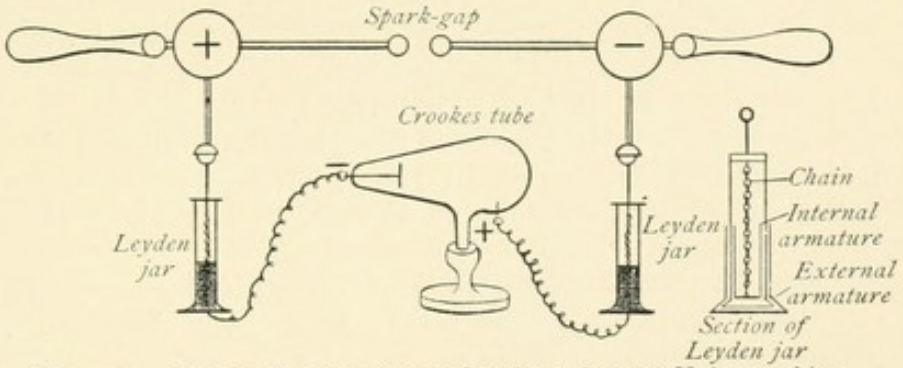


FIG. 323.—Manner of connecting a Crookes tube to a Holtz machine.

minute, or 66,666 a second. The time of exposure is also much lessened by the use of Tesla's formula, being only eight or ten minutes for any part of the body, instead of one or two hours, as formerly. For the hands and feet the exposure is practically instantaneous.

For further information on this subject the reader is referred to *The x-Ray, or the Photography of the Invisible*, by Dr. Morton and Mr. Hammer.

The fluoroscope was invented by Edison, and is an invaluable instrument in *x*-ray examinations. Röntgen found that fluorescent subjects were excited by the *x*-ray, and Salvioni devised a tube having at one end a pasteboard cover coated with fine crystals of platino-cyanide of barium, and at the other an eye-piece through which the operator could view the shadow cast upon the fluorescent screen by the intervention of the opaque object between it and the Crookes tube.

Edison, after experimenting with eighteen hundred different substances, found that tungstate of calcium had better fluorescent qualities than platino-cyanide of barium, and adopted a large camera or dark chamber in the form of a stereopticon, which allowed the operator to use both eyes at a convenient distance from the screen.

By means of the fluoroscope the operator can determine whether *x*-rays are being produced or not in the Crookes tube. He can also make a rapid inspection of the parts under examination, and from as many different positions as necessary, before resorting to the photographic plate for a permanent record.

Uses of the *x*-Rays.

1. *The Study of Anatomy.*—The human skeleton, no matter how carefully mounted, gives an imperfect idea of the true relations of the bones to one another. Under the *x*-rays these relations are perfectly represented; the junction of epiphysis with bone and the centers of ossification are clearly shown. Fig. 324 shows the arteries of a dead infant; the vessels were injected with plaster of Paris through the umbilical vein.

Prof. Diakonof suggests that structures such as arteries, veins, and bronchioles may be injected with mercury on account of the ease with which it can be manipulated, and the fact that the same injecting fluid can be used over and over again. Two sets of vessels in the same organ may be injected simultaneously—one set with mercury, and the other with a material still more opaque. He recommends the following mixtute: gypsum, cinnabar, and red lead, 20 parts each; flour, 10 parts; add enough water to make the mixture sufficiently fluid to flow into the smallest vessels. This shows a very dark shadow in the skiagraph, in strong contrast to the shadow thrown by mercury.

2. *Fractures and Dislocations.*—The position of the fragments in a recent fracture, the condition of an ununited fracture, and the question of the existence or non-existence of a dislocation can be settled by the *x*-rays.

3. *Diseases of Bones.*—In Fig. 325 is represented a tubercular focus in the os calcis. In this case the *x*-rays settled the diagnosis between sarcoma and tubercular osteitis.

4. *The Detection of Foreign Bodies.*—The first and most frequent application of Röntgen's discovery was to the detection of foreign bodies in the tissues. Fig. 326 represents the hand and wrist of a colored girl who seven years previously received a charge of buckshot. In Fig. 327 is seen the knee of a man containing a bullet. This was supposed to be a case of rheumatism until the radiograph was taken, and then the fact was recalled that the patient had received a bullet in the thigh seven months previously. The missile took a downward course, and most unexpectedly found its way to the knee-joint, as shown in the picture. A toy whistle in the esophagus of a little girl is represented in Fig. 328. It had been in that position nine days when Dr. Law removed it with esophageal forceps.

5. Mineral concretions, such as renal and vesical calculi, are impervious to the *x*-rays, and with increased dexterity on the part of examiners we may shortly expect much light in the diagnosis of these bodies. Calcareous and atheromatous deposits in arteries can also be determined with accuracy. Dr. Kümmel of Hamburg has shown that in arterial sclerosis the sclerosed arteries become visible as black stripes on the skiagram. So far, gall-stones have not been seen by the *x*-rays. Laurie and Leon by experiment have shown that urinary calculi composed of oxalate or phosphate of lime are more opaque than bone, uric-acid calculi of almost the same opacity, and gall-stones very slightly more opaque than flesh.

Potain and Cerbanisco claimed to make a differential diagnosis between deposits of gout and rheumatism by the aid of *x*-rays. Ac-

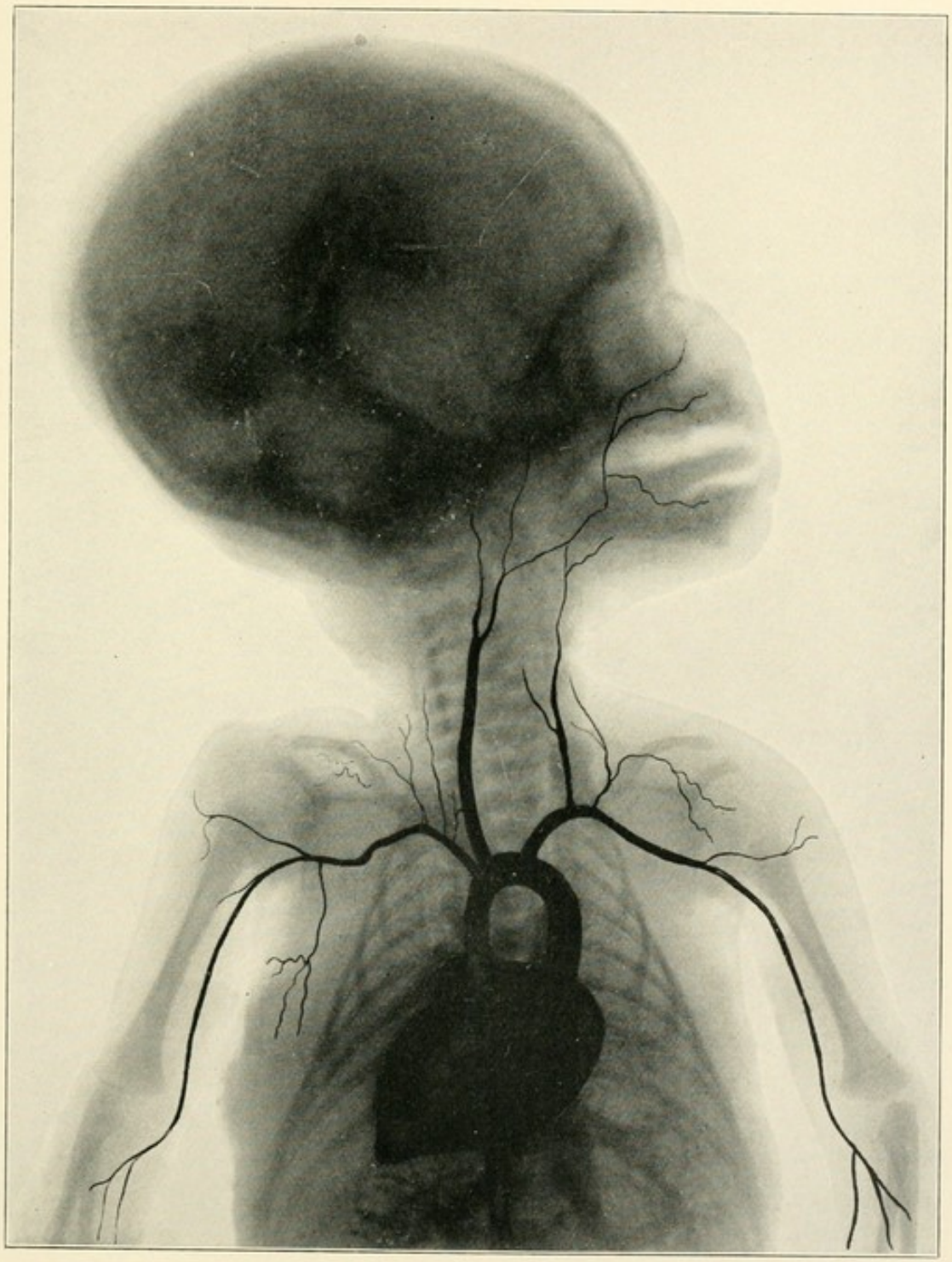


FIG. 324.—Arteries of an infant (photograph by Dr. Arthur Ayer Law).

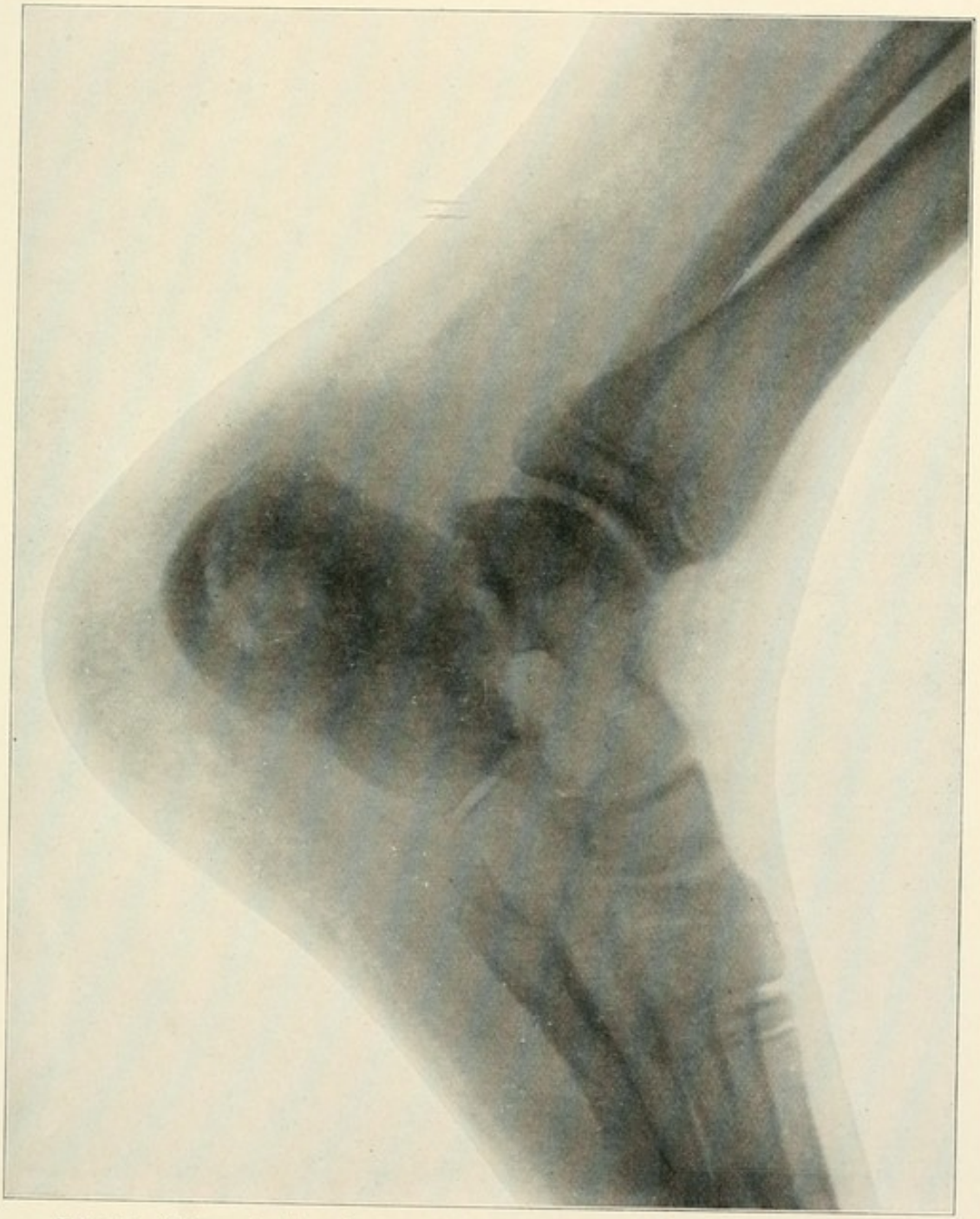


FIG. 325.—Tubercular focus in the os calcis (photograph by Dr. Arthur Ayer Law).

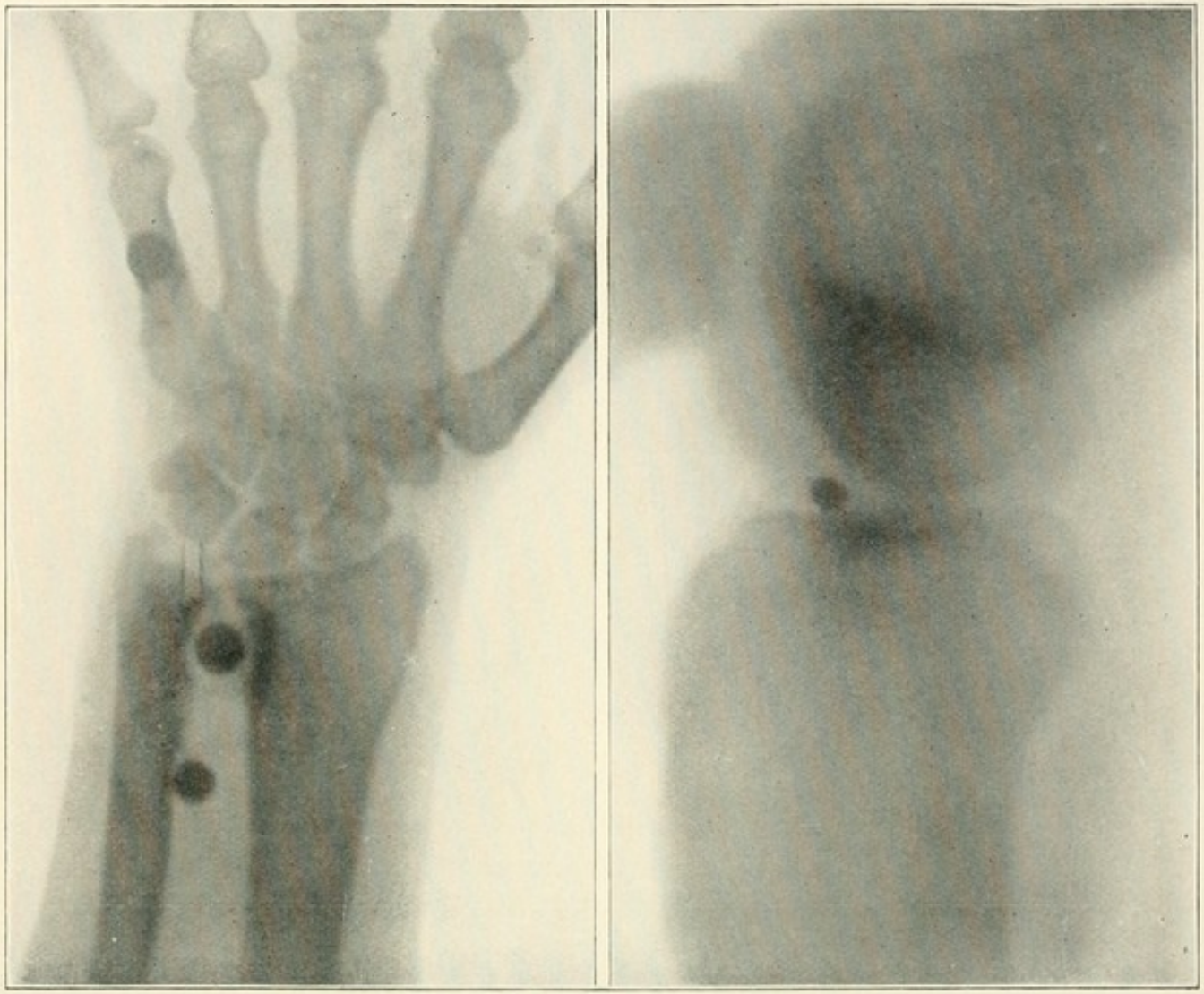


FIG. 326.—Hand and wrist, showing buckshot.

FIG. 327.—Knee-joint containing bullet.

(Photographs by Dr. Arthur Ayer Law.)



FIG. 328.—Toy whistle in the esophagus (photograph by Dr. Arthur Ayer Law).

cording to these observers, the former show a translucent central part limited by a narrow dark border, which is again enclosed in a wider opaque area. This central clear portion is absent in rheumatic thickening. It is attributed to the greater permeability to the rays of urate of soda as compared with rheumatic deposits, and also with the normal bone salts—a conclusion which they have confirmed by further independent observations.

6. Under the fluoroscope the soft tissues can be studied. Thus, the heart casting a darker shadow than the surrounding parts, its pulsations can be observed as a wave of shadow changing shape, while another shadow representing the liver is seen to rise and fall with respiration.

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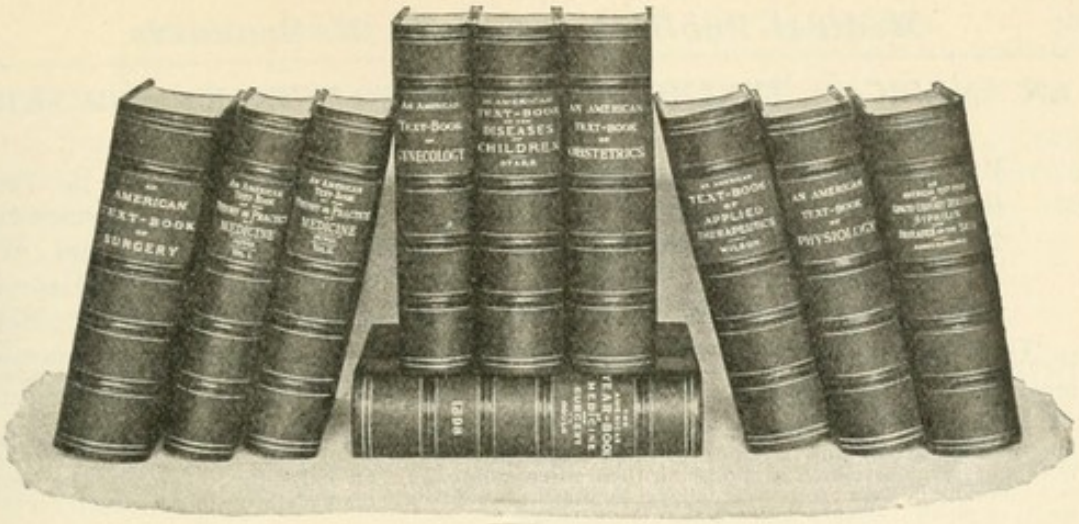

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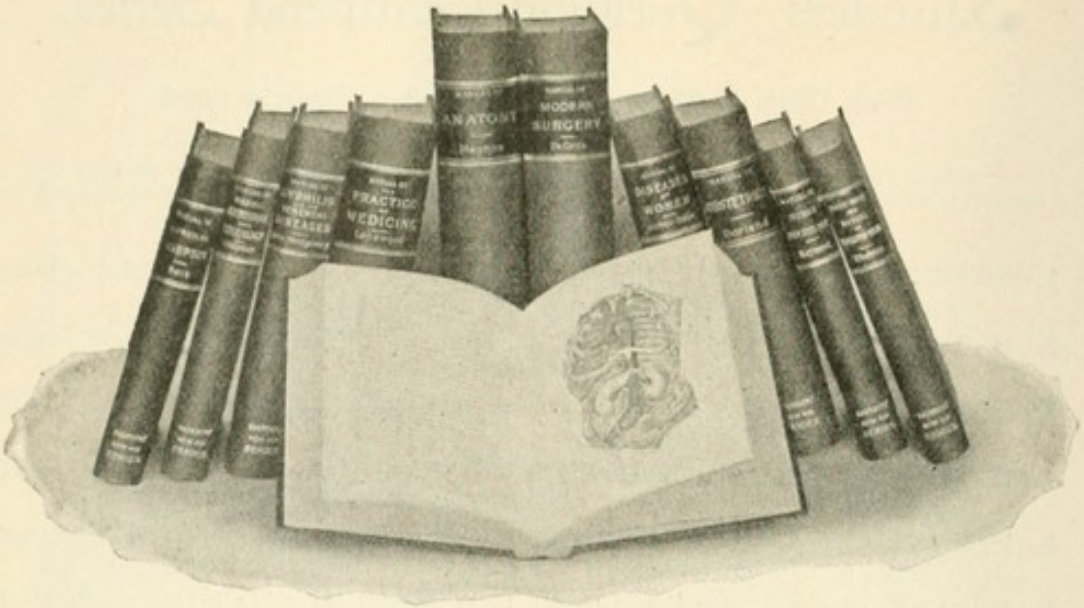

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