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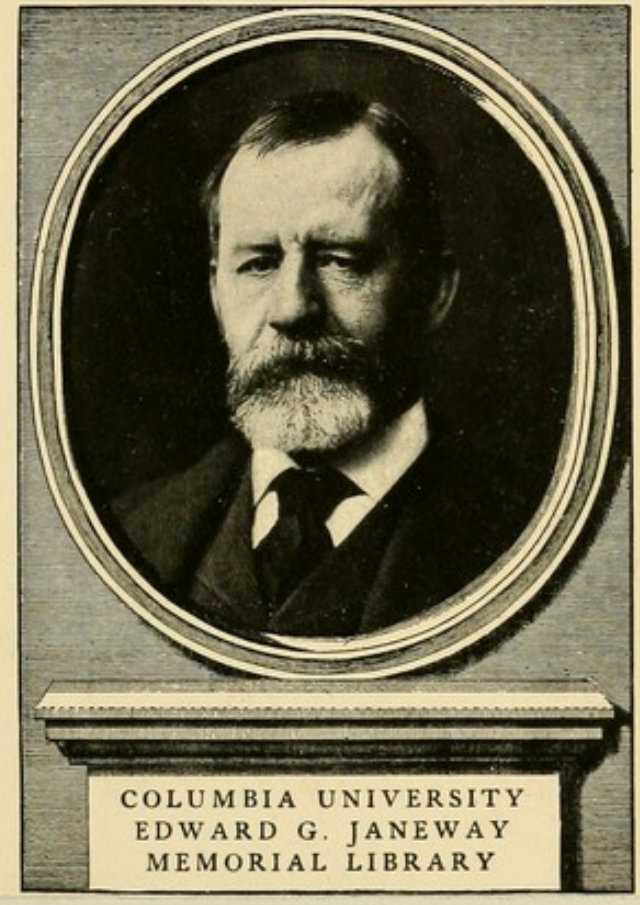

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SURGICAL DISEASES
OF
CHILDREN

A MODERN TREATISE ON
PEDIATRIC SURGERY

By
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ILLUSTRATED

SECOND EDITION, REVISED AND ENLARGED

E. B. TREAT & COMPANY
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1914

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To any hapless child,
Crippled, injured, ill,
And to any doctor
Who sees and fain would help,
This book is dedicated.

U.S.P. Man. 6/23

PREFACE TO SECOND EDITION.

There is still need to extend the knowledge and the practice of the surgery of infancy and childhood and reviewers and practitioners have given such general approval to the first edition that author and publishers feel encouraged to produce a second edition. One of the reviewers [1] shows so keen an insight into the intent and scope of the book and expresses it so clearly that, in presenting the second edition, I cannot do better than to quote his words. "This volume is in every sense something more than a mere chronicle of surgical pediatrics. It strives at and attains a higher goal. There is a clear and consistent effort to present to the careful reader the practical essential differences between child-surgery and adult-surgery; between child-pathology and adult-pathology. Nor is this all—the book is new and up-to-date in the best sense because it not alone gives full credence and value to the importance of experimental medicine and surgery, but painstakingly seeks to make clear the relationship and inter-dependence of the surgery which in the past has erroneously been called 'practical' and that which has with equal error been styled 'theoretical' or 'experimental.' The author has wisely decided that modern surgery must necessarily be a combination of the two and the skill with which he has woven the intricate woof of modern surgical physiology and pathology into the strong basic warp of well-recognized surgical principles seems to the reviewer the most admirable fact of the entire work. Finally the author's great care in presenting essential details should be commented on favorably——"

In making changes for the second edition I have endeavored to live up to the principles integral in the first and have also given due consideration to and endeavored to profit by all criticisms.

Considerable new matter has been added—not every thing new that has been proposed—but such as will likely have permanent interest and value. A few subjects have been entirely rewritten. Among more than a hundred emendations, may be mentioned:

Transfusion with Brewer's tubes, arthroplasty, motion after dislocation and other joint injuries, anomalies and deformities of the skull, Abbott's method for scoliosis, tonsillectomy, fistulæ and cysts of the neck, Cook's operation for relapsed clubfoot. Altera-

[1] N. Y. Medical Record, July 24, 1909.

tions have been made mainly by insertions and condensations so that there are only 25 more pages in the entire book. A number of notes have been placed in the form of an appendix, with appropriate reference numerals in the main text. I have adhered to the plan of avoiding statistical arguments as too cyclopedic for the scope of this work, and have introduced case reports only where the concrete example would serve better than a general statement to present the subject. A number of new illustrations have been added. The book is offered with a realization of its limitations, but in the hope that it will be equally as well accepted as the first edition; and that it will be even more widely read, for never before has the growth of interest in the subject been equal to that of recent years.

SAMUEL W. KELLEY.

CLEVELAND, OHIO, August, 1913.

HISTORICAL AND PREFATORY

SURGICAL pediatrics was later and slower in its development as a special department of study and practice than medical pediatrics.

As is well known, numerous writers from the ancients down have alluded to the behavior of disease in children—the surgical occasionally, as well as the medical—and yet as late as 1846, when Coley wrote an introduction to his "Practical Treatise on the Diseases of Children," he made the following statement: "I am not aware, however, that any author, British or foreign, has published a work comprehending all the diseases incident to children and their appropriate surgical, as well as medical, treatment. This omission may be accounted for by the division of the profession, which has limited the education and practice of physicians who have hitherto been the principal or only writers on infantile disorders."

This remark Dr. Coley makes after professing himself acquainted among modern writers, with the works of Astruc, Armstrong, Hamilton, Cheyne, Heberden, Becker, Plenk, Burns, Capuron, Clarke, Gardien, Comet, Gölis, Dewees, Underwood, Billard, Meissner, Marley, Maunsell and Evanson, Barrier, Barthez and Rilliet, Rees, etc. I am ready to vouch that Dr. Coley's statement is well founded, for on perusal of many of the authors he mentions, and others not in his list, it becomes evident that none of them had given adequate attention to the surgical side of children's diseases.

Take, for example, Underwood—writing in 1795—who devoted 188 pages, or Part I., of his second volume to "All such complaints as may fall under the province of the surgeon, with others that may be said to be of a mixed kind which," as he says, "should be all familiar to every accoucheur." But Underwood addressed his text as much to the laity as to the profession, and there is little or nothing in it to enlighten or guide the surgeon. Even John Syer, surgeon, of London—who, being a surgeon, might be expected to do better in this respect—in his treatise written in 1812, presented no topics which might be called surgical, excepting purulent ophthalmia, croup, and rickets. Under croup, he did not even mention operative measures. However, tracheotomy, although known, was little esteemed until Trousseau's revival of it in 1850-57. As to rachitis, Syer gave no definite account of the deformities, and

only a general description of deformity apparatus. For these, as for other diseases, he presented "The General Principles of Their Domestic Treatment."

Dewees' "Treatise on the Physical and Medical Treatment of Children" (1826) included ophthalmia, croup, hip-disease, hydrocele, herniæ, and several skin affections, but even these few surgical topics cannot be said to have been handled surgically.

Eberle's book (1833) had practically nothing surgical. Billard —the English translation of whose work appeared in 1839—included in his treatise diseases of the skin, herniæ, prolapse of the rectum, intussusception (at least the kind found postmortem), malformations of various parts, and also fractures—intrauterine and of the new-born. But he pointed out no differences between those abnormalities and similar conditions in the adult, nor did he give the treatment for them. His attention was centered on "Recent Clinical Observations and Investigations in Pathological Anatomy," for this was the period of a new enthusiasm in that branch of medical science.

Evanson and Maunsell (1843) included syphilis, rachitis, skin diseases, foreign bodies in the larynx, fractures, herniæ, nevi, tongue-tie, hare-lip, spina bifida and ophthalmia, imperforate anus, and various deformities of the genito-urinary organs. Although they sometimes advised and described the treatment then considered appropriate for these difficulties, their general attitude seems to be expressed in a remark which appeared in connection with making an artificial anus in the groin (page 138), as follows: "The operation would be a very hopeless one; but a consideration of its merits, and of the exact modes of performing the other operations, belong rather to the province of the surgeon than of the child's physician—who, in that capacity, has merely to ascertain the nature of the deformity, and must draw upon his own general knowledge of surgery or apply to another practitioner for the means of its removal."

These authors mentioned are but examples. Others who might be cited—for instance, Stewart (1843)—were much like them. So that it appears to be true that physicians had until then "been the principal or only writers upon infantile disorders," and had made little progress in surgical pediatrics.

But Coley purposed, as every good author should, to do better than his predecessors, and in the matter of surgical diseases he in some degree succeeded. He not only discoursed on the herniæ, imperforate anus, clubfoot and other distortions, hare-lip, laryngotomy and tracheotomy, foreign bodies swallowed or lodged in the pharynx or in the vermiform appendix, prolapsus ani, pyothorax, vesical and urethral calculus, imperforate urethra and vagina, phi-

mosis and paraphimosis, diseases of the joints, burns and scalds, spina bifida, and other surgical topics, but he advised and described the surgical treatment which experience or the literature up to his time had taught him. He also treated of diseases of the eyes and of the skin quite extensively. But Coley's book seems to have attracted little attention.

J. Forsyth Meigs, writing in 1848, presents nothing surgical, although his work more nearly equaled the quality of those on general medicine than had any upon diseases of children up to that time. Nor can the lectures of Charles West, the most admirable clinician and oft-quoted writer of his time, be said to deal with both sides of his subject.

In Churchill (1850), a few topics, as tracheotomy, paracentesis for pleurisy, hare-lip, cleft palate, imperforate anus, and spina bifida, receive some surgical handling. Condie does not consider that surgical subjects fall within the scope of his treatise.

But by this time the knowledge of anatomy, of physiology, of pathology, and of the history of diseases and injuries had increased to such an extent, the observations of practical surgeons had so accumulated, and the establishment of hospitals for children had so improved the facilities for the study of their diseases that their peculiarities and their importance could no longer be quite ignored by the profession.

About the year 1850, in Paris, while Trousseau taught the diseases of children, the surgical side was taught by Giraldès, who, however, published little in permanent form until later.

In 1855, J. C. Forster, in London, had been making "A few remarks on the surgical diseases of children," and in 1860 his 8vo volume was published. It was also in the year 1860 that A. A. W. Johnson delivered, at the Hospital for Sick Children, a course of "Lectures on the Surgery of Childhood."

In 1863 we find that the Council of the Medical Society of London, "recognizing the importance of this subject, have been led to believe that the interests of its members might be promoted and the profession benefited by having their attention drawn from the broad field of general medicine and surgery to the comparatively small one of the diseases of children, and on the strength of this belief have, abandoning the custom by which they have been hitherto bound, defined the subjects for the Lettsomian lectures," and they nominated as lecturer, Mr. Thomas Bryant, who delivered three admirable lectures on the surgical diseases of children.

M. Giraldès, in Paris, had been followed as the leading teacher, by Guersant, whose "Notices sur la Chirurgie des Enfants," a series of very pointed and practical papers, found their way into an English translation for publication about the same time.

The work with both scalpel and pen, of the pioneers in this special line, had now become so valuable that still further interest was aroused and talent engaged in its behalf.

In 1869, Timothy Holmes issued his "Surgical Treatment of Children's Diseases," a book of nearly 700 pages, and in quality well worthy of its great author.

You will please observe that Holmes omitted, from the first edition, some special subjects, viz., diseases of the eye and ear, orthopedics and diseases of the skin, "not," he says, "because I am in favor of cutting up surgery into little pieces, but because the volume had already exceeded what I had intended, and these subjects are all excellently treated in works which are in everybody's hands." However, in the second edition—yielding to a sense of the fitness of things—he added a chapter on orthopedics. I mention this point in particular to illustrate the fact that the other specialties had advanced so much faster than pediatrics, and particularly than surgical pediatrics, as to have completely outstripped it in development as a distinct branch of our profession.

This statement is capable of verification by reference to the history of the other branches, and is particularly shown by the specialties of the eye and ear, skin diseases and orthopedics, and later gynecology. Obstetrics, which, synchronously with anatomy, had become separated in the work of the medical schools from surgery, had remained in practice more distinctly in the hands of the general practitioners. But obstetrics, fecundated by its former companion, surgery, gave birth to a charming daughter, gynecology, who soon grew to maturity, came out in society with the greatest eclat, became the reigning belle, and turned the heads of many susceptible young men for a long season. Thus gynecology, with other specialties, chronologically took the lead of surgical pediatrics.

It is curious to observe in this connection that the "Compendium of Children's Diseases," of Johann Steiner, of Prague, which appeared about this same time, had for its English translator no less a personage than Lawson Tait, who added a few notes on the "Surgical Ailments of Children." One can but speculate on what might have happened if Lawson Tait had felt a greater attraction for surgical pediatrics than for gynecology.

But my cursory sketch has brought me down to times almost within the recollection of the majority of my readers. You are familiar with the record of the last thirty and the magnificent work of the last twenty years in the surgical diseases of children.

To continue a comparison among the recent achievements of those still active in professional life would require a nicer discrimination and might involve greater consequences than I care to

assume; but I may at least mention, in passing, and almost at random, the names of Pooley, Marsh, St. Germain, Fumagalli, Bassini, Willard, Ribiera y Sans, R. W. Parker, Charon and Gavaert, Karewski, McEwen, McClellan, Keen, Ridlon, Taylor, Wharton, Packard, Morris, Morton, Phocas and O'Dwyer, Senn and Murphy, Fenger and Matas, Stiles, Kirmisson, Broca, Frölich and Estor, although I have omitted scores of worthy authors, brilliant investigators, and able practitioners, whose writings have been turned to account in this field. Some of them I shall have occasion to credit later, but shall make no attempt to give numerous references to the literature consulted. I have freely availed myself of the clinical and pathological writings of medical pediatric teachers of the present time, whose names are familiar to all who work with children. But I must here express my admiration for those surgical works which have been presented to the English reading profession by Timothy Holmes, Edmund Owen, and D'Arcy Power in special treatises, by G. A. Wright, and by numerous contributors to Keating's great cyclopedia, and acknowledge my indebtedness to their guidance in my practical studies of the surgery of childhood. I have endeavored to pay my debt to them and to the profession by adding my own mite of observation and experience. At the date of this writing no American has yet produced a book devoted entirely to pediatric surgery, and to adapt a treatise to present conditions of medical education and practice must be regarded as a pioneer endeavor. We are yet far from the ideal state, either of the study or the practice of surgical pediatrics.

I am indebted to Dr. Wm. J. Butler, of Chicago, for the Sections on Opsonins, Opsonic Index and Vaccine Therapy, and on the Diagnosis of Syphilis from the Blood; and to Dr. Homer J. Hartzell and Dr. Henry Jenkins, of Cleveland, for work upon the Index.

My thanks are due the publishers for their liberality in extending the size of the work far beyond the bounds at first projected and permitting an equally generous use of illustrations.

The illustrations, excepting otherwise marked and credit given, are nearly all of them from photographs taken and sketches made by myself.

S. W. K.

CLEVELAND, Ohio.

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CHAPTER I

EXAMINATION, CASE-TAKING AND GENERAL SUBJECTS

EXAMINING AND CASE-TAKING—ANESTHETICS—ASEPSIS AND ANTISEPSIS—BANDAGING, DRESSING AND THE APPLICATION OF SPLINTS—HEMORRHAGE AND ITS CONTROL—SHOCK—AFTER OPERATION—LAVAGE, GAVAGE AND RECTAL FEEDING—ANATOMY, GROWTH, AND DEVELOPMENT.

EXAMINING AND CASE-TAKING

THERE should be children's surgeons as well as children's physicians; or, "if one objects to cutting up surgery into little pieces," as Timothy Holmes says, it should at least be required that the surgeon extend his knowledge to pediatrics. Thus only can he be qualified to practice successfully among children. Moreover, he should possess in eminent degree, sympathy, tact, patience, firmness, and gentleness in dealing with his little patients. His observing and reasoning powers should be of the keenest, for often all depends upon the objective signs and symptoms, the patient lending no aid. In examining and in operating, his touch should be accurate and delicate, for the tissues of the young are softer and more frail, and the structures and spaces smaller than in the grown-up.

The temptation to hasty and superficial examination of cases incident to all lines of practice are greatly increased in the cases of infants and children, whose speechlessness, fright, unruliness, lack of comprehension and compliance, and natural restlessness, together with the numerous peculiarities of their disorders, render the task so difficult and tedious that one is tempted to end the interview by making a guess at the condition. But if the surgeon be possessed of the proper qualifications and trained in his art, he can almost invariably proceed step by step unfailingly to secure the necessary information and complete his examination and diagnosis. Again, the novice in pediatrics, witnessing the facility with which the experienced practitioner proceeds to his examination with well-directed questions and deft touches, and goes straight to a diagnosis which proves to be the correct one, is apt to imagine that anyone can easily do the same. He fails to recognize that what seems like divination is the result of knowledge, and of skill acquired by innu-

merable careful systematic examinations and long experience; and he does not realize that the examiner makes many observations with his eyes and ears and with his senses of touch and smell and temperature, and performs a numerous series of reasoning processes during the time that he appears to be only chatting with the mother or playing with the child before performing any ostensible examination. It will not be necessary in every case to make a complete record by all the means described below, but it is advised that the student of pediatric surgery make a systematic examination of each case before he ventures upon diagnosis and treatment.

In emergency of injury or disease the surgeon may come directly to the special or local examination of the wounded or affected parts and proceed at once to apply the appropriate treatment, reserving until afterward the systematic survey of the patient's history and health conditions when such may have an influence on the case. But in most cases it is better to proceed methodically and elicit the history in chronological order and logical sequence. I have small respect for the judgment of a surgeon who fears to hear the history before he examines the case, lest his opinion be prejudiced. It is especially desirable in the case of a child that the history be heard first, so that the examination can be rightly directed and an injured or painful point not unexpectedly encountered, or an exploration not unnecessarily repeated. In answering questions upon the history, while the patients themselves do not, as is sometimes the case with adult patients, try to deceive the surgeon, parents or guardians often make misstatements—either unintentionally through ignorance, or intentionally, when by doing so they may hide their own carelessness or negligence. It is sometimes better to hear the history in the absence of the patient, or while he is asleep, during which he should be inspected, and perhaps also handled. If a written record of the case is to be made, the date will of course be noted, then the name of the patient, following which should appear the name and address of parent or guardian. The age of the child should be recorded, and if it be under four years the fractions of a year should also be indicated; if under two and a half years the fractions should be expressed in months. In the rapidly changing conditions of early life a few months, and in the new-born babe even a few days or hours, make a great difference in the disorder that is likely to be present, or in the result of an injury, or in the advisability of an operation and in the probable outcome of the case. Consider, for instance, an intracranial hemorrhage, or a fracture, or an imperforate anus, or a cleft palate.

Sex should be noted in the case record; although, aside from the malformations of the genito-urinary organs, the surgical dis-

eases of the sexes are not so widely differentiated as in the adult. Young boys and girls are very much alike as to their ailments, as they are also similar in the characteristics of mind and disposition, which so widely vary in men and women. Still, little girls more often have gonorrheal vaginitis than little boys have specific urethritis; and boys show hemophilia, while girls do not; and more boy babies than girl babies are injured in the act of birth, and so on. With a little more age the differences in psychical, as well as physical, endowment, and consequently in habits and occupation begin to manifest themselves. For instance, we find the boy more often daring exposure and contracting empyema, while, on account of muscular weakness and more sedentary games and employments, more girls than boys have lateral curvature of the spine. Fortunately, aside from school life, which oftentimes is trying enough, occupation has seldom had opportunity to leave its brand upon the body of the growing child.

Race or nationality should be noted, for, while no race or nation is absolutely prone or immune to any disease to which the species is heir, it is often extremely interesting to trace the effects of race, and of climate, food, dress, and manner of life in producing or favoring diseases or injuries: for instance, the prevalence of rickets among Italians and Negroes.

If the case is one of disease, it increases the importance of inquiring into the family history. This inquiry, without offending or arousing the suspicions of the parent, should disclose any probability of syphilis, or of hemophilia, and even family tendencies to rheumatism, to neuroses, to tumor-growth. Although we now think that tuberculosis is but very rarely directly inherited, a predisposition to that disease may be a heritage; moreover, its presence in a family or in a habitation increases the chances for infection, so that the question of tuberculosis should always be inquired into.

Coming now to the personal history, one would like to know whether the child was born at full term, whether there was any difficulty, accident, or injury at the birth, or any infection or inflammation following the birth. Then whether the babe was breast fed or artificially fed, and if the latter, what was the food. What, if any, illness or injury previous to the present has the patient sustained. Answers to these questions may only serve to estimate the resistance to disease or the recuperative power, or an injury or disease may be the direct, the indirect, or the predisposing cause to the present trouble.

In taking the history of the present trouble it is well to fix the date of the onset as accurately as possible. Upon this point misstatements are particularly apt to occur. Sometimes these are readily detected, as when a mother declares that a pigeon-breast or a spinal

curvature came since last week's bath; but often one would very much like to know truly when a boy began to limp, or when a tumor first appeared, or when it first began to grow rapidly, or when the attack of poliomyelitis took place. Questions as to the acquired vices are very seldom appropriate upon the list for the young subject, yet one should not forget that frequently there are vices of feeding, and of the abuse of drugs and patent-medicines, and of tea and coffee, and even of alcohol.

As to the personal examination of an infant or a child, although the surgeon should have a methodical plan, it by no means follows that he can take the steps of his examination in the order he had planned. He should be prepared to begin at either end or any place in his list, or to vary his program instantly, according to the behavior of the patient; to interrupt any procedure at any point in order to make some other observation when the opportunity offers. But returning, he should continue with persistent patience until a satisfactory knowledge is secured. A child should always be stripped for examination, and this should be in a comfortably warm room. Exposure to cold is not only unpleasant and possibly injurious, but moderate cold increases the muscular tonicity and quickens the reflexes so as to be deceptive. If possible, observe the child while he is at play, as his instinctive attitudes and spontaneous movements, as well as his voluntary complaints, are more instructive than those elicited by the examiner. Hasten slowly. Nothing is to be gained and everything may be lost by haste or abruptness in the examination of a child. I have often noticed a child more obedient to signs than to words of command. He will understand pantomime more readily than language. For instance, you hold out your arms and he will come to you, but if you say "Come to me," he will turn the other way. It seems as if he regards your presence and your voice as two distinct causes of alarm, and it will take him twice as long to get used to both of them. Once fix the child's attention, and then be careful not to startle him, and he will obey you almost like the hypnotic subject. With older children one can accomplish something by talk, but even with them one should not talk too much about what he is doing or going to do, but chat about anything else—toys, games, school—while going on with the examination. Begin with the simple steps of the examination and come to the more difficult or alarming later. Children vary greatly as to fear and as to the endurance of pain under examination. It is wrong to prolong an examination painfully for the sake of eliciting the last iota of information unless the case turns on that last fact. But if a disagreeable thing should be done, one must have the firmness to do it. If a child is altogether vicious and intractable, it is useless to waste time in coaxing—complete the examina-

tion at once. It never pays to deceive a child by telling him that it is not going to hurt when the next moment gives you the lie. One may thus succeed for the moment, but the child's confidence is lost and was worth infinitely more. Better tell him it may hurt a little, but not more than he can stand, and you may be astonished at his fortitude. I have many times remarked upon the fortitude with which a child would bear severe pain, such as the placing of skin sutures or the reduction of a fracture or dislocation, when an anesthetic was inadvisable or not at hand. A general anesthetic should usually be given for thorough examination of painful or difficult cases, such as obscure joint injuries, severe burns, suspected intussusception, sounding the bladder, and the like. Sometimes the anesthetic is necessary for muscular relaxation, as in searching for tumor in suspected intussusception, or other abdominal tumor, or differentiating between muscular spasm and true ankylosis of a joint. Children do not relax the muscles upon request. They may if the attention is diverted, unless the muscle is spastic.

The child's height, weight, and degree of growth and development in proportion to its age should be observed. Also the state of its nutrition, the appearance of pallor, puffiness or edema, cyanosis, icterus, or skin eruption, cicatrices, ulcers, or discolorations. Observe the hair and scalp. Notice the size of the head and its relative size. At birth it should exceed in size the thorax, and not until between the second and third year does the thorax exceed the head in size. If the head is too small, one seeks for microcephaly; and if too large, for rachitis or hydrocephalus. Observe the chest—its size and shape and respiratory movements. Look for bulging or retraction of the intercostal spaces, for failure of expansion, or for distension of one side or region; for beaded ribs, or Harrison's groove, or the asymmetry of spinal curvature, or rickety deformity. Observe the countenance, with its play of expression, its look of transient pain or of continued suffering, of tetanic rigidity, of mental alertness or dullness, or apathy or vacuity. . Observe the special senses and speech, the teeth, tongue, throat, and nares. The lymphatic glands should be sought by palpation, and, if palpable, the cause sought. The heart and lungs, the liver and spleen, the abdomen and its organs, the hernial regions, the bladder and genitalia should each receive attention. The feces and urine may need inspection, or, like the morbid discharges of wounds, sinuses, the throat, genital organs, or skin lesions, or the blood itself require laboratory investigation. Too little attention is usually paid by the surgeon to the general condition of the child, the stage of its development, the state of its nutrition, and the condition of the other organs or systems than the one particularly affected; and even the afflicted member is too often looked upon as a mechanical prob-

lem—a field for the exercise of mechanical dexterity, operative technique, or as material for the testing of a favorite apparatus. A systematic examination of the patient will not only enable one to "take stock" of the organism as a whole, but may lead him to important discoveries of underlying conditions or of complications which would otherwise be overlooked. Complications are not so frequent in young subjects as in older, but they do sometimes occur; while it is certain that constitutional vices and chronic diseases are sometimes entirely ignored, the attention of the examiner being entirely taken up with a recent injury or a local manifestation of disease.

The extremities should be carefully examined in every case of acute illness in children. The digestive disturbances, the exanthemata and respiratory inflammations are so common that one's attention is apt to be drawn away from an acute osteomyelitis, or periostitis, or synovitis. The instinctive attitude and motor state of the limbs should be observed, and any change in position, motion, or outline noted. The hand should be passed over each extremity in a search for swelling or tenderness or heat, and the action of the joints should be tested.

The attitude and motor state are, in general, more reliable indices in the child than in the adult, and in the infant than in the older child. The younger the young patient is, the less are the attitudes and motions dictated by fashion, altered by customary occupation, influenced by habit or affectation, or assumed with the intention of deceiving. They may be modified not only by disease, but by bashfulness or fear. The attitudes and motions of a well child are graceful and easy; conversely, an uncomfortable or restrained or a constrained or awkward movement indicates disease or injury. A well child is active while awake and rests quietly while asleep. Conversely, if the conditions are reversed and the child becomes inactive while awake or restless during sleep, something is wrong with him. Muscles may be tense merely from cold, or from fright and struggling, or from pain, spastic contracture, or reflex irritation. General muscular relaxation comes from extreme prostration or brain disease. When a child which has been bed-ridden for some time begins to toss about, constantly changing position and at rest nowhere, it is a semeion of evil. Dressings should be examined and search made for some complication. In croup or other obstruction in the air passages it indicates very grave air hunger. If there has been hemorrhage it shows extreme anemia. In all cases it heralds the approach of nervous exhaustion. If the child lies on his back and cries whenever touched or moved, one thinks of pleuritis, appendicitis, peritonitis, scurvy, pseudo-paralysis, extreme rickets, synovitis. But it might be a distended bladder

or hernia. If he draws up his legs to lash out again and twist and turn himself, he likely has irritation and pain, but not inflammation. If the child who has symptoms of pleuritis and has been lying on the affected side, turns and prefers the dorsal decubitus, one will likely find a large effusion. When the patient with empyema, on whom thoracotomy or resection has been performed, refuses to lie on the affected side, it is because the drainage tube is too long or the dressing pads about it not properly placed, or the pillows so arranged that the wound is drawn asunder. Rigidity of the cervical muscles occurs with caries of the cervical spine, and with retropharyngeal abscess and rheumatic torticollis or diphtheria. The retraction of the neck accompanying meningitis, cerebellar tumor, pneumonia, or typhoid is not so apt to be confused. With opisthotonos in a wounded patient, one thinks of tetanus, but should bear in mind the possibility of meningitis or of overdosing with strychnine or nux vomica. Paralysis of cervical muscles, allowing the head to loll forward on the breast, is seen as a sequel of diphtheria. It is sometimes difficult to distinguish in young children between paralysis and what Fothergill called "the muscular listlessness of malnutrition." And care is necessary in differentiating between true paralysis, the pseudo-paralysis of scurvy, and the acute epiphysitis of hereditary syphilis. One has seen the pseudo-paralysis of scurvy mistaken for acute poliomyelitis, and syphilitic epiphysitis mistaken for traumatic separation of the epiphysis. If a single arm of a new-born infant appears paralyzed, very likely it is a birth palsy, but before concluding that it is due to injury of a nerve alone it is well to examine closely for fracture of a clavicle or separation of the upper epiphysis of the humerus, which may either simulate paralysis or be associated with it. If an older child refuses to use his hand or forearm and we find nothing wrong with them, we may discover that his collar-bone is broken. Or he will not put his foot to the floor, and after a while it is found that he has psoas abscess, pericecal inflammation, ureteral calculus, or a hernia.

The domain of the nervous diseases connected with children's surgery will not be entered upon in this chapter. The attitude and motor state characterizing hip-joint disease and diseases simulating it, of tetany, spinal caries and curvatures, the various fractures and dislocations, diseases and injuries of muscles, bones and joints, limp from strain or old fracture, will be alluded to in due course. Enough has been said here to illustrate the necessity of careful examination of the young patient and somewhat concerning the manner of the investigation. Something should be said of the body temperature and our respects paid to the overworked clinical thermometer. Temperature is an important symptom and should be watched. But its variations are by no means as significant in the

case of a child as of an adult. Even in health there may be a considerable daily variation, and with the unstable nervous organization of the child, very slight or transient causes, such as indigestion, fright or anger, will send the mercury up. The pulse, too, is subject to frequent changes in its rate from passing disturbances which would have no effect upon an adult. Respiration to a less degree exhibits this instability, so that a recorded rise or fall of any one of these should be considered in their ratio, one with the others, and in conjunction with other symptoms, such as the appetite, the cheerfulness and comfort of the patient, sleep, the excretions of bowels and kidneys, condition of skin and tongue and throat, the appearance of the wound, if one is present. If all is well otherwise, a transient fever is not alarming.

But a persistent fever, even though not high, is something to be carefully inquired into and watched with suspicion, and investigated again and again until its presence is explained. Conversely the absence of fever is no proof that a case is doing well, or that a wound has not suppurated. This, says Powers, is "perhaps because, as the young tissues are more elastic, the tension is less marked and there is less septic absorption." And perhaps the unreliable, undeveloped nervous organization sometimes works too little, as at other times too much. However explained, one has often observed the fact.

If only other instruments of precision were as convenient and as easy of application as the thermometer they would be more popular—the sphygmomanometer, for instance. Although the blood-pressure is not often a matter of great concern in pediatric surgery, it is well to know the normal. This has recently been investigated by Stowell (Arch. Ped., Feb., 1908) by observations upon 216 patients. He concludes that vascular tension is lower in childhood than in adult life. The following may be taken as the averages in health: In men, from 100 to 145 mm.; in women, 10 mm. less; in infants under 2 years of age, 75 to 90 mm.; 3 years, 91 mm.; 4 years, 89 mm.; 5 years, 95 mm.; 6 years, 96 mm.; 7 years, 102 mm.; 8 years, 101 mm.; 9 years, 102 mm.; 10 years, 112 mm.; 11 years, 102 mm.; 12 years, 111 mm.; 13 years, 107 mm.; 14 years, 110 mm.; 15 years, 109 mm.; 16 years, 117 mm.; 17 years, 103 mm.

The aid of the clinical laboratory must often be sought, and the chemical, microscopical, and bacteriological findings examined before one arrives at his final diagnosis. The percentage of hemoglobin in the blood, the leucocyte count, the differential count, and the iodine test for glycogen are all useful and valuable when considered in connection with the other symptoms and the history of the case. The normal amount of hemoglobin is comparatively high

in the new-born babe, being above 100. It falls rapidly for a few days and has reached 100 by the second week. It continues to fall for about two months, and then remains rather low for the first two years, after which it rises until about puberty. In young children the average is from 85 as the high to 65 as the low limit.

The normal total number of leucocytes per cubic millimeter is larger in infancy than in adult life. At birth they number 12,000 to 25,000. They diminish rapidly during the first few days, reaching 9000 to 14,000. The general average during childhood is from 6000 to 12,000.

The presence of a leucocytosis is evidence of an inflammation which the system is resisting. It should always be searched for in a case suspected of being an inflammation of pyogenic origin, such as septicemia, appendicitis, osteomyelitis, peritonitis, empyema, pyemia, and the like.

The absence of a leucocytosis does not deny the possibility of the presence of an inflammation, or even of pus, for either the system may be so overpowerd by the infection or so debilitated as to make no resistance of this kind against the disease, or the pus may have become walled off so that no further absorption is taking place and the leucocytosis has returned to the normal. If the leucocytosis is progressively increasing, it is probable that suppuration will ensue, and it is an indication for prompt operation under circumstances in which operation should forestall suppuration, for instance, in appendicitis.

One should not, however, be deceived as to the condition by a high leucocyte count, for this may mean leukemia and not leucocytosis, unless the number of polymorphonuclear cells is also increased. In the differential count of the polymorphonuclears it should be borne in mind that the normal frequency of the various forms of leucocytes is different in infancy from that in adult life, as may be seen from the following comparison:

	INFANT.	ADULT.
Lymphocytes	40-60	20-30
Large mononuclears	4-12	4-8
Polymorphonuclears	20-40	62-72
Eosinophiles	2-4	½-4
Mast cells		1/40-½

Leucocytosis may be present in wasting disease which is approaching a fatal end, this cachectic leucocytosis being either toxic or excited by terminal infections. Or it may be caused by severe hemorrhage or by malignant disease. Moreover, there is a transient physiologic leucocytosis following cold bathing and

massage and ingestion of food. There are a number of acute infectious diseases in which leucocytosis does not take place—for instance, measles, malaria, unmixed tuberculosis, mumps, and typhoid. Thus the presence of a leucocytosis may help to decide whether an inflammation is tubercular or pyogenic, or whether a known tuberculous inflammation has become complicated by a mixed infection; whether a swelling in the parotid region is due to some other infection than mumps; whether one has to deal with a typhoid or an appendicitis or peritonitis. The value of the leucocyte count depends not merely upon the actual number of leucocytes, but greatly upon the relative proportion of the polymorphonuclears to the total number of leucocytes. In the increase of leucocytosis they should maintain their relative proportion.

Leucopenia indicates serious malnutrition or severe anemia, or leukemia complicated by an infection, or infection with no reaction against it, and it contra-indicates operation under any but imperative circumstances.

Eosinophilia is one of the symptoms of malignant tumors, but it may also be present in leukemia, in trichinosis, in many skin diseases, in scarlet fever, in chronic bronchial affections.

The presence of glycogen in the leucocytes, as determined by the iodin test, confirms a diagnosis of non-tuberculous suppuration, and while not always present in suppuration, it may sometimes be found when the leucocyte count is low. If not found in the known presence of suppuration, it is presumptive that the inflammation is purely tuberculous.

The uses of electricity in the diagnosis of paralyses and their degenerations are the same in children as in adults. But its application is often accomplished with difficulty, owing to the fear and consequent struggling of the child, or, at best, the usual fidgetiness under excitement. The formulæ of the qualitative and the quantitative reactions in health and in disease, with descriptions of the apparatuses are fully laid down in the works on electro diagnosis and therapeutics.

The X-ray has a permanent place in pediatric as in general surgery, more especially in the field of diagnosis, but also in the study of anatomic development. In the first conflagration of enthusiasm which swept round the world after the announcement of this new and wonderful form of force, a great deal of damage was done, innocently enough, in the use of the powerful and treacherous agent. By dear experience it was learned that the use of the ray is not without danger. That, although extremely useful, it is not to be employed indiscriminately, unnecessarily, nor carelessly. It is capable of exerting powerful general, as well as local, effects, appearing insidiously, yet lasting persistently, which are as injurious in some

cases as they are beneficial in others. Not only do the well-known surface burns and painful keratoses and ulcerations occur months after the exposure, which at the time caused no warning sensation and no lesion, but profound alterations in metabolism, especially of the spleen, the lymphatic tissues, and the bone marrow.[1]

Inhibition of growth has been reported by several observers, and in adults sterility. We do not know whether permanent changes in the glandular structures of children might result. But one would not willingly take the risk. Special caution is advised in employment of the X-ray in the presence of nephritis, of toxemia, and of anemia or combinations of these conditions. The condition of the patient should be learned and the necessity or utility of the use of the ray carefully considered before it is resorted to.[2] This is particularly true in children, who should have all portions of the person not necessarily exposed protected from the ray and the time of exposure as short as possible. If the exposure must be repeated the intervals should not be too short nor the repetitions too many. Exact rules cannot yet be formulated, but these are the general principles. We should not, however, because of danger, abandon the use of so valuable an agent. The surgeon's knife and anesthetic also are deadly if used without caution, knowledge and skill. We are yet only learning how to use the X-ray properly. Knowledge is necessary to make intelligible radiographs. It is a simple enough matter to get a view with the fluoroscope, and even to make and develop a plate and print from it. But to have the radiograph show all that it should show, to have the position of patient, the distance of the tube, the direction, intensity and quality of the rays regulated, and all sources of error excluded and to do no harm to patient or operator, these are things, with many more, yet to be elucidated. Specialists are at work endeavoring to discover the laws involved and to standardize the whole apparatus and technique. Knowledge and experience are necessary to properly interpret a radiograph. We have, most of us, learned our anatomy first in the dissecting room and afterward in the practice of our art, but always looking at the surfaces of organs and tissues—not looking through them. Only in imagination had we seen them as they are, with length, breadth and thickness, until the X-ray revealed the three dimensions at one view.

Most of our anatomy was learned upon the adult cadaver, and afterward as pediatrists we were obliged to learn the anatomy of the child. Now we must again resume our studies and familiarize ourselves with radiographic anatomy before we can read with un-

[1] Edsall, Jour. Am. Med. Ass'n, Nov. 3rd, '06.

[2] Försterling, Centralblatt für Kinderheilkunde, N. Y. Med. Rec., Oct. 13th, '06.

derstanding the revelations of the X-ray. One has been amused to see a surgeon who would not think of breaking that good rule of comparing the diseased limb with the corresponding sound one, take up a radiograph of a child's extremity and remark upon it without pausing to think that he had not a normal radiograph for comparison and was quite unfamiliar with the radiographic anatomy of that period of development. Having studied the normal we may appreciate deviations from it. True, it is easy enough to see the shadowy presentments of fractured diaphyses and so to correct resulting deformities, especially if two views are taken in two different directions, as should be but is not always done. But these are the cases in which the diagnosis and the correction of the condition are perfectly easy without the X-ray. It is in the intraperiosteal fractures, which are more common in infancy and childhood than at any other time of life, and in the puzzling injuries near joints and epiphyses, and in the changes wrought by arthritis, osteomyelitis, syphilis, tuberculosis, tumor growth, in questions upon the normal or retarded development of skeletal structures, relative to renal and vesical calculi and to foreign bodies lodged in the respiratory or digestive tract or buried in the tissues, and of the position and condition of viscera—these are the cases in which knowledge of the normal radiographic anatomy, and skill and experience in the interpretation of radiographs are indispensable to the intelligent use of this agent. Unfortunately, this is a form of knowledge not accurately communicable in books, because the radiograph is only rightly read in the negative. Even the print fails to reproduce what is seen in the negative, and engraving is still more unsatisfactory. Only the rudiments can be acquired at second hand. Real skill must be acquired at first hand from the study of patients and negatives. When both radiographers and surgeons generally have reduced the making and interpreting of radiographs to more exact rules we shall have something intelligible and reliable; and a great number of the pictures now on our shelves will be cast aside because not according to standard.

Children are particularly attractive subjects for the radiographer, on account of their small size and ready permeability by the rays. But they are difficult subjects, for the reason that their cartilaginous bones are too easily permeated, and because absolute immobilization during the exposure is essential to fine work, and the child through fear of the crackling and flashing apparatus and the strange surroundings is the most difficult of patients to immobilize. Tact and patience, together with the avoidance of a strained or awkward position, aided by the compression tube, or finally an anesthetic, will secure success. The most frequent use of the X-ray in pediatric surgery is in the study and diagnosis of

bone and joint development, injuries and diseases; and next in usefulness the location of foreign bodies. The epitheliomata and the superficial forms of tuberculosis in which the ray has been found useful seldom occur in children.

Exploratory punctures and incisions, rectal, vesical and vaginal explorations, laryngoscopy, bronchoscopy, esophagoscopy, gastroscopy, rhinoscopy, otoscopy and other methods of examination have their applications in appropriate conditions in the surgery of childhood.

To complete the record of a case it would be necessary to add the diagnosis, noting any diagnosis that had been previously made, then the complications, prognosis, advice, operation, dressing or other treatment, progress, and result. In some forms of record it is useful, too, to mention whether an in- or out- patient, home or office patient, or where seen, and whether referred by another physician, or seen in consultation.

PREPARATION FOR AND MANAGEMENT AT THE OPERATION

Except in an urgent case the surgeon should see that the patient to be operated upon is in good condition, with all the organs not involved in the disease or injury working sufficiently well. Many an operation performed in the most workmanlike manner has failed of the desired result because the patient was ill nourished, anemic, exhausted or otherwise out of condition, and the operation badly timed. But extra precaution is necessary in the examination of children before operation on account of their liability to the sudden onset of diphtheria, the exanthemata, and especially scarlatina with its proclivity for attacking wounds. One may be obliged to do tracheotomy with diphtheria present and certain to infect the wound, or to amputate a limb or resect a joint, knowing that amyloid degeneration has occurred. But one would not undertake to correct a deformity or remove an innocent growth or perform any elective operation unless the general condition was first made as good as it could be hoped to attain. Examine the patient and take the temperature before any operation of expediency. Inquire whether he has had the exanthemata, especially if there is any scarlatina or other infectious disease in the house or among the playmates. Ascertain whether the child be a hemophiliac or be subject to convulsions (Guersant). The former should be especially prepared for an operation if it must be done, and in the latter case extra precautions may be necessary in securing the dressings. The results of some operations, for instance, a hare-lip, may be entirely frustrated by a convulsion. In preparing a patient for operation not only the heart and lungs should be examined

and the temperature taken, but the condition of the kidneys, stomach, spleen, intestines and blood should be ascertained. In all regulated hospitals there is a standing rule requiring a house doctor to make the necessary urinary tests of every patient before operation. But this is most apt to be neglected in children, especially if a specimen of urine be a little difficult to secure. Prohibitive kidney or heart disease are not common in children, yet do occur, and the surgeon should see to it that the order is thoroughly carried out and trouble avoided. The blood should be tested for hemoglobin in any case possibly anemic before any operation of election. If hemoglobin is low, general anesthesia becomes more dangerous, collapse more probable, recuperation and repair after operation less likely to take place. General anesthesia lowers hemoglobin. Sixty-five per cent. is a low normal limit in a child. This does not deny that operation may be successfully done if necessary, with a hemoglobin percentage much lower than sixty-five per cent. But it leads one, being forewarned, to avoid unnecessary risk when severe operation can be postponed, or to take extra precautions against shock, hemorrhage, and other untoward events in a case that must undergo operation.

In a jaundiced case, or in any case where there is certain to be a heavy blood loss, its coagubility should be tested. It is the part of prudence to inquire concerning hemophilia in the family of any case before any operation, and to test a suspicious case with a small wound.

A single laxative the day or evening before the day of operation does not always thoroughly empty the intestinal tract of fecal contents. A thorough clearing of the canal may require several days or a week or more, with careful regulation of the diet, and perhaps use of medicines to prevent fermentation. A stomach or intestines distended even with gas, while especially bad in an operation on abdominal or pelvic viscera, is an evil in any case requiring general anesthesia, or subjected to the shock of operation. In examining the urine the doctor should not, as is too often the case, content himself with a perfunctory test for albumen, but should use the microscope, and should not fail to test for bile, for sugar, and even for an excess of uric acid, and these examinations should be made upon more than one specimen. It is not only in cases of marked jaundice, as, for instance, in some gallstone cases of adults, that hemorrhage from bile-poisoned blood takes place, but in slighter cases of hepatic incompetence with bile eliminated in part by way of the kidneys.

In infants and children, prone as they are to frequent disturbances of the digestive organs, and in whom the integrity and highest efficiency of the nutritive functions is essential to successful

surgery, great attention should be directed toward the state of the nutrition, and to the food, before any serious operation. If removal to a hospital, or the nature of the operation will require a change in the accustomed food, this removal and this change should be made sufficiently long before the operation to demonstrate its safety and practicability. In an operation of any magnitude or difficulty, or where strict asepsis is necessary, it is best that the child should be removed to a hospital; this not only for the convenience of the surgeon and enabling him to do better work, but for the care of the child by experienced nurses. In some cases and circumstances the home may be made suitable by a considerable amount of preparation. But a trained surgical nurse should be called in to make the preparations and she should be one accustomed to the nursing of children. With children old enough to observe their surroundings it is expedient that time be allowed for the patient to become accustomed to the hospital or acquainted with the nurse; and with children accustomed to run about, a few days in bed before the operation will render them much more reconciled to lying still afterward. Minor operations, pus cases, or emergency work may have to be done at the home. Do not depend upon a parent of the child to hold it or otherwise assist during the operation. Parents are apt to grow nervous and unsteady, or by their emotion tend to excite the patient, or may even faint and draw off the attention of one of your assistants, or may suddenly and frantically refuse to allow the operation to proceed, and make a scene which will sorely try the surgeon's equanimity. It is best before beginning the operation or even the administration of the anesthetic to insist upon the parents and also any other children leaving the room, assuring them that everything possible will be done for the welfare of the patient, and they must quietly abide the result. The other children are excluded not only to prevent disturbance at the time, but because it is not wise to let children witness scenes of bloodshed. Their faculty of imitation is developed beyond their judgment, and their sensibilties, even if they are not shocked, may be perverted. It is usually asserted that children do not suffer from apprehension of an expected operation and are often indifferent or cheerful or curious about it. This, fortunately, is true of most young children; but occasionally with older children they suffer extreme dread, the vivid imagination of childhood adding tenfold terrors to the unknown ordeal. Here some judgment is necessary about allowing a child to know beforehand that an operation is to be done. It is well to avoid any display of instruments or apparatus; but sleight-of-hand smuggling of instruments is rarely called for, often a failure, and outrages the child's confidence. The best time of day for operation is usually as soon as possible after breakfast time. Though

children may not be much disturbed through apprehension, they are apt to be not only impatient but perhaps faint or depressed for want of breakfast. Power is quite right in insisting that when the operation is to be done at nine or ten in the morning the patient should take a good sized cup of warm milk at seven o'clock. In this country we are apt to use one of the beef-peptone or malted milk preparations, according to the child's age, or similar concentrated food with little bulk and almost no residue.

ANESTHETICS

The use of anesthetics is often indicated and seldom contraindicated in children. The child's fear should be overcome with gentleness and reassuring words. A few drops of perfume on the inhaler may aid. Anesthetics are more often required for purposes of examination than with adults. In examining all cases of severe injury, especially about bones and joints, if there is any doubt of the diagnosis it is well to anesthetize, examine, and then if necessary reduce and dress under the anesthetic. At the first dressing of a severe burn in a child a few whiffs of an anesthetic, as Owen suggests, are a merciful aid. In minor operations upon young infants, such as tenotomy for club-foot, reduction of simple fractures or dislocations, or circumcision, anesthesia is not invariably necessary. But with hare-lip, incision of the membrana tympani, or the application of the Paquelin cautery, anesthesia should be used. A painful procedure, even though not serious but prolonged, or likely to need repetition, like electrolysis for nevus, is best done under anesthesia. Anesthesia during intubation, and especially during extubation, is recommended by some authors, but is quite unnecessary. Tracheotomy requires an anesthetic unless the child is unconscious from asphyxia. The same preparation for anesthesia by testing the vital organs and unloading the primæviæ as would be done with an adult is necessary. While cardiac or renal disease which would make anesthesia extra hazardous or fatal are not common in early life, they can occur, and the status lymphaticus is not uncommon and should be looked for, as it is dangerous with any anesthetic, especially so with chloroform. Respiratory diseases which would affect unfavorably the use of an anesthetic are common, but readily demonstrable. With any obstructive disease of the respiratory tract chloroform is usually preferred to ether. The author cannot agree with those who assert that anesthetics, especially chloroform, are almost devoid of danger in children. He has several times seen alarming and twice very alarming conditions, though fortunately no death under their use. One of the worst cases was a boy of two years and another a girl of six. In both cases chloroform was the anesthetic. The symptoms were those of

suspended respiration, the heart continuing to act. Perhaps the feebler development of the respiratory as compared with the circulatory systems in children alters the effects as compared with adults. As a rule children bear anesthesia better than adults, with less nausea and quicker recovery. But it should not be too long continued. Semi-anesthesia is admissible in infants, and there seems to be less danger from reflex irritation while in this stage than in adults. In the young the stage of rigidity may be entirely omitted and complete insensibility quietly take place. As to choice of anesthetic, it is generally taught that chloroform is better as well as pleasanter for the young patient, because, their hearts being usually unimpaired, danger of a failure of circulation is less imminent, while their air passages being small the mucus secretion excited by ether is avoided. But of late years surgeons have turned more to ether as undoubtedly safer. In the Boston Children's Hospital ether is used entirely. In the Hospital for Ruptured and Crippled, New York, ether is always used excepting for quite young children or infants, when chloroform is used. Thus custom varies. Notwithstanding that various new agents are exploited from time to time or older ones revived, practice seems to adhere to ether, chloroform, the A. C. E. mixture, and one or other of these in combination with oxygen, the preference being for chloroform or ether. Thus nitrous oxide was tried again, but is not well borne by infants and young children. Ethyl chloride as a general anesthetic acts better, but while very powerful is so very transient in its effect that almost any operation that can be done with it can be done without it, or with a very little ether. I have had no experience with spinal or intra-neural, nor scopolamine-morphine anesthesia in children. Nor are local anesthetics often of use excepting to a limited extent upon the mucous membranes of older children, or the ethyl chloride spray for a skin incision. (1)

ASEPSIS AND ANTISEPSIS

Asepsis and antisepsis are fully as important in the surgery of children as in that of adults. The modern tendency to asepsis rather than antisepsis by chemical agents is particularly beneficent in its application to the surgery of childhood. The same antiseptic agents and precautions are employed and in much the same manner, but a few precautions and slight modifications of methods are necessary. Children are especially susceptible to poisoning by carbolic acid. Some surgeons have the same opinion of mercuric preparations, but my own experience would lead to the opinion that children are comparatively tolerant systemically of mercury, though the skin is easily irritated by strong solutions. Iodoform poisoning is complained of by some observers. The injection of iodoform

emulsion into tuberculous joints and cavities is nearly abandoned, not because of poisoning but because of failure of the object of its use. It is doubtless well to avoid too free use of it either in powder upon wounds as few surgeons employ it now, or in packing cavities with iodoform gauze, as is frequently done. Sterile gauze or cyanide or borated gauze can be used instead. In washing out suppurating cavities the danger of using carbolic or preferably mercuric, or still better, iodine or creolin solutions can be obviated by following the antiseptic wash with a free flushing out with sterile water or normal salt solution. Or the milder germicides can be employed. Such is Thiersch's solution—salicylic acid 2 parts, boracic acid 12 parts to water 1000 parts. Washing of cavities with anything is less indulged in than formerly. Of those mentioned iodine is perhaps most efficient. In many cases sterile normal salt solution alone answers every good purpose of the disinfectant solution. As dusting powders for wounds, finely powdered boracic acid, or boracic acid 6 parts to iodoform 1 part; or campho-phenique, or aristol, or zinc oxide, or bismuth subnitrate used freely. All dusting powders should be impalpably fine and sterile. They are of questionable utility as germicides excepting as drying agents, but if we use them at all they should at least not do harm.

In preparing the skin of a child for operation its delicacy should be borne in mind. One has seen it abraded by friction and green soap under the hand of an over-zealous assistant accustomed to preparing for operation the rugous, seamy skins of grimy mechanics and weather-beaten teamsters. Equal care should be used but less force. A piece of gauze or flannel should take the place of the scrubbing brush, and the soap be very thoroughly washed off with sterile water before the use of ether, alcohol, or bichloride, and these latter in turn should be followed by sterile water. It is easy to produce a dermatitis upon a child in preparing for operation.

BANDAGING AND DRESSING AND THE APPLICATION OF SPLINTS

Bandaging, dressing and the application of splints upon children constitute a fine art. Their limbs are often so rounded and soft, lacking the angular muscular and bony markings of later years, that bandages and splints easily slip about and become loose. If, in order to avoid this, the bandage is applied too tightly or too heavily, as is very apt to be done, the soft tissues are compressed, the circulation interfered with, the skin excoriated. The thoughtless or willful restlessness of the child adds to this difficulty. Carelessness in regard to wetting with urine or soiling the dressings is very annoying, and sometimes really hazardous to the welfare of the wound. Much care is necessary in keeping dressings in proper

position and condition. Rubber sheeting or oil-silk skillfully disposed in the dressings help to safeguard the wound. Sometimes it is expedient to fasten a waterproof conduit to the urinary organs by means of adhesive strapping. When splints or plaster bandages are liable to be soiled or wetted they should be varnished with a solution of shellac in alcohol, which dries quickly. Perineal bands can be treated in the same way, but can often be substituted by a piece of pure India rubber tubing, which withstands water, perspiration and urine. Splints, braces and trusses, plaster jackets and bandages should be frequently inspected to see that there is no undue pressure or chafing. The skin beneath their edges should be kept perfectly clean and dry, and powdered with equal parts of lycopodium and oxide of zinc, or powdered talc and boric acid, or similar dressing. Stuffing bits of absorbent cotton under only makes matters worse. When making a dressing everything that will be needed should be at hand before the work is begun. If the dressing is painful it should be completed with dispatch. Children will bear sharp, momentary pain bravely, but will break down if the pain or apprehension of pain is prolonged or repeated. In dressing an extensive burn it should not all be uncovered at once, nor be long uncovered. The fresh dressings should be ready, in sections, and after the cleansing quickly applied.

The Plaster of Paris Bandage or Splint is almost invaluable in pediatric surgery. Its adaptability to shape and its firmness, not to mention its cheapness, recommend it. Silicate of soda, molded millboard, poroplastic felt, leather, wood, woven wire, shaped sheet-metal, steel frames, and other materials have their uses and their advocates; but plaster of Paris still holds first place for general usefulness, for firm fixation without undue pressure at any point. Any surgeon knows how to put on a good plaster bandage, but not every surgeon puts on a good plaster bandage. There is an art in it that has to be acquired by practice. Fresh and fine dental plaster only should be used. It is generally used in the form of a roller of open meshed crinoline. The two and a half and three inch sizes are most frequently useful. Occasionally a two-inch roller will be handy for a small extremity. The dry plaster-roller being immersed in water till the bubbles cease to rise is then deftly applied spirally without reverses, each layer being rubbed over with the wetted hand; and this process repeated until the desired thickness is produced. Cold water delays the setting of the plaster and hot water hastens it. In England plaster is often used with "house-flannel," which is nearly as thick as a blanket. The flannel is cut to the size and shape suitable to the part to be splinted, and then having been saturated with a creamy mixture of plaster and water can be very quickly applied and secured in place with an ordinary or a plaster roller. Such a plaster splint can be more quickly removed than the

bandage put on spirally. In applying a plaster roller care should be taken not to draw the turns too tightly. The bandage need not be so thick as to be burdensome. It is important to have the parts to be bandaged held in the desired position before the application of the bandage is begun, during the entire time of its application and afterward until the plaster sets. To change the position after the bandage is on or partly on may cause ulceration or worse from pressure where it wrinkles. The parts should be carefully held without pressure upon the plaster until it sets firmly, which should take but a few minutes. While the plaster is still soft its edges should be smoothed and slightly everted with the finger. A spoonful or two of sugar in washing the hands helps in the removal of the plaster. Rubber gloves save time and preserve the surgeon's hands from roughness. The removal of a plaster bandage is difficult to those unaccustomed to the work. It can be done with a pocket knife, or better with a pruning knife. There are in the market numerous plaster bandage shears, saws, and other cutters which will not cut, and guards to protect the skin. My own preference is for Engel's saw or Esmarch's knife. The former has a crescentic blade like a Hey's saw, but much stronger. It is useful to cut a very heavy bandage or a jacket or cast which is to be "sprung" off and used again. The Esmarch knife is for ordinary use. It has a short, strong blade and a good-handle, the butt of which tapers to a wedge that is useful for raising or separating the cut edges. The trick of using the knife is in beginning at the edge and in cutting diagonally through the plaster instead of at right angles to the surface. The plaster having been wetted with water, which is just as good as acetic acid or anything else, the upper edge should be raised with the left hand and cut, and as the cutting proceeds one side is steadily drawn away from the skin surface. The old-fashioned Heister's mouth-gag is handy for separating the cut edges of a heavy cast. The plaster bandage is useful for immobilization of almost any part that is not subject to rapid swelling or does not require daily inspection or dressing. Even in these latter cases it can be used by making a suitable window over the wound or sinus. It is very useful in fractures after the first swelling has subsided. It is often used after hernia operations in children. Spinal caries is frequently and successfully treated by immobilizing with the familiar plaster jacket or collar, hip-joint disease with the plaster spica, and other tuberculous joints are kept at rest by the same convenient means. One of its most useful applications is in the treatment of clubfoot, in maintaining the corrected or overcorrected position after this has been obtained by force or by cutting operation; and no shoe, splint or other device is so successful and so safe in this class of cases.

HEMORRHAGE AND ITS CONTROL

The proportion of blood to body-weight is stated by physiologists to be, in the adult, as 1 to 12 or 14, or an average or 1 to 13, or about 8 per cent. In the new-born child the blood is about 5 per cent. of the body-weight. In a case of hemorrhage in an adult, very dangerous symptoms supervene upon the loss of one-half the total quantity of blood, and death ensues when a little over 5 of the 8 per cent. has been lost. A dangerous quantity from an original supply of only 5 per cent. would very soon ebb away. Does the smaller proportion of blood account for the fact that hemorrhage is badly borne by the infant?

But as "the individual does not perish from want of blood, but from want of motion of the blood," [1] and as the motion cannot be maintained without a proper degree of tension, it may be that the tension is originally low, so that a small loss serves to depress it fatally. One factor in producing arterial tension is the proportion between the volume of the heart as compared with the width of the arteries. According to Beneke, in the adult the volume of the heart bears the proportion to the width of the aorta, of 290 to 61. Before puberty it is as 140 to 50, while in the infant it is as 25 to 20. Is this the reason for low tension? However, arterial tension is influenced also by the vaso-motor system as well as by the caliber of the vessels and quantity of the blood. Can it be that the undeveloped nervous system of the young is at fault in maintaining vascular tension? The rapidity of blood loss is a large factor in producing the depression which follows, as was often observed in the days when phlebotomy was in common practice. The tissues are said to be more liberally supplied with arteries and arterioles in proportion to the veins, and consequently a less proportion of the blood would be contained in a slow-moving venous current. Does a child bleed more rapidly than an adult? Or have his blood elaborating organs a smaller working capacity? (2)

These queries are given for want of anything better to account for the generally accepted observation that children, and especially infants, bear hemorrhage very badly. Whatever the physiological reason, it is plain that he who essays to operate in vascular tissues upon a child should be versed in the methods and supplied with the means for the control of hemorrhage, and know the necessity for economy of blood. The Esmarch bandage should be used in all operations upon the extremities in which the subsequent oozing will not be especially detrimental, and in all dissections enough hemostatic forceps should be at hand, and used freely. When possible, vessels should be caught between forceps before

[1] Vergl. Auch L. von Lesser. Transfusion und Autotransfusion. Samml. Klin. Votträge ver. 86.

severing. When necessary, vessels should be tied, but fewer ligatures will be used in proportion to the number of hemostats, for the child's vessels contract well after the use of the torsi-pressure. Where there are oozing surfaces hot gauze sponges or irrigation with hot normal salt solution should be used; cavities may be packed with gauze: in suitable situations the thermocautery, the hot or cold wire snare or the galvanic knife employed, and every care exerted to save blood.

SHOCK

It has been my experience, and I believe this accords with the experience of all pediatric surgeons, that children bear starvation, hemorrhage, cold, and pain very badly, and that they suffer severely from shock under injury and operation. That peculiar condition of general depression which we call shock seems to be a composite of lowered states of various functions, which may vary somewhat in their several degrees, yet all contributing to make the picture of partially suspended animation. The patient is dazed yet conscious, the mental faculties clear but acting feebly. The nerve centers are slow to receive and to send out impulses. The cutaneous and other reflexes are slow if not absent. The pupils react feebly and are probably dilated. The skin and mucous membranes are pale, and the former covered with cold perspiration. The pulse is rapid and weak, the respiration shallow, and the temperature below normal. Last to be mentioned, but not least in importance, the blood pressure is lowered. Yet no one of these alone constitutes shock.

There is available much accumulated knowledge of shock, not only through the observations of very numerous clinicians, but through valuable experimental studies by Lennander, Crile, Erlanger, Hooker, and Howell, and many physiologists and surgeons. It is understood that shock may be produced by different causes, and that the various phenomena combining to make up the symptom group called shock may vary in their relative prominence in different cases. For instance, Howell distinguishes between vascular shock and cardiac shock. And yet we have not a complete understanding of the physiology of its production. Nor has any accepted classification been arrived at. (3)

In this unsettled state of knowledge it will obviously be impossible for me to offer anything conclusive on the subject of shock in children. Yet the observations of clinicians upon this subject have so far generally been borne out by the physiologists and experimenters, and it may be worth while to combine the accepted knowledge available with experience of the conditions as found in children's surgery and evolve a practical lesson for the pediatric surgeon. Reviewing the factors productive of shock as occurring

in the adult, it would seem that some of them are more powerfully operative, while others would scarcely ever enter into, the problem of shock in the infant or child. Starvation or malnutrition, athrepsia, is a condition clinical observation would lead one to consider particularly prone to the depressing influences producing shock. And while this is no doubt true of the adult, it is more emphatically true of the very young. The infant or the child whose nutrition is poor, who is losing weight, no matter whether this is due to disordered digestion or to an obstruction somewhere in the digestive tract, will, if subjected to operation, suffer a more than ordinary degree of shock and be slow and difficult to rally. This forbids operations of election such as that for hare-lip or hypospadias or other external deformity in marasmic or ill-nourished patients. It darkens the prognosis in operations for stenosis of the pylorus, stricture of the esophagus, or any obstruction in the digestive tract which has produced partial starvation.

Hemorrhage has long been known to be one of the powerful factors in the production of shock. According to Crile's researches it has this effect even if it does not, as usual, cause much lowering of blood pressure. All pediatric surgeons are agreed that hemorrhage is one of the principal causes of shock and bad operative results in the young, and practical as well as theoretical remarks on the subject will be found in a preceding section of this book.

Cold.—Exposure to cold is placed by Wright as next to hemorrhage in its depressing effect upon children. Whether this is due to their small size, the small volume of blood in circulation, or to the thinness and vascularity of the skin or to an easily affected heat center, might be difficult to determine. But the practical lesson is that the child upon the table should be well protected by warm clothing, exposing only the field of operation. The limbs should be protected by cotton batting bandaged on. If the operation is to be severe, it is best to use a water mattress at a temperature of 100 F. upon the operating table, or hot-water bags disposed about the patient. After washing the field of operation the wet towels or sheets should be removed, and dry sterile ones substituted, for a wet surface is soon chilled. Exposed tissues should be covered as much as possible with warm gauze. And the patient's bed should be so prepared for his reception as to maintain his animal heat.

Heat.—In this connection heat should be referred to as a cause of shock, both as in a case of burn and as summer heat. As is well known, burns of the skin-surface produce severe shock, and this in proportion to the area of the skin burned and not to the depth of the burn, the shock evidently resulting from the injury to the numerous nerve endings. Summer heat has not been classed as a factor particularly predisposing to shock, yet its known depressing

influence upon infants, and the prevalence of diseases of nutrition in the heated term, would incline us when we may, to choose a cooler season for operations of any magnitude.

Duration of Anesthesia and of Operation.—Anesthesia must be considered a cause of shock to which children are sensitive, although, as stated in a preceding section, it is well borne if not prolonged. Shock from trauma of operation bears a relation to the duration as well as to the violence of the traumatism. Every effort should be made to expedite the work. Everything should be in readiness before the work is begun, instruments in place and needles threaded. The patient should not be anesthetized beforehand and be kept waiting in anesthesia till preparations are completed. Nothing can be more exasperating to a conscientious surgeon with a child upon the table than a dilatory nurse or a fumbling assistant. Everyone assisting should be given to understand that from the word "Ready" every step is to progress without hurry but without delay to the completion of the operation.

The degree of the effect of manipulation of the various organs or tissues on blood pressure and as a factor of shock should be familiar to the surgeon. The important contributions of Crile to this subject are well known. Likewise the contributions of Lennander on the relative sensitiveness of different tissues. A discussion of these points need not be entered into here, as I have no evidence that the general principles involved are any different in children than those in adults. In connection with these two subjects of duration of the operation and the effects of manipulation, I cannot do better than to quote the following from Bloodgood's admirable article in Bryant and Buck's American Surgery: "Within certain limits of time, I do not believe that the general anesthetic or the exposure of tissues to the air is as important a factor in producing shock as the rough handling of tissue. It frequently, then, becomes a choice of evils, and personally I would prefer a little longer operation for a gentle dissection, bloodlessly, to a shorter operation with more hemorrhage and rough handling."

But the principle that the greater the injury or irritation of sensory nerves the greater the effect on the vaso-motor centers and the consequent shock, I think has a particular force when applied to children, because the delicacy of their tissues and the smallness of their anatomical spaces renders unnecessary and damaging trauma exceedingly liable to occur. Therefore with them the very gentlest manipulation, the most accurate dissection with the sharpest of instruments is imperative. Dragging upon organs or tissues and tearing or blunt dissection should be avoided even more assiduously than in the adult.

Other Factors of Shock.—We now come to mention briefly

certain other factors which are usually considered in a causative relation to shock. Fear or dread of operation or of a resultant impairment are absent entirely in the case of the very young. If surrounding friends are judicious enough to maintain silence as to the coming ordeal and its results, they are a very small factor with older children. If a child is comfortable and amused for the present hour he is happy. He has no regrets for the past nor fears for the future. He is not depressed by brooding over his condition, and after the operation soon becomes accustomed to confinement to bed and makes the best of it.

Autointoxication probably exerts the same baleful influence upon the child that it does upon the adult. There is no evidence to show that it is more or less. But excepting in cases of malformation of rectum, imperforate anus, or acute obstruction of the intestinal tract, such a " stercoremia " is very unlikely to occur. The chronic intestinal obstructions and obstipations comparatively frequent in adults are rare in childhood.

Alcoholism is an element of danger in anesthesia and in injury and operation which can be counted out of the list in children's surgery. Diabetes, whether as dangerous under operation as it is sometimes represented, need not be considered; and nephritis, while not common, could be found if present, and precautions taken. As to cases of infection, whether general or local, it is my impression that while the young are very prone to be attacked by them, the resistant forces also rally quickly, and there is more to be hoped from the young than from their elders under similar conditions. Anemia, whether in young or older patients, is not a promising condition for operation. Yet if Bloodgood's excellent advice were followed and the surgeon would insist upon a complete blood count in all cases where there is clinical evidence of anemia, or, indeed, in every instance, believing it more important than an examination of the urine, he would seldom get into difficulty because of anemia. Jaundice is a condition not very likely to be met in a child requiring operation, unless it were in the new-born. Then, if possible, the operation should be postponed.

Diagnosis.—The diagnosis of shock is easy in a typical case, but may be difficult in a slighter case; but instructions upon the diagnosis are not easy to write. The art must be learned, to a great extent, by experience. If one will remember the principal phenomena of a marked case and be prepared to observe them even though manifested in slighter or varying degrees, he will probably appreciate the condition of his patient in time to be of the greatest service to him. The dazed or listless condition of the mind, with the abatement of the reflexes and the pallor, are different from the alertness, the nervousness and anxiety and the flush

of the patient who is frightened or excited rather than shocked. The clammy skin, the rapid, feeble pulse, the shallow respiration, call for immediate attention to the condition of shock. The probabilities are that if the child survives the immediate effect of the injury, and shows any power of reaction, and there has been no blood lost, that he will recover from the shock. Or that if upon the operating table with a patient previously in good condition the anesthetic be immediately withheld, the operation suspended and treatment instituted, that he will recover. If the child was feeble, and especially if there has been hemorrhage, the prognosis is much darkened. If reaction takes place it will come but slowly and complications are likely to supervene.

Treatment.—Anything which could increase shock, such as an anesthetic, operation, manipulation of tissues, should be interdicted, even if the unfinished operation must be resumed at some future time. The patient should lie upon the back, with the head low and the feet elevated. The angle may be forty-five or more degrees, temporarily. Oxygen should be administered, especially if anesthesia had been used. Artificial heat should be applied to maintain the normal body temperature. Small doses of morphia should be used subcutaneously as soon as the patient regains consciousness, and if there is pain enough should be used to control it—remembering the susceptibility of the young to this drug. The extremities and abdomen should be bandaged firmly toward the heart, preferably with cotton beneath the roller. This is quickly and easily accomplished in children. Salt solution should be given at a temperature of 105 F., or at least above the normal, and also subcutaneously. If there has been hemorrhage a larger amount should be used than if there has not. If the condition is very critical the salt solution should be given intravenously. It is probable that if there has been no hemorrhage the salt solution will not be so efficacious in relieving the shock, but it is not harmful and should be used in all cases. The necessary apparatus is very simple, consisting of a needle or canula tied into the end of a yard or two of flexible rubber tubing, to the other end of which is attached a glass funnel, an irrigation bottle or a rubber bag. The ordinary fountain syringe answers the purpose. The apparatus as well as the solution should, of course, be carefully sterilized, and in every hospital should be kept ready for immediate use. The solution is made by dissolving dried granulated salt in sterile water in the proportions of a drachm to the pint, filtering into sterilized flasks, stoppering with non-absorbent cotton and sterilizing for one hour at a temperature of 220 degrees F. for three successive days. For intravenous injection one of the superficial veins in front of the elbow should be exposed, and this procedure, as D'Arcy

Power remarks, " is no easy operation in a bloodless child." It may be necessary to expose one of the venæ comites of the brachial instead. The vein being exposed and a ligature thrown around it, the needle or canula (the solution having been first allowed to run through enough to expel the air) is thrust into the vessel with its point toward the heart, and the ligature half tied. The solution is then allowed to flow, slowly, or more rapidly if the case is urgent. There is no danger of introducing too much of the solution, from a few ounces to a half pint, or a pint, usually. It is usual to allow it to flow till the pulse shows an improvement by becoming slower, fuller and with better tension, and then soon after, the canula or needle is removed, the ligature drawn tight and the tying completed, and the wound dressed. The needle or canula can be left in the vein for some hours and the injection repeated if necessary. Usually if a child is going to recover he does so promptly. Strychnine has lost its reputation with many as a remedy for shock, yet is still used by some, in at least one dose. Montgomery uses, also, aseptic ergot. Some use hot coffee or whisky with the salt enema. Adrenalin chloride in salt solution (1 to 20,000) is greatly recommended, but until it or some other agent can be proven more reliable and lasting in its effects, it will be better to depend on the salt solution, with position, oxygen and heat, and perhaps massage over the heart.

Hypodermoclysis is done with the same kind of apparatus as is used for intravenous injection. The skin of the pectoral region is prepared by antiseptic washing, and the needle (after allowing the air to escape) is thrust in at the outer edge of the pectoral muscles, pointing toward the axilla. Or it can be introduced at the lower angle of the scapula or over the flank or abdomen. The solution runs slowly till the tissues will not retain more without too much tension for rapid absorption. (4)

AFTER OPERATION

After operation (5) a good rule is to give a rectal enema of a few (two to eight) ounces of normal salt solution at a temperature of 100 degrees F., and if the operation was moderately severe this should be repeated at intervals of four hours for the first twenty-four or thirty-six, as it helps to prevent shock and allays the anesthesia thirst. The bed should have been carefully prepared with hot water bottles a half hour before the conclusion of the operation, and the child should be placed therein in the easiest possible position in regard to the wound, and yet so that vomited matters may readily escape from the mouth. He should be constantly watched till consciousness is fully established and he is taught not to toss about nor interfere with the dressings. Generally young

patients recover from an anesthetic sooner than adults. Oxygen, either in the form of the pure gas or obtained by free ventilation, is the best of treatment, but if nausea proves distressing and persistent, lavage may stop it. If pain is present it should be controlled by an opiate. Children bear severe or prolonged pain very badly. That is, it depresses them, and, following an operation, it adds to and prolongs shock. The opiate should be repeated as necessary until the pain abates. The following table from Holt gives the dose of the opiates most useful with young children:

	1 month.	3 months.	1 year.	5 years.
Paregoric	mi	mii	mv to x	mxxx to xl
Deodorized tinc.	m 1/20	m 1/10	m ¼ to ½	m 2 to 3
Dover's Powder	gr 1/20	gr 1/10	grs ¼ to ½	grs 2 to 3
Morphine	gr 1/1000	gr 1/600	grs 1/200	gr 1/30 to 1/20
Codeine	gr 1/300	gr 1/200	gr 1/60	gr 1/10 to 1/8

Used hypodermically, the effects of morphine are more prompt and more powerful, and caution should be used and the dose lessened. In case of great pain, more may be used than under ordinary conditions. But always time should be given for effects to subside before repeating the dose. The condition of the patient as to expression of countenance, attitude, color, the urine, stools, pulse, and temperature should be carefully watched, for the child, even less than the adult, notices his own functions and symptoms, and no surgeon should wait for any patient or nurse to make the first discovery of untoward signs. The temperature may go below normal at the close of the operation, notwithstanding that artificial heat has been used, but if pulse and respiration remain good, and especially if there has not been great blood loss, reaction comes quickly and may go to the other extreme, giving a rise of temperature of one, two or three degrees within twenty-four or thirty-six hours and then subsiding. This aseptic or reactive fever, which comes promptly, occasions little alarm. It is thought to be due to the absorption of the nucleins and albumoses occasioned by the wound. But a fever that comes later, after the first day succeeding the operation—that comes with a chill or with a slow rise—may mean mischief. It may be due to wound infection, or to bronchitis or pneumonia or nephritis, or one of the exanthemata, tonsilitis or diphtheria, or to autointoxication from the intestinal tract. Especially if the fever is accompanied by a furred tongue, foul breath, a disturbed or distended abdomen, and loss of appetite or a morbidly craving appetite, an active laxative may clear the situation. With children the chances of wound infection are greater than with adults, the danger of hypostatic pneumonia less, but of food pneu-

monia (?), the exanthemata, diphtheria, or digestive disorder more. Young patients demand food and can usually take food sooner after operation than adults. An infant will sometimes be nursed by its mother almost immediately after awakening from the anesthetic and show no bad result. A child will often be on "soft diet," or nearly on "full tray" on the next day after the operation, unless it be a cleft palate or abdominal case or there be other special caution necessary. In fact, there seems to be an almost incessant demand for nutrition by the child's tissues, and wounds will not heal or even remain aseptic unless the nutrition is assiduously kept up. If food cannot be given by the stomach, rectal feeding should be promptly resorted to in the operated case, lest, even if collapse do not result, recovery will be jeopardized or retarded.

If the nature of the wound and its dressings will admit, the young patient should sometimes be taken up in the arms of the nurse; at any rate its position should be changed. While not so prone to hypostasis or bedsores, this is useful. With infants and young children a certain amount of "mothering" seems to be a necessity. Without it they become apathetic and give up the fight for life.

An abundance of fresh air and sunlight should be provided. Because children's beds are small is no reason why more of them should be crowded into a ward. Too many people think any little corner will do for the child's bed. There is no class of patients who so promptly fade and languish when deprived of air and sunlight, and none will respond so quickly to their health-giving influence.

LAVAGE, GAVAGE AND RECTAL FEEDING

Lavage and gavage may be unfamiliar to the surgeon, and a short description will be presented here. Lavage may be called for in case of ingestion of poison or of prolonged vomiting after anesthesia. No especial pump or suction apparatus is necessary. A soft catheter of the caliber of the child's index finger, attached by a piece of glass tubing to two or three feet of flexible rubber tubing, connected with a funnel and a pitcher to pour the solution from, comprise the apparatus. Sterile water, normal salt solution, or solution of sodium bicarbonate, or, in case of poisoning, an antidote, are the fluids used. The patient is usually sitting, but may be reclining. Infants require no mouth-gag; older children generally do. The patient's hands should be restrained. The length of tube required to reach from the lips to the stomach can be measured off by the eye. It should not include the bit of glass tubing. An assistant holds the funnel and pitcher above the patient's head. The surgeon depresses the tongue with his left index finger and passes

the tube rapidly through the pharynx and into the stomach. The funnel is then elevated to allow the air or gas to escape from the stomach, and then lowered to allow any fluid contents to siphon off. A few ounces of the solution, warmed to 100 or 110 degrees F., are then poured into the stomach and then allowed to siphon off by lowering the funnel, and this process repeated until the water runs clear. If desired, a few ounces of water may be left in the stomach to allay thirst, if retained. In removing the tube it should be pinched between thumb and finger to prevent dribbling, and withdrawn rapidly, or vomiting will follow.

Gavage is forced feeding through the stomach tube. It is done in the same manner as lavage, and usually after a preliminary washing, the liquid food, partially predigested if desired, being left in the stomach. The tube should be pinched and rapidly removed, and the mouth held open for a moment to prevent gagging. If the food is regurgitated, more can be introduced at once. Nasal feeding is done in the same way, excepting that the tube is passed through a nostril. It has the advantage of avoiding gagging. It is useful in some cases of injury or operation upon the mouth or jaws. These methods, one or the other, are useful whenever, for any reason, the child cannot or will not swallow food, as after tracheotomy, intubation, fracture or tumour of jaws, hare-lip, cleft palate, and the like. Both the stomach washing and the forced feeding are quite safe and in constant use among pediatrists. Rectal feeding can be resorted to in older children, almost the same as in adults. But in infants the bowel soon becomes irritated, and, after a few feedings, rejects the enema.

ANATOMY, GROWTH, AND DEVELOPMENT

"It is worthy of remark," says Guersant, "that at the moment of the execution of the operation on children the task claims from the surgeon the most exact knowledge of anatomy, for, the region being of less extent and the spaces smaller, we are often obliged to limit the incisions and to give them only such dimensions as are absolutely necessary. The neck of a child of two years, for example, upon whom tracheotomy is to be performed, does not allow of the same field for action as in the adult. The incision of the perineum in a patient of the same age demands more care on the part of the surgeon in the performance of lithotomy. We should, in short, be well persuaded of a fact, of which many persons seem ignorant, that operations are more difficult in children than at a more advanced age." These words of a famous surgeon are true, not only because of the small size of the anatomical parts in children, but because of many peculiarities in their anatomy with which

it is necessary to be familiar. But these differences and peculiarities undergo continual changes with the development and growth of the child, and cannot be adequately described in a general way. They will be presented when we come to deal with particular organs or regions as they appear at the age and stage of development most likely to need the surgeon. However, it may be observed that all through infancy and childhood the skin is softer, smoother, and freer from rugosities and wrinkles than in the adult; and that the subcutaneous cushion of fat is thicker and of lighter hue, and gives a more rounded outline to the figure. But fat is not found abundantly packed about the internal organs nor padding the omentum of the child. The fasciæ and aponeuroses are well developed at an early age, but are more delicate than in the adult, and stretch and yield more readily to force. Therefore the fasciæ do not so certainly, as in the adult subject, determine the course of a burrowing abscess. The muscles are not only smaller, but their tissues are softer, and this, together with their lack of innervation, renders them weaker in proportion to their size than in the adult. The bones of the child are much less firm, but more elastic, and the periosteum thicker and more vascular and much more easily peeled from the bone and more closely attached to the epiphysial cartilage than in later life. All the blood-vessels are larger in proportion in the child than the structures they supply or drain. The superior development of the vascular system over other systems—for instance, the respiratory, the muscular, and the digestive—is most noticeable at or soon after birth. As development and growth proceed the respiratory system becomes more able for its duties, the digestive system is completed by the addition of the teeth and the elaboration of its glandular structures, by various modifications in its tissues and in its forms and their relation to other anatomical parts. The locomotor and prehensile apparatus not being requisite to early life in the present environment of human offspring, are slower to develop. The brain, after waiting for the development of the vascular, the respiratory, and the digestive systems, proceeds rapidly up to the seventh year. The nerves are of large size in the child in proportion to the structures they innervate, but their large size does not indicate great force, for the nerve centers are not completely developed. Lastly, the generative organs remain in a comparatively undeveloped state until puberty approaches, when they, together with all the structures derived from the epiblast, including neoplasms when present, display a great impulse of development.

The delicacy and softness of all the tissues in the young makes them liable to extensive injury in case of violence, and also more apt to tear out under undue tension of the surgeon's sutures, or to cut

through if his ligatures be too tightly drawn in tying. This softness and delicacy should be borne in mind when applying a tourniquet, when applying the taxis, when reducing dislocations or fractures, using an osteoclast or employing force for any purpose, even when retracting the lips of a wound or exploring a cavity.

It may aid the surgeon's observation of the growing child to borrow certain measurements from the artist. The ideal figure of an adult male (artistic ideals are copied from the most perfect specimens of the species) is eight heads tall. That is, the whole figure, from crown to sole, is eight times the distance from the level of the top of the head to the level of the chin; and the central point is at the os pubis. In the infant at birth the whole figure is four heads tall, and the point midway between the crown and sole is at the navel. At two to two and a half years old (the end of the period of infancy, the completion of the first dentition) the child is about five heads tall. At four to five years its head is one-sixth of its whole height. After the sixth year (the point when childhood merges into youth), growth in height proceeds more slowly, so that it is not until the fourteenth year that the figure is seven heads tall. Meanwhile, owing to the greater proportionate growth of the lower half of the figure, especially of the extremities, the central point has gradually traveled downward from the umbilicus and approached the os pubis. During adolescence—that is, from puberty until complete development—the figure grows about one head taller, and the adult type is attained.

The medical profession has long recognized the existence of great differences in height, weight, and bodily and mental development between different infants and children of the same chronological age. These differences are not merely because of sex; they pertain to the child's anatomy, physiology, and to mental and moral characteristics, and they obtain at all ages throughout the period of development to the adult. In other words, the chronological age of the child by no means indicates accurately his or her age from the anatomical or physiological point of view. In the words of Crampton, whose contributions have recently drawn attention anew to this subject, "It is vastly more important for us to know how far a child has developed, and what he is, than to know merely how many years and months he has lived, although the latter fact will always have a relative significance," and he formulates the proposition that physiological age should be taken as a basis of all record investigation and pedagogical, social, ethical, or medical treatment of children. Rotch has recently [1] presented studies looking toward the establishment of an index of anatomical or physiological age,

[1] Meeting of the Section on Children, Am. Med. Assoc., Chicago, June, 1908. Also Rotch's "Living Anatomy and Pathology," 1910, p. 49 *et seq.*

Table Showing Average Weight, Height, and Circumference of the Head and Chest from Birth to the Sixteenth Year. (Boas.)

AGE	SEX	WEIGHT		HEIGHT		CHEST		HEAD	
		Pounds	Kilos	Inches	Cm.	Inches	Cm.	Inches	Cm.
Birth	Boys	7.55	3.43	20.6	52.5	13.4	34.2	13.9	35.5
	Girls	7.16	3.26	20.5	52.2	13.0	33.2	13.5	34.5
6 mos.	Boys	16.0	7.26	25.4	64.8	16.5	42.0	17.0	43.5
	Girls	15.5	7.03	25.0	63.6	16.1	41.0	16.6	42.2
12 mos.	Boys	20.5	9.29	29.0	73.8	18.0	45.9	18.0	45.9
	Girls	19.8	8.84	28.7	73.2	17.4	44.4	17.6	44.6
18 mos.	Boys	22.8	10.35	30.0	76.3	18.5	47.1	18.5	47.1
	Girls	22.0	9.98	29.7	75.6	18.0	45.9	18.0	45.9
2 years	Boys	26.5	12.02	32.5	82.8	19.0	48.4	18.9	48.2
	Girls	25.5	11.56	32.5	82.8	18.5	47.0	18.6	47.2
3 years	Boys	31.2	14.14	35.0	89.1	20.1	51.1	19.3	49.0
	Girls	30.0	13.60	35.0	89.1	19.8	50.5	19.0	48.4
4 years	Boys	35.0	15.87	38.0	96.7	20.7	52.8	19.7	50.3
	Girls	34.0	15.41	38.0	96.7	20.5	52.2	19.5	49.6
5 years	Boys	41.2	18.71	41.7	106.0	21.5	54.8	20.5	52.2
	Girls	39.8	18.06	41.4	105.3	21.0	53.5	20.2	51.3
6 years	Boys	45.1	20.48	44.1	112.0	23.2	59.1	....	....
	Girls	43.8	19.87	43.6	110.9	22.8	58.3	....	....
7 years	Boys	49.5	22.44	46.2	117.4	23.7	60.6	....	....
	Girls	48.0	21.78	45.9	116.7	23.3	59.5	....	....
8 years	Boys	54.5	24.70	48.2	122.3	24.4	62.2	....	....
	Girls	52.9	24.01	48.0	122.1	23.8	60.8	....	....
9 years	Boys	60.0	26.58	50.1	127.2	25.1	63.9	....	....
	Girls	57.5	26.10	49.6	126.0	24.5	62.5	....	....
10 years	Boys	66.6	30.22	52.2	132.6	25.8	65.6	21.0	53.5
	Girls	64.1	29.07	51.8	131.5	24.7	63.0	20.7	52.8
11 years	Boys	72.4	32.83	54.0	137.2	26.4	67.2	....	....
	Girls	70.3	31.87	53.8	136.6	25.8	65.8	....	....
12 years	Boys	79.8	36.21	55.8	141.7	27.0	68.8	....	....
	Girls	81.4	36.90	57.1	145.2	26.8	68.3	....	....
13 years	Boys	88.3	40.04	58.2	147.7	27.7	70.6	....	....
	Girls	91.2	41.36	58.7	149.2	28.0	71.3	....	....
14 years	Boys	99.3	45.03	61.0	155.1	28.8	73.3	....	....
	Girls	100.3	45.50	60.3	153.2	29.2	74.1	....	....
15 years	Boys	110.8	50.26	63.0	159.9	30.0	76.6	21.8	55.5
	Girls	108.4	49.17	61.4	155.9	30.3	76.8	21.5	54.8
16 years	Boys	123.7	56.09	65.6	166.5	31.2	79.2	....	....
	Girls	113.0	51.24	61.7	156.7	30.8	78.8	....	....

based upon the development of the wrist joint, the appearance of the centers of ossification in the unciform bone, the epiphysis of the lower end of the radius, the cuneiform, the semilunar, etc. Whether it will be proven that the entire anatomy of the child and the stage of the development of its circulatory and digestive systems and its brain—in short, of all its bodily and mental organs and functions—corresponds to and can be determined by the state of one joint, or even of all the epiphyses or all the connective tissues, remains to be demonstrated.

Recent investigations [1] upon 200 subjects varying in age from infancy to adolescence, and in mental capacity from idocy to brilliancy warrant the belief that the ossification of the wrist of an individual is not an exact index of the state of ossification of the remainder of the skeleton. That while age, height, and weight increase in general with advance in carpal ossification there are so many exceptions found, in both sexes, as to make classification by such a method impracticable for regulating the life of the child. There was found no relation between degree of carpal development and quality of mind. The relation between the stages of puberty and those of carpal ossification is too indefinite to be used as an index of physiologic development. Carpal development when observed at intervals and considered with other factors may aid in estimating the rapidity of growth of the skeleton.

The changes that take place in the child at puberty are well worthy of our attention. Crampton's tables [2] show that at characteristic ages the sexually mature are more than 33 per cent. heavier, 10 per cent. taller, and 33 per cent. stronger than the immature. Yet the instability of the physical and mental organization at this period—the increased morbidity without increased mortality—should be borne in mind by the surgeon.

Newer applications of the idea of considering anatomical or physiological, rather than chronological, age, are more needed in pedagogical, social, and economic studies, where they have been neglected, than they are in medical or surgical lines, where the underlying principle has been studied with relation to normal development and in connection with achondroplasia, cretinism, rachitis, syphilis, and other conditions of faulty development or disease, as well as traumatism.

For the surgeon the study of the development of the joints and bones will always possess special interest on account of frequent injuries and diseases of these structures and the definite relationhip between their anatomical and physiological structure and condition and their pathological processes.

[1] Long and Caldwell. Am. Jour. Diseases of Children, Vol. 1, No. 2, Feb., 1911.

[2] Pediatrics, June, 1908.

CHAPTER II

GENERAL SURGICAL PATHOLOGY OF THE DEVELOPING PERIOD

MALFORMATIONS—GIANTISM—ACROMEGALY — ACHONDROPLASIA — TUMORS IN INFANCY AND CHILDHOOD—RETENTION CYSTS.

THE departures from the normal state which may appropriately be considered in a treatise on pediatric surgery may be divided, from the clinical standpoint, into three classes.[1] In the first class may be placed all those abnormal conditions which are found exclusively in children. To this class belong the congenital malformations, the obstetrical injuries, including meningeal hemorrhage and Erb's and facial paralyses, dislocations, cranial and other fractures, the early evidences of hereditary syphilis, separation of the epiphyses; croup, with its frequent demand for aëroporotomy; rickets, with its numerous deformities requiring surgical attention; eneuresis, pyloric stenosis of infants, hydrocephalus, cancrum oris and noma, certain herniæ and hydroceles, and certain varieties of tumor. In the second class may be placed all those surgical affections which, although not found exclusively in children, practically belong to the surgical diseases of childhood because of their far greater frequency at this time of life. To this class belong hemophilia, intussusception, prolapse of the rectum, hip-joint disease, tubercular dactylitis, post-nasal adenoids, enlarged tonsils, foreign bodies in the nose and ear, and cervical adenitis.

If, now, we include in the third class all those diseases which, when occurring in the child, present different phenomena, run a different course, reach a different termination, or react differently to treatment from the same diseases when occurring in the adult, we will find upon our list not only the fractures and dislocations and empyema, but the infections and nearly the whole list of surgical ailments, even if we do not mention orthopedic cases and numerous eye and skin affections which properly should be included.

Obviously, if I were to endeavor to assort into a pathological classification and to trace the structural and functional changes presented in all these abnormal states and to compare them in their resemblances and in their differences with like states when there

[1] This classification was suggested to me by the perusal of T. Holmes.

are such presenting in the fully developed organism, this chapter and this book would extend to inordinate size. It must suffice for the present purpose to present a brief account of the more common among them, in some of their phases in relation to surgical pediatrics.

MALFORMATIONS

Malformations may take their origin in an error of development of the embryo itself, or in some fault of its environment during intrauterine life. In some instances of the first class of cases the cause is still more remote than the individual embryo, having been present in the ovum or spermatozoön and communicated through the mysterious force of heredity or the laws of reversion or atavism. As conspicuous instances of inherent error of development, will be cited malformations occurring through failure in union of the visceral arches of the head and face and the dorsal and ventral plates, resulting in hare-lip and cleft palate, extroversion of the bladder, hypospadias, epispadias, exomphalos, branchial fistulæ, and at least some of the cases of cranial meningocele and spina bifida. Ano-rectal imperforations and malformations of pharynx and esophagus manifestly belong to the same general class. Here, also, belong the cases of fetal inclusion, supernumerary limbs, as tripodism, polydactylism, the dermoid growths; at least some of the cases of deficiency of limbs, club-foot and hand, and of syndactylism, and anomalies of the muscular system, transposition of organs, et cetera.

In the second class, in which malformation was acquired by reason of surroundings during the formative period, are the cases of intrauterine amputations of limbs or digits, and constrictions by amniotic bands; distortions of parts caused by pressure, as in at least some of the cases of clubfoot and of genu-extrorsum and the like; and dwarfing or suppression of a limb or a part, such as the lower end of the radius or ulna, causing clubhand. Of the causation of perhaps the majority of cases of clubfoot and many other deformities, there is at present no satisfactory explanation.

Some phases of this subject will be touched upon in the section on Teratoma, in the chapter on Tumor Growth.

A classification descriptive of the malformations has sometimes been used, arranging them in three classes, according to whether there was (a) excess of development, (b) deficiency of development, or (c) distortion of parts. Such a grouping need not be attempted here, but a description of such malformations as have a practical surgical, as well as a pathological, interest will be presented.

GIANTISM

In curious contrast with the normal growth and development

are those rare conditions in which gigantic growth takes place. This may be general or partial—that is, it may affect the entire individual, or only certain parts. General giant growth, which is symmetrical and complete, is very rare. In most cases the increased size is mainly due to increased length of the long bones. There is often knock-knee, or infantilism—usually a head of only average size, with very ordinary intelligence, and various stigmata of degeneration. The giant growth usually commences about puberty. Occasionally supernumerary organs, accessory ribs, etc., are associated with general giantism.

ACROMEGALY

Acromegaly, or Marie's disease, is closely allied to giantism. It presents giant growth of hands or feet, and sometimes also of the forearms and legs, or of some of the bones of the face, especially the lower jaw and the bridge of the nose. In the extremities the overgrowth of the bones is not as great in proportion as that of the soft parts. A marked peculiarity, and one which distinguishes acromegaly from giantism, is that the joint spaces are very wide. Osteophytes are apt to appear in the neighborhood of the joints. Of the special sense organs the eye suffers most in acromegaly. Pressure on the chiasm produces optic neuritis, exophthalmos, and narrowing of the vision fields, the degree of impairment varying with the amount of pressure, which may result in complete blindness. Enlargement of the pituitary body and disease of the thyroid are reported in connection with acromegaly, but the pathology of the condition is obscure. It is not to be confounded with elephantiasis, nor with enlargements in connection with the lymphatic or the vascular systems. Hemihypertrophy of the body or of other parts has been described. (6)

ACHONDROPLASIA

Strikingly different from the condition of giantism is achondroplasia, also called chondro-dystrophia fetalis, and, unfortunately, fetal rickets. It should not be confused with rickets, nor yet with hydrocephalus, nor cretinism. As its name indicates, it is a disorder of cartilage growth. This affects the primary cartilage, which should begin ossification early, but causes early cessation in its growth and a premature ossification. It does not affect those cartilages which normally remain cartilaginous until late in fetal life, and it does not affect those parts of the skeleton which are developed in membrane. Thus the vertebræ and the flat bones escape, while the long bones and the base of the skull are dwarfed. The bones of the extremities never attain length, but grow in thickness and flare widely and abruptly at the joints. They do not bow

as in rickets, and in rickets the flaring is gradual. The dwarfing of the base of the skull, with continued growth of the vault, produces the peculiar depression in the region of the eyes and bridge of the nose, with the expanded and overhanging forehead characteristic of these curious dwarfs. At birth the upper and lower extremities are very short, perhaps less than half the normal length; while the head is large, maybe an inch or two larger than normal, and appears still more so on account of its peculiar shape. The belly is large, and the skin has the appearance of being altogether too large, resting in folds at the flexures of the extremities. The fingers are short, of nearly equal length and each bent slightly outward at its middle, giving the so-called "trident hand." The infant may be born dead or may die soon, or may survive and even live to old age. Generally the babe develops slowly, both physically and mentally. Dentition is late, closure of the fontanel especially late, perhaps in the fourth or fifth year. Walking is delayed until the third or fourth year. The muscles appear weak and the tendons and ligaments loose. Later, bowing of the long bones may appear. In adult life great muscular strength may be developed. The mental condition remains backward, but not idiotic. Dwarfs of this class were formerly often employed as court jesters, on account of their odd appearance and usual amiable humor. The adults have normal sexual power. Achondroplasia is not regarded as a transmissible disease. In case of pregnancy of a woman thus afflicted, Cesarean section is usually necessary. No treatment for achondroplasia avails.

TUMORS IN INFANCY AND CHILDHOOD

One need not deny the possibility that some infectious agents or animal parasites as yet unknown may be the causes, primary or secondary, of certain forms of tumor, although the proof of either of these theories has not yet been produced. Neither need one repudiate the evidence of Virchow and his followers that without unusual irritation some tumors never would come into existence, and others never would change from benign to malignant, although it is also evident that there must be a predisposing condition of the cells or tissues which determines their peculiar behavior when the irritation is applied.

Nor should one refuse to believe if proof were adduced that either an endogenous infection or a toxemia produced within the system excites the abnormal cell-multiplication, which results in a neoplasm.

In using in this section a modification of Cohnheim's classification of tumors and definitions resulting from it, it is not assumed that his theory of tumor formation through defective develpment

satisfactorily explains all varieties of tumor, nor why, after lying dormant during a long time, embryonal rests proceed to proliferate.

There is no explanation or theory, neither among those purely speculative nor among those deduced from experiment or clinical or laboratory study, which is satisfactory and applicable to all cases, and consequently there is no satisfactory classification.

Certain it appears that Cohnheim's theory not only contains a good deal of truth, but that it lends itself well to the classification and description necessary in the teaching of science.

I know of no recorded observations more interesting and instructive, more illuminating to the subject, than those of Cohnheim and Maas with periosteal grafts. Small bits of periosteal tissues were set adrift in the jugular veins of animals. At intervals of weeks or months later the animals were killed and the experimenters found, as they had expected, that the grafts had lodged as emboli in the smaller branches of the pulmonary artery and had, true to their inherent genetic nature, produced bone. The size of each piece of bone was limited to the size of the lumen of the vessel in which the graft was lodged, and when sufficient time had elapsed the bone was entirely removed by absorption. Leopold, working with Cohnheim, made observations equally valuable. They placed grafts of mature tissue in the anterior chamber of the eye and peritoneal cavity of rabbits and noted the time of their growth to maturity and their subsequent removal by absorption. They also found that embryonic tissue taken from fetuses and transplanted in the same way showed remarkable vitality and power of growth—very much greater than that of mature tissue. Grafts of fetal cartilage increased two or three hundred per cent., becoming miniature enchondromata, and resisted the absorptive processes of the surrounding tissues for several months.

These experiments demonstrate the genetic fidelity of cells, the astonishing vital force in embryonic cells, and also they show the important fact of a physiological resistance which normal cells possess against the encroachment of abnormal growths.

It is easy, after following the steps of these experiments, to form a mental picture of a matrix of superfluous embryonic cells belonging to the epiblast or the hypoblast or the mesoblast, and either remaining in their proper situation or accidentally transplanted during the arrangement of the folds of the blastodermic layers—but arrested in their development and lying dormant, while the cells all around them continue active and go on with the development of the individual.

A tumor is a localized erratic growth from just such an arrested matrix of embryonic cells or degenerate cells. It differs from an hypertrophy in that the latter is a numerical increase of

tissue elements maintaining the structure and shape of the type of the part or organ affected. It differs from inflammatory enlargement in that the latter results from the presence of pathogenic organisms or their toxins and is the effect of such agents upon mature cell-tissues.

In treating of the subject of tumors one is obliged to bear also in mind the subject of retention cysts. It is perhaps as difficult to differentiate some of them structurally as clinically from true tumors. They are not true tumors. Retention cysts are produced by obstruction in the natural outlet of a gland, causing retention of its secretion or excretion, and changes in the wall of the obstructed cavity, and oftentimes of the adjacent tissues, by the dilatation and pressure.

We will leave to the pathologists to decide whether the matrix of embryonic cells from which the tumor springs is always of fetal origin or may be post-natal—produced by mature cells not capable of producing cells of a higher type—but producing degenerate cells, incapable of normal development or of the reproduction of cells of normal type.

It is conceded that the cell-type and structure of a tumor depend upon the germinal layer from which its matrix is derived, and it is probable that the character of the tumor depends not only upon the layer, but upon the stage at which its embryonic cells were arrested. (7)

The classification of tumors which adheres most strictly to their origin in the germinal layers is that of Senn,[1] who exceeds Cohnheim in his strict application of this theory, and whose classification has the merit of covering the ground in a comprehensive and comprehensible manner.

Reviewing now the varieties of tumor found in infants and children, we will begin with the Fibroma.

Fibroma.—These benign tumors, the type of the connective tissue tumors, occur anywhere that there is connective tissue. Pigmental moles are fibromata and are usually congenital. They are prone to undergo change into sarcoma or carcinoma. Fibromata may be single, and in one variety extremely painful; or may be multiple and appear by hundreds as small, painless, movable nodules in the connective tissue immediately beneath the skin, or as shotty enlargements along the nerve trunks.

Fibromata are sometimes found growing in the naso-pharynx, most often, but not always, springing from the fibrous covering of the basilar process of the occipital bone.

Fibro-angioma and fibro-sarcoma are not unusual in this

[1] "The Pathology and Surgical Treatment of Tumors," by N. Senn, to which the writer is greatly indebted in the preparation of this article.

region, almost always in boys and young men up to twenty-five. They are seldom seen under the tenth year.

Fibromata may grow upon the tongue; or upon the alveolar process, springing from the periosteum or from the peridental membrane and called fibrous epulis to distinguish them from carcinoma or sarcoma in the same situation. Fibrous epulis is usually small, dense, smooth in outline, and has a pedicle and may undergo ulceration. It bleeds freely, and sometimes, if the operator cuts into instead of around the base of the tumor before detaching from the bone, it will bleed copiously.

Fibroma may come from the connective tissue of the alveolar process itself and require chisel or saw for its removal.

Fibromatous tumors of the heart have been reported.

Keloid, which is a variety of fibroma, is occasionally found in childhood, and cases have been reported as occurring congenitally, but it is rare before puberty. Vaccination scars and pierced ears are sometimes the site of keloid.

Etiology.—Fibromata (including sub-varieties keloids and desmoids) are among those tumors apparently caused by irritation or trauma, and are, perhaps for that reason, less frequently found in infancy or childhood than in adult life up to thirty-five or forty years. However, as has been said, they do occur even congenitally, either alone or in combination with adenoma, lipoma, or angioma. According to Virchow, there may be an hereditary tendency to fibroma.

Symptoms and Diagnosis.—It takes its origin in mesoblastic tissues. It is smooth in outline and movable, being encapsulated. It is slow of growth. The more rapidly growing and more vascular uterine fibroma is not a tumor of childhood. Fibroma is painless unless connected with a nerve or pressing upon it or inflamed. It is less apt to ulcerate than papilloma. The skin covering a superficial fibroma is more apt to be stretched smooth and thin, atrophied, than the covering of a papilloma. In the latter the skin grows with the tumor.

Prognosis.—The amount of danger from fibroma varies with its location, as to whether it presses upon an important organ or occludes a passage. Another source of danger is its liability to undergo a change into a sarcoma, especially if irritated or wounded. Keloid is apt to return even if removed, and fibroid polypus may return.

Treatment.—Easily accessible fibroma should always be removed, on account of the danger of the transition to sarcoma. In fibroma of internal organs the risk of operation has to be considered and may make it more prudent to refrain from operation. But if the location is not extemely dangerous the tumor should be

removed. Being encapsulated, it should be enucleated, but if ulcerated or adherent, as a result of inflammation, it should be excised.

Myxoma.—Myxoma may be congenital, but most often appears as a red, pea-sized or cherry-sized growth at the umbilicus of the infant, the so-called fungus umbilici or polypus.

A rather common variety is polypus of the rectum, which is a soft vascular myxofibroma. It is attached to the wall of the rectum by a pedicle, and the pulling upon the pedicle may cause reflexly

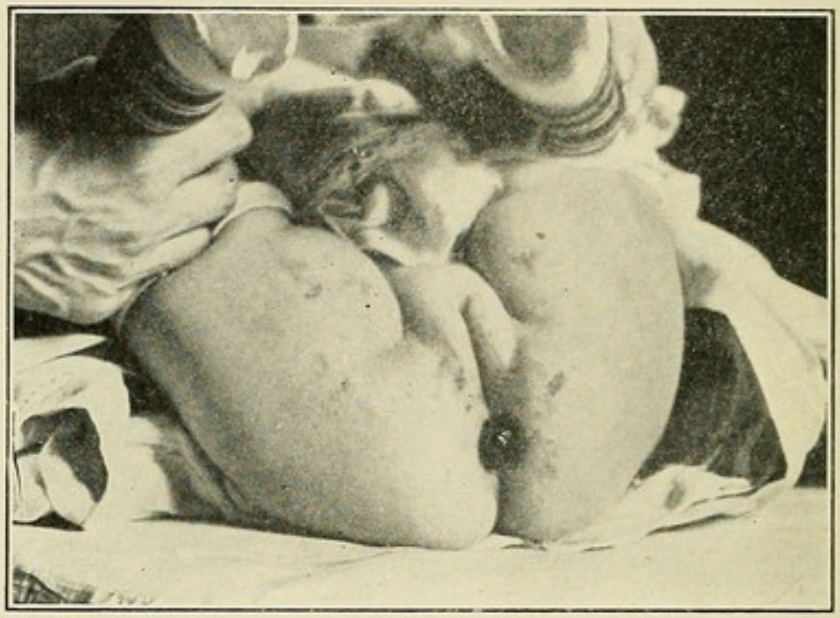


Fig. 1. Myxo-fibroma of rectum. The tumor may be located a finger length within the sphincter; but is sometimes attached so low and with a pedicle so long that it may appear outside.

great irritability of the bladder, and is almost certain to cause frequent stools, with tenesmus, pain and bloody mucous discharge. The tumor may be located a finger length within the sphincter, but is sometimes situated so low with a pedicle so long that it may appear outside during defecation, as seen in Fig. 1.

Some rectal polypi are adenomata, which may be multiple. D'Arcy Power does not call any of them myxomata but true adenomata, consisting of Lieberkühn's crypts, grouped irregularly in a stroma of fibrous tissue. But he says, "Cystic, fibrous and dermoid polypi occur as pathological curiosities." Pure myxomata occur as polypi of the nasal cavities, though not as frequently in children as from puberty on, usually following catarrhal inflammation of long standing. They are generally multiple, pedunculated and translucent, swell in damp weather or on taking fresh cold.

Polypi in the auditory canal also occur following chronic inflammation with moist discharge.

Myxo-lipoma will be referred to under the heading of lipoma.

The teratomata often have myxomatous tissue; and myxosarcoma occurs but is best classed with the sarcomata.

Symptoms and Diagnosis.—Myxoma is much like fibroma in its nature, and has an even greater tendency to change into sarcoma. It is soft, fluctuating, and translucent, and when located on the surface is small and sessile or pedunculated. When interstitial in its location it may grow large. A myxoma grows slowly, and if it takes on rapid growth should be suspected of having changed to sarcoma, and specimens taken from its base should be subjected to microscopic examination.

Prognosis.—Pure myxoma is benign, but its liability to undergo sarcomatous transition gives it a doubtful prognosis.

Treatment.—A myxoma should be removed. At the umbilical site the tumor may be snipped off and the wound touched with caustic. Sometimes it is sufficient to ligate the pedicle and use a drying powder, as oxide of zinc. The tumor and the moist surrounding surface will have disappeared in a few days.

Rectal polypi should be ligated through the base and snipped off. Although cure has resulted by avulsion performed by the sphincter ani, and in other cases by the finger or forceps of the surgeon, simple avulsion is not a good plan. Serious hemorrhage has occurred from the artery supplying the tumor; and also incomplete removal has been followed by recurrence.

Nasal and aural polypi are removed by snare or forceps or sharp spoon. Here again recurrence may follow unless the work is thoroughly done, the basal attachment being also removed and if possible the instrument followed by caustic.

Lipoma.—Pure lipoma, lobulated, circumscribed, encapsulated, is a rare tumor in childhood, though it is said to occur even congenitally; but fatty tissue, associated with nevus, with muscular, fibrous, myxomatous, cartilaginous or bony tissue or with giantism, or with congenital sacral tumors resembling spina bifida, are not uncommon. There may be general hypertrophy of fat, and in cretins the peculiar enlargements at the root of the neck, sometimes called "pseudo-lipoma." Lipoma is the most innocent variety of tumor, being dangerous only from its size or position. Like the sucking pads of infancy, it does not lessen during emaciation due to inanition.

Treatment.—Treatment of lipoma is excision. The treatment of combination tumors in which lipoma forms a part will be mentioned under appropriate heading. General hypertrophy of fat or "lipomatosis," and the fatty enlargements of cretinism have no surgical treatment.

Enchondroma.—Of the innocent growths occurring congenitally or in infancy and childhood, enchondromata are among

the most common. Chondroma of bone almost always makes its appearance before puberty. Chondroma in the region of the first branchial tract is more apt to show itself after puberty. They may grow sub-periosteally, or as frequently from the interior of the short long-bones. A favorite site is the phalanges, which they distort badly. They are apt to be multiple, perhaps affecting several or all of the fingers of one or both hands. They may appear in the parotid gland, in the testicle or the ovary or upon the cranial bones.

Hereditary influence is evident in some cases, trauma plays an important part in exciting the growth of the chondromatous matrix, and the rachitic condition predisposes toward if it does not actually produce cartilaginous tumors of bone. Enchondromata are hard unless cystic on the surface; and painless unless pressing on a nerve. They usually grow steadily and slowly but occasionally are rapid in growth, simulating malignancy in their rapid increase, as in the noted case, reported by Paget, of a little girl who had enchondroma of the upper two-thirds of the tibia which reached a circumference of two feet in eighteen months. Usually its slow growth and being multiple help to distinguish enchondroma from osteo-sarcoma. When unmixed, enchondroma is encapsulated. A strong steel needle may help to distinguish enchondroma into which it can be thrust, from osteoma, which stops the needle upon its surface.

The prognosis in pure enchondroma is favorable while it remains such; but its liability to transition into sarcoma should be borne in mind.

Chondroma of bone usually ceases to increase when the skeleton has attained its growth, but it may, when situated at the epiphyseal cartilage, seriously impair joint motion.

However, its removal may prove a very troublesome matter by implicating the joint. A pedunculated tumor can be extirpated; but if it involve the whole thickness of the shaft of a long bone it cannot be removed without amputation. Enchondromata springing from the interior of long bones must be removed from their depths or they may recur.

Enchondroma of the parotid gland may, after attaining a moderate size, cease to grow. Its proper treatment is enucleation, great care being taken to remove all the tumor and to avoid injuring either the facial nerve or the duct of the gland.

A small enchondroma of the testicle or ovary may be removed, but if large, castration or ovariotomy is indicated.

Osteoma.—An osteoma is a tumor composed of osseous tissue which may be either compact or cancellous. It is generally composed of cancellous bone covered with chrondromatous or myxo-

chondromatous tissue. Osteomata occur frequently in childhood, the time when bone growth is very active; and they often spring from near the epiphyseal line, the point of greatest activity in the bone growth.

There is much resemblance between the osteoma and the enchondroma and frequent mixtures and transitions occur. The osteoma, like the enchondroma, is hard to distinguish from inflammatory growth. It shows hereditary influence or a predisposing cause, may follow irritation or traumatism, is painless, apt to be multiple, slow of growth and may stop growing when the young patient has arrived at his full stature. Osteoma may be symmetrical on the two sides, different members of the same family or different generations may have the same bones affected. They spring from either bone or cartilage or connective tissue near bone, or other connective tissue or serous membrane, or testicle or parotid. A favorite site is the upper epiphyseal line of the humerus.

Pure osteomata are innocent and do not produce metastasis, but may require removal if they cause pain or interfere with joint motion. When thoroughly removed they do not recur.

Myoma.—Rhabdomyoma (composed of striated muscular fibers) is so rare as to be a pathological curiosity. Nevertheless, a number of writers since Zenker, including Cohnheim, Marchand and Eberth, have reported cases. When rhabdomyoma does occur it is always congenital. It usually develops in connection with kidney or testicle and, although complex in structure, when benign, is best described as a myoma, as that issue most truly indicates its genesis.

Myoma and myo-fibroma have been found in the heart muscle. Rhabdomyoma of the scrotum has been reported by Rokitansky, and another case by Neumann, in the testicle of a boy of three and one-half years. Striated muscular fibers were also found in a tumor of the parotid in a boy of seven years by Prudden. They have also been found in vesical polypus and in tumors of testicle and ovary. Striated muscular fibres occur more frequently in sarcoma, and are best, at least for clinical reasons, classed under that heading.

Leiomyoma (composed of unstriped muscular tissue), although of much greater importance to the surgeon of adult life, seldom presents itself to the child's surgeon. Myoma of the uterus (so common and so important) and of the prostate, practically belong entirely to adult life. Myoma of the uterus has never been known to occur congenitally, and it is stated that the youngest patient ever known with that disease was ten years of age.

Neuroma.—Ashby and Wright report the case of an eleven-

year-old girl who after years of suffering was operated upon for a neuroma in connection with the posterior tibial nerve. The tumor reached from the middle of the leg to nearly the middle of the inner side of the foot. The tumor and nerve were inextricable, and five inches of the latter were removed with the tumor. The result was a good recovery without sensation in the foot. Microscopically the tumor was a myxo-fibroma. Nerves could be traced for some distance in it and then became degenerated and lost.

The authors state that this is the only neuroma they have ever met in a child, and we know theirs has been a large experience with children.

This "neuroma," which proved to be a myxofibroma, seems to be a fair example of the neuromas reported. They are very rare, and, after all, many are painful myomas, or fibromas or myxomas connected with a nerve in various parts of the body, or as a bulbous tumor traversed by nerve filaments in amputation stumps.

The true neuromata are apt to be plexiform, and occupy the side of the face, the temporal region, the ear or the eyelid, or the neck, where they can be felt beneath the thin skin of these parts; but most of them on close examination are composed of fibrous tissue (springing from the nerve sheath) in which the nerves are embedded.

It is said that plexiform neuromata are always congenital; and that multiple neurofibromata, or what Virchow called "general neuromatosis," involving in some cases nearly all the nerves in the body, almost always appear in children or young adults.

The subcutaneous painful tumors, the amputation neuromata, are painful, and also other neuromata if they press upon nerves. But neuromata can exist without pain. Numbness may or may not be present. A neuroma, excepting the plexiform variety, is apt to be definite in outline and spindle-shaped, its long axis in the line of a nerve trunk. It is movable and encapsulated. Multiple neurofibromata are painless and are situated upon branches of nerves. A plexiform neuroma somewhat resembles an angioma in its shape, but can be differentiated by its firmness under pressure, and remaining the same when the vascular trunks of the part are pressed upon or rendered vascular by position.

Neuroma is of itself innocent, but may undergo transition into sarcoma, or may impair the health by pain or disable a part by pressure upon the nerve supplying it.

Treatment.—Neuroma if troublesome should be removed, otherwise not. The painful subcutaneous neuroma should be excised; likewise the plexiform neuroma. Amputation neuroma when painful should be excised, together with the old scar enclosing it and a portion of the old nerve to which it is attached. Tumors

situated upon nerve trunks should be enucleated without injury to the nerve. It is scarcely ever necessary to remove any portion of the nerve trunk; and is unjustifiable unless absolutely unavoidable and the part is rendered useless by the presence of the tumor. Multiple neurofibromata seldom give trouble and are not necessarily removed unless they do.

LYMPHOMA.—The case reports and even the text-books are very confusing on the subject of lymphoma. We sometimes see lymphoma, lymphadenoma, lymphosarcoma, and Hodgkin's disease all under one heading as if they were synonymous, and again even lymphadenitis is included.

No variety of tumefaction is so extremely common in children as enlargement of the lymphatic glands. Of the possible causes of lymphatic enlargement aside from lymphoma, carcinoma (secondary, of course) would be the most unusual in a child. Sarcoma would be less rare; while the obscure poisoning of leukemia and pseudo-leukemia, or of syphilis, or of tuberculosis producing a chronic adenitis, or by pyogenic microbes producing an acute adenitis, rank as common causes of enlargement. The remote possibility of glanders as a cause of lymphatic enlargement should be borne in mind. Differentiating from all these and also from lymphangioma we have very rarely in children, more commonly in young adults, the true lymphoma, a benign encapsulated tumor composed of lymphatic tissue which did not exist before, does not result from any infection or blood disease and does not implicate adjacent glands. It is found most in those situations where the lymphatic glands are most numerous. It shows neither heat, pain, redness nor tenderness; is movable, smooth in outline, slow in growth, and if several tumors appear at once they increase at the same rate.

Treatment.—The treatment of lymphoma is enucleation.

SARCOMA.—Sarcoma is almost the only form of malignant tumor found in children. It is not as frequent as with adults, but is more malignant; that is, it is very apt to grow rapidly, to produce early a profound impression on the general health, and to recur after operation. Males are more frequently affected than females.

Round-celled sarcoma, the most malignant of the three principal varieties, is apt to occur in connection with the kidney, bladder, testicle or ovary, vagina, brain or retina (when it is called glioma), skin and subcutaneous tissue, lymphatic glands, fascia, periosteum and bone.

The spindle-celled sarcoma, often called the recurrent fibroid, ranks second in degree of malignancy. It is most apt to spring from fascia, periosteum or bone.

The giant-celled, or myeloid, sarcoma, which is apt to contain fibrous or osseous elements, is the least malignant of the three. It is likely to be found upon the articular ends of the long bones and upon the jaws. The epulis, as described under the heading of fibroid tumor, may contain sarcomatous elements, and possess the characteristics of malignancy.

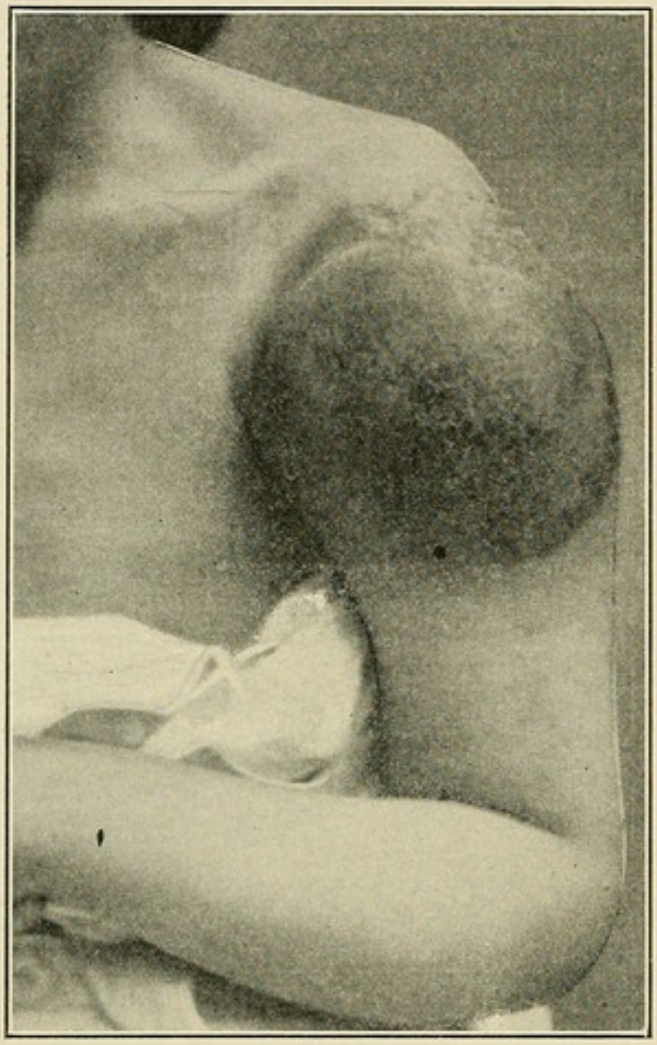


FIG. 2. SARCOMA OF UPPER END OF HUMERUS. Tumor said to have been growing three months. Inoperable. Patient died in less than two months after this photograph was taken. No autopsy. Girl aged 12 years.

According to some authors, sarcomata, including gliomata (sarcoma of the neuroglia), constitute seventy-five per cent. of all the brain tumors of children. This figure is too high. Sarcoma of the tongue has been reported in a few instances. Fibro-sarcomata are found in the naso-pharynx.

Nævi sometimes become sarcomatous. Primary sarcoma of the liver and pancreas have been reported. In both these situations the symptoms and diagnosis are so difficult that the disease is well advanced before a diagnosis can be made. It runs a rapid course of a few weeks to a fatal end. Of sixteen cases in patients aged from five to eighteen years collected by Wm. A. Edwards, of sarcoma of the mediastinum, all proved fatal in from three weeks to ten months.

Sarcoma of the kidney, it is stated on the authority of Döderlein, occurs in childhood in thirty-eight per cent. of all cases of sarcoma of kidney at all ages. It is generally of the round-celled variety, although the spindle-celled do occur, and some contain

muscle tissue, both striped and unstriped, connective tissue in variety, and even epithelium. All cases not operated upon end fatally, the average duration being one year. The tumor is usually painless, smooth and rounded, is usually solid, may be so soft and vascular as to give pseudo-fluctuation; may be cystic and give real fluctuation; may be so friable as to bleed upon manipulation by the examining surgeon. It grows rapidly. It often springs from the adrenal and grows forward rather than laterally and its presence



FIG. 3. FIBRO CYSTIC SARCOMA. Operated by the author at St. Clair Hospital. Boy two years.



FIG. 4. Same case as Fig. 3, two years after operation, showing no recurrence.

usually excites ascites. It is most closely resembled by hydronephrosis, and hydroperinephrosis.

Early operation of sarcoma of the kidney, as of sarcoma in any situation that is operable, is imperatively indicated.

Sarcoma of the testicle occurs in childhood. It is next in frequency to sarcoma of the kidney. It occurs early, is complicated in structure, is quite malignant and runs a rapid course.

Primary sarcoma of the bladder is more frequent in infancy and childhood than at any other period of life, and has so far proved rapidly and inevitably fatal.

(For primary sarcoma of lymphatic glands see section on Diseases of the Lymphatic Glands.)

Symptoms and diagnosis.—A sarcoma is usually regular in outline, and may be globular, flattened, circular, oblong (see Figs. 2, 3, 4, and 5) or elliptical, according to situation and the surrounding structures. It is smooth and if subcutaneous not attached to the skin. If large, the surface veins are enlarged. If located in soft parts, the tumor is movable. Its consistency may vary from solid to fluctuating. A soft tumor may give pseudo - fluctuation. Myelogenous sarcoma may give pulsation and bruit.

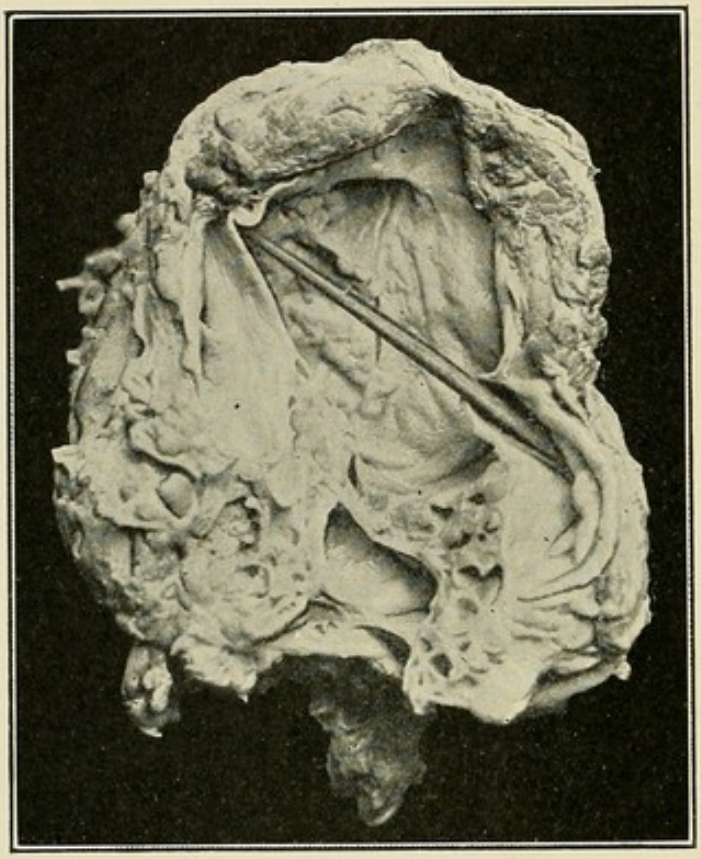


FIG. 5. FIBRO CYSTIC SARCOMA, removed from boy of 2½ years, shown in Fig. 3.

In sarcoma of internal organs, the first symptoms are usually due to pressure and vary according to the location of the neoplasm. Sarcoma usually grows more rapidly than carcinoma. It is more definitely distinguished by touch from surrounding structures. Not implicating skin or mucous membrane, it grows larger before ulcerating than does carcinoma, but it infects the surrounding region and the system more rapidly. As a rule it does not spread by way of the lymphatic system nor implicate adjacent glands. It spreads by the blood stream. It extends locally along the course of blood-vessels or nerves or fascial layers. It does not produce cachexia until it has ulcerated or general metastasis has occurred. Sarcoma of internal organs may be accompanied by a rise of temperature resembling typhoid, but less regular. In all cases a very searching and critical inquiry should

be made as to just where and when the tumor first appeared, and the rate of its growth. If possible, the surgeon should decide whether the tumor started from connective or epithelial tissues. If it takes its origin from the mesoblast and presents the characteristics of malignancy, it is probably sarcoma. If it springs from epiblastic or hypoblastic tissues, it is probably carcinoma. But the most important thing for the surgeon to decide clinically is that the tumor is malignant, and his treatment must be conducted accordingly.

Treatment.—The treatment of sarcoma is early and thorough removal if the situation of the tumor is such that this can possibly be done. The growth of the tumor is so rapid and its extension into surrounding tissues and at large through the system is so early that a diagnosis should be made promptly and excision or amputation performed. Remembering that sarcoma extends by way of the connective tissues, the operator should carry his incision well beyond the margin of the tumor into apparently normal tissues, and also remove the adjacent lymphatics, and in subcutaneous sarcoma the skin covering the tumor. In cases of sarcoma of an extremity, early and thorough removal may succeed in eradicating the trouble; but it is apt to be followed by recurrence necessitating final amputation. Implication of large vascular or nervous trunks of an extremity generally calls for amputation as a primary operation at a safe distance above the tumor. Treatment of sarcoma by the internal use of drugs is obsolete. Local treatment by electrolysis, X-rays, caustics, and the like, and partial removal are worse than useless; and excision or amputation after metastasis has taken place are contra-indicated.

Treatment by use of sterile cultures of the streptococcus erysipelatis and of the micrococcus prodigiosis may be experimented with in inoperable cases,[1] and by some has been advised after all excisions of sarcoma upon external parts, in order to prevent recurrence.

Carcinoma.—Cancer is less frequent in children by far than is sarcoma. When it does occur it is most likely to be an encephaloma, with an excessive number of cells in a very sparing lattice stroma. This produces a soft, rapidly growing tumor of great malignancy. The favorite sites of cancer in childhood are the kidney, the eye or the orbit, and the ovary. Epithelioma of the lip, or growing from the umbilical scar or other scar has been known to occur, but is a very rare curiosity. Carcinoma has occurred in the mediastinum, in teratomata and in certain congenital anomalies. Melanosis lenticularis progressiva or xeroderma pigmentosa, may in its later manifestations present a variety of epi-

[1] See reports by Coley and Bull.

thelioma occasionally occurring in childhood. Scirrhus is so extremely rare as to be practically unthought of in examining a child's tumor.

Carcinoma in children presents the same characteristics of malignancy as like growth in the adult—the rapid growth, invasion of neighboring tissues, implication of the skin and lymphatics, metastatic growths, production of systemic cachexia, tendency to ulceration and hemorrhage, and to recurrence if removed.

Diagnosis.—The rarity of carcinoma in children should be borne in mind; yet the fact that, although rarely, it may occur in childhood, in infancy, or even congenitally, will prevent one from dismissing it from the consideration of a suspected case. As in the adult, heredity is to be investigated. Locality is important, for cancer always has its origin in tissue derived from the epiblast. However, it might appear in a teratoma, dissociated from homologous tissues. Carcinoma in the very young grows rapidly, so rapidly that it may resemble inflammatory swelling, or a gummatous enlargement. But the rate of its growth is not as great as that of an acute inflammation, nor even as that of gumma. A gumma would come late in childhood, and would be accompanied by other signs of syphilis. Cancer would have less pain and less tenderness and less heat than any inflammatory swelling excepting chronic abscess. A cold abscess could be differentiated by aspiration. Edema of distal parts and dilatation of superficial veins might be present with any enlargement which interfered with lymphatic or venous circulation. Redness upon the surface might belong either to cancer or to inflammation. Hardness of the tumefaction is not a sign likely to be helpful, as it is seldom present in carcinoma in early life. Fluctuation does not settle the diagnosis in favor of abscess, for a soft cancer may appear to fluctuate. Carcinoma usually has definite margins, and infiltrates, and involves surrounding tissues, and so becomes fixed in its position. It tends to softening and ulceration. If subcutaneous it attaches itself to the skin.

A tumor with well-defined margins, and not very tender, with adjacent lymphatic glands enlarged while the other lymph nodes appear normal and there is no ulceration of the skin or other cause of lymphadenitis, is a carcinoma. Carcinoma of the skin might be mistaken for a tuberculous lesion; but cutaneous cancer, excepting xeroderma, is almost unknown in children. Actinomycosis has its own characteristic symptoms. Chronic ulcer is rare in children. Syphilis has multiple lesions. Sarcoma does not implicate the adjacent lymphatics, but extends by the blood stream. The differentiation from sarcoma may be impossible; and it is not so im-

portant as that the surgeon should recognize the malignant character of the growth, and deal with it accordingly.

Prognosis.—As a rule the younger the patient the more rapid the growth and the greater the malignancy. As children very seldom present either of the varieties of cancer which in the adult are most amenable to surgical treatment—the accessible epithelioma or the slow growing scirrhus—but usually have the rapidly growing and very malignant encephaloma, and that often located internally, the average prognosis is very dark indeed.

Treatment—Treatment is the same as in the adult, early and

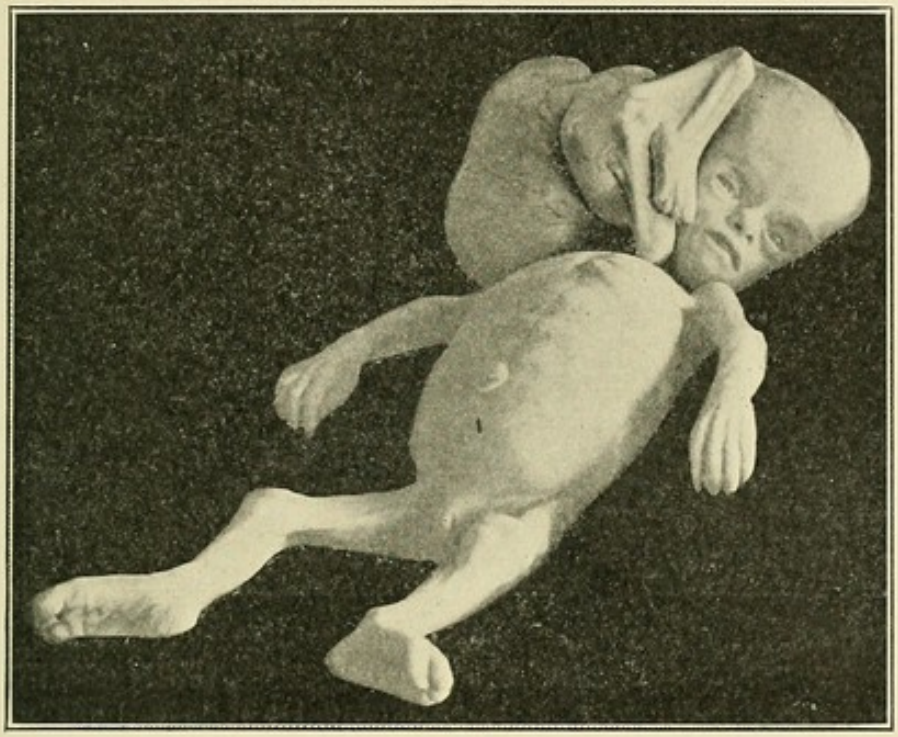


FIG. 6. PARASITIC FETUS, attached to the head of the autosite. Dr. I. N. Garver.

complete removal if the tumor is accessible. If it cannot be thoroughly removed with every cell of the infected tissue, best not operate at all. If not operated upon it is well to keep the skin closed as long as possible, or if it opens to keep it dressed antiseptically to prevent pyogenic infection.

TERATOMA.—In infancy and childhood may be found teratoma in all its varieties. *Fetus in fetu,* joined twins, and parasitic fetus are classed as ectogenous teratomata. Branchial cysts and dermoids are classed as endogenous teratomata. The interesting controversy as to whether double monstrosities and parasitic fetuses are due to fusion of two separate embryos or to a division of the undifferentiated protoplasmic cells of a single embryo, similar to

that which takes place in lower animals and plants, I shall not pause to indulge in. That the dermoids, with the possible exception of ovarian dermoids, originate from a matrix of displaced embryonal cells from the epiblast and sometimes also from the hypoblast and mesoblast, is an accepted theory. The teratoma is very apt to show at birth or to develop very soon after, though the dermoid may not appear until the embryonal matrix is stimulated to growth by the extraordinary development of the epiblastic structures which takes place at puberty. The parasitic fetus when not included in the autosite is very apt to be attached to its sacrum, sternum, umbilicus or head. Fig. 6 is from a photograph showing the parasitic fetus attached to the head of the autosite.

The branchial cysts are of course located in the situation of the branchial clefts and may be called mucous, atheromatous or serous, according to their contents.

Dermoids and Tridermic Tumors.—The generally accepted opinion is that dermoids are caused, not by inclusion of one individual by another, but by dissociation or dislocation of some of the blastodermic elements of one individual, which took place during the developmental infolding of the various layers. These misplaced matrices developing, produce specimens of their various structures—for instance, skin or mucous membrane, or epithelial cells (columnar, ciliated or squamous), hair follicles and consequently hair, sweat glands and their resultant secretions, teeth, bone cartilage or nerve tissue; simple or more complex according to the nature of the embryonal elements that are displaced and intermingled.

This places them in a class by themselves—the teratomata, distinguished from all other classes of tumors in which only one blastodermic layer is represented. This theory of their origin is supposed to account for the position in which dermoids are most often found, namely, where the different germinal layers fold in and coalesce, near the orbit (Fig. 7), in the neck, in the coccygeal region, in the ovary, in the testicle or scrotum; though they have been found in various other regions. But some embryologists claim that after impregnation of an ovum a single segmentation cell may split off before the establishment of the germ layers. And they say that it may be presumed as probable that almost up to the formation of the germinal layers any single segmentation cell even if dislocated, possesses the potentiality of producing all of the layers if necessary. So that if a cell of this kind were caught and infolded in the layers formed by the other cells it might proceed to develop into a parasitic growth of complex or organized structure. In that case the difference in the origin of included fetus and of dermoid tumor would be that the former came from

dissociated segmentation cell, while the latter was derived from a misplacement taking place after the formation of the layers.

In 1895 Max Wilms[1] published the results of careful and extensive studies, in which he claims that dermoids of the ovary are not teratomata, and are therefore not present congenitally; but that they are formed directly from an ovule in the ovary, by a kind of parthenogenesis. Krœmer's studies support the views of Wilms; and Krœmer shows that it is hardly proper to call the process parthenogenesis because, while this is a normal process in lower plant and animal life for the propagation of species, in the case in hand it is a pathologic process in which the growth and development of organs are atypical and without any definite law. Dr. Hans Arnsperger[2] agrees with Wilms and Krœmer, and they all take the view that the embryologic parts are formed from the ovule and the cystic parts from the follicle. Wilms explains dermoid cysts of the testicle in somewhat the same manner, by a pathologic growth of the sperm cell. Wilms proposed the name "rudimentary parasites" or "embryomata" for encysted tumors and "embryoid tumors" for the solid variety. B. Novy announces,[3] after a series of microscopical studies, results virtually agreeing with the views of Wilms, who seems to be the first to have advanced proof of the ovulogenous theory. Dr. Francis Munch[4] gives an elaborate critical review of Wilms' work. After referring to the fact that dermoid cysts of the ovaries and testicles are distinguished from dermoid cysts occurring elsewhere, in that they are composed of three layers of the blastodern, Munch sug-

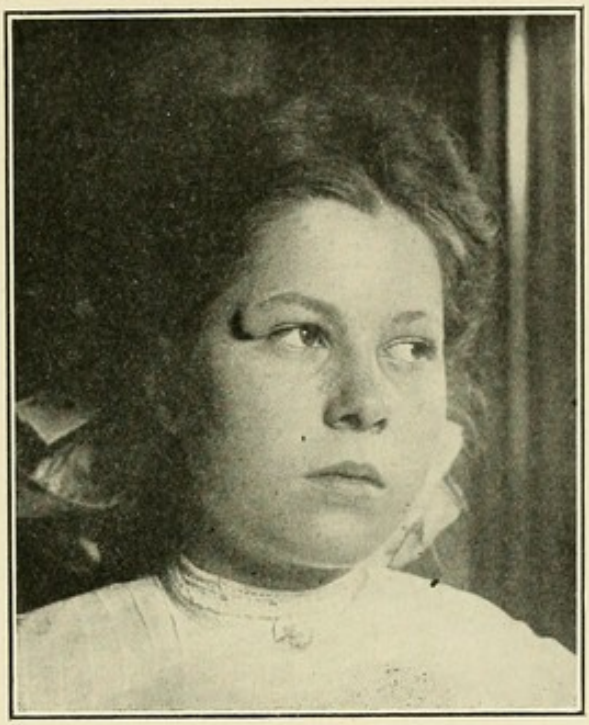


FIG. 7. DERMOID CYST, near the orbit.

[1] Deutsche Archiv. f. Klin. Med., Bd. IV.

[2] Archiv. für Patholog. Anat. und Physiologie und für Klin. Med. Bd. 156 (Eünfzehnste Folge, Bd. VI.) Hft. I. Zur Lehre von dem sogenannten Dermoidcysten des Ovarium.

[3] Wiener Klinische Rundschau, Aug. 6, 1899.

[4] Semaine Médicale, Sept. 6-13, 1899.

gests the name "tridermic tumors" as more appropriate than the name proposed by Wilms. He seems convinced that the theory of the parthenogenetic origin of these tumors, so far as the ovary is concerned, is well sustained, but that the exact similarity of those occurring in the testicles has not yet been definitely proven, although they are probably also of parthenogenetic origin. Of course the beginnings of all dermoids as of all teratomata and of all tridermic tumors are present at birth, and may be noticed then or not discovered until later. Dermoids of the testicle, or if we accept the name proposed by Dr. Munch, "tridermic tumors" of the testicle are very rare. In 1885 Verneuil [1] published an analysis of nine cases, all he was able to find in the literature, to which he added one case observed by himself jointly with Mr. Paul Guersant. Dr. Theodore Kocher [2] refers to these ten cases of Verneuil and adds four more cases, which were all he was able to find; one each from Tilanus,[3] Geinitz,[4] in Altenberg, Lang,[5] in Insbrück, and Bitha and Bilroth.[6] Mr. Holmes (1869) refers to Verneuil's cases and then adds one from Dr. Van Buren,[7] of New York. Mr. Curling states (1845) that "Dr. Duncan, of Edinburgh, removed a congenital tumor of the testicle from a boy eight years of age. Dr. Goodsir examined the tumor and found skin, hairs and portions of cartilage in it," and he mentions Erichsen's allusion to Mr. Marshall's case.[8] I do not know whether these cases were among those known to Verneuil. In 1886, D'Arcy Power [9] reported a case and exhibited before the London Pathological Society a specimen of a dermoid tumor of the testicle removed from a boy of four years. Power remarks that in the previous two hundred years only ten cases had been recorded. Possibly he alludes to those collected by Verneuil. Manly [10] reported a case (in a man sixty-one years old) before the New York Academy of Medicine, February 14, 1899. C. C. Morris [11] reports a case of dermoid of the testicle removed by him from a boy of twelve years.

These are the only cases that a cursory look through the literature brought to my notice. There were probably others, but dermoids of the testicle certainly are not common, for Mr. Curling, with all his vast experience, writes as follows: "Cysts containing

[1] Archives Générales de Médecine 5e serie t. v, et vl.
[2] Krankheiten des Hodens und seiner Hüllen, des Nebenhodens Samenstrangs und der Samenblasen, p. 390.
[3] Schmidt's Yahrbücher, 100, 171.
[4] Deutsche Klinic, 1862.
[5] Virchow's Archiv, Bd. 53.
[6] Chirurgie, Bd3Abth. II, T. Lief.
[7] New Syd. Soc. Bien. Retrosp. for 1865-6.
[8] On Diseases of the Testis, p. 406, 1852.
[9] London Lancet, Oct. 23, 1866.
[10] Jour. Cutan. and Genito-Urinary Diseases, V. 17 (1899), p. 229.
[11] St. Louis Med. Review, Vol. XLIV, No. 19, p. 326, Nov. 9, 1901.

skin, hair, bone, teeth and other structures foreign to the part have, in some rare instances, been found in the scrotum in connection with the testicle. No case of the kind has fallen under my notice."

Senn says (1900): "There is no doubt that most of the cases of dermoid tumors of the testicle that have been reported were not within the testicle, but were on it—that is, were dermoids of the scrotum. That dermoids in this locality are not common is evident from the fact that Kocher [1] found only fourteen cases recorded in literature."

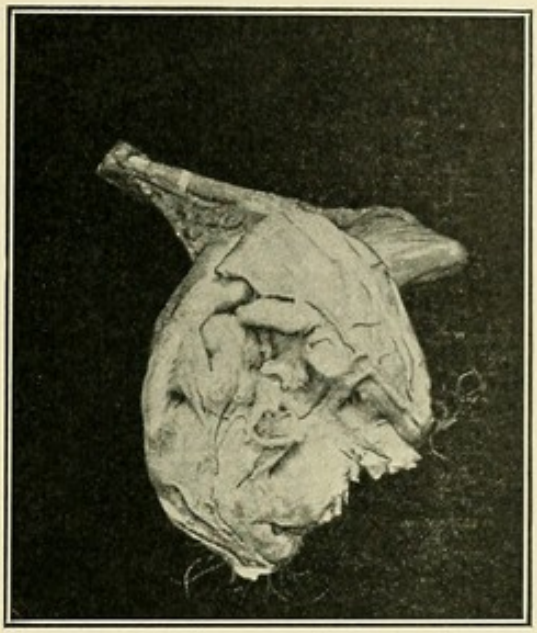


FIG. 8. DERMOID OF TESTICLE, removed from Wm. T., aged 2½ years.

In 1902 I reported [2] a case of dermoid of the testicle. Wm. T., aged two and one-half years, brought to me on account of a growth of the size of an English walnut in the situation of the left testicle. His mother was positive it had not been there at birth nor until he was a year old; but since appearing it had grown slowly and steadily, notwithstanding that both internal medicines and local applications from several physicians had been used. The tumor was firm, the lower end being of a bony hardness, and the upper portion, though fluctuating slightly, very tense. No pain, redness, tenderness, nor apparent heat. The scrotum was movable over the tumor. The veins showed rather large and blue upon the surface. There was no enlargement of adjacent lymphatics. Upon these data I based a diagnosis of dermoid cyst and removed it. The tumor corresponded anatomically to the testicle and did not involve any structure but the testicle. Recovery, uneventful. When seen seven and a half years later, patient was a large healthy boy. Fig. 8 is from a photograph of the tumor, which contained bone, fine hairs and several cavities filled with the sebaceous-appearing material found in dermoids.

Ovarian dermoids are not nearly so rare as those of the testicle. The following case presented additional symptoms of obstruction of the bowels and illustrates points in the diagnosis.

[1] Pathology and Surgical Treatment of Tumors, 1900, p. 655.
[2] Jour. American Med. Ass'n, Feb. 14th, 1903.

Elsie M., aged seven years and ten months, American born, third child of German parents who had six children. Others all healthy and no history of tumors or deformities in the family. Elsie was small for her age, weighing 41½ pounds. (Average weight for girls at seven years is 48 pounds, at eight, 52.9.) She was pale, delicate, fair, bright and lively, had had only whooping-cough and measles. Two and a half months previously she had been very sick with what had been called "inflammation of the bowels," with severe pain in the abdomen and intestinal obstruction. Seven weeks later she had suffered a second, similar attack, which was severe during four and a half days, when it subsided rather promptly. On my first examination, June 11, 1900, a tumor was easily palpable in the hypogastric region and seemed to be of the shape of a distended bladder. It extended nearly to the umbilicus, was dull on percussion, and firm, no fluctuation being made out. It was only slightly movable in its position. The parents declined operation. June 18. On the previous day the child had had an attack of pain lasting about an hour. Urine scanty. Tumor much more movable. It could be moved upward till its upper margin was nearly an inch above the umbilicus and a space separated it from the os pubis, and was movable laterally. June 25. The tumor could be moved freely upward and to the left lumbar region—not so far on the right side. Tried to get a skiagraph in hope of showing teeth or bone, but the result was unsatisfactory. Parents still refused operation, although the possibility of the supervention of malignancy, danger from purulent inflammation and resultant peritonitis which might be fatal or cause adhesions and render removal of the tumor more difficult later,—danger from twisted

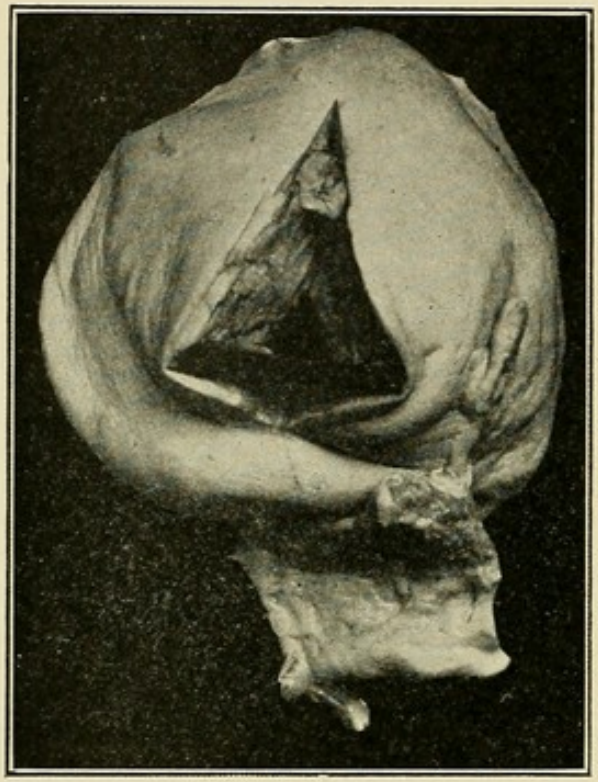


FIG. 9. DERMOID OF OVARY, removed from Elsie M., aged 7. The cyst contained fluid. Its walls contained irregularly shaped pieces of cartilage part of which was ossified, masses of atheromatous material and fine hairs.

pedicle, from obstruction of the bowels, or from pressure on the bladder, were explaind to them. On July 23 patient had an alarming attack of "inflammation of the bowels." Extreme abdominal pain, worse in paroxysms, a quick pulse, and intestinal obstruction. Enemata and local heat had been used without relief. I thought it probable that a loop of intestine was pressed between the tumor or its pedicle and the spine. On placing the patient's body almost vertically, head downward in an exaggerated Trendelenburg position, massaging the abdomen and using copious enemata, free escape of gases and feces occurred, the pain ceased, and the attack was ended. This alarming attack decided the parents for operation. September 29, at Cleveland General Hospital, I removed the tumor through a small median incision. It proved to be a dermoid cyst of the left ovary, of the size of an orange, and consisting of a cyst containing fluid, and a solid portion containing irregular-shaped pieces of cartilage, part of which is ossified, masses of atheromatous material and fine hairs. Recovery, uneventful. Fig. 9 is from a photograph of the tumor.

Angioma.—Representatives of the angiomata are quite common in early life. Capillary angioma or nevus is the form most frequently met. It is always congenital, and even though small at birth it may soon show noticeable growth. The favorite site of nevus is the face and orbit, but it may come anywhere upon the skin or upon the mucous membrane or where the two join.

A cavernous angioma usually requires more time for its growth and may attain quite troublesome size in some situations in later infancy, childhood or youth. It may be situated not merely in the skin but in deeper connective tissues, even in bone, and in such organs as kidney, liver or spleen.

The plexiform angioma, which formerly was wont to be called "cirsoid aneurism" or "aneurism by anastomosis," is most apt to appear about the brows or temples, or about the arms, the legs, or the fingers, but may attack connective tissues anywhere.

Superficial angioma or nevus may in time become cavernous, or plexiform, and extend not only wider but deeper. (See Fig 10.) An angioma may be no larger than a pinhead, or it may cover a whole extremity or displace important organs. Senn quotes a case reported by W. Koch of an angioma which at the birth of the child was of the size of a walnut, located above the right clavicle. It grew slowly until the child died at the age of eighteen months. The tumor then measured fifteen inches in a horizontal and seven in a vertical direction. The tumor was made up of three compartments, only one of which was external, one occupied the deep region of the neck, and the third occupied the mediastinum and the right pleural cavity, where it had displaced the lung.

Angiomata of the tongue, palate or rectum are not uncommon, and have been reported in various muscles and in the mammary gland. They may also occur within the cranium and in the larynx.

An angioma is composed of a network or plexus of blood-vessels or cavities which had no previous existence, but grew from an arrested matrix of angioblasts. They have a structure of connective tissue and muscle and a lining of endothelium similar to normal vessels; but they do not, like normal vessels, cease to grow when they have attained the proper size and number. They go on increasing and multiplying, communicating with the previously formed vessels of the tumor tissue and with the normal vessels. They may be stationary or grow slowly or rapidly, or may take on inflammation, with all the dangers of sepsis or septic thrombophlebitis, or they may through inflammation undergo spontaneous cure. They may become transformed into very malignant sarcoma, may undergo hyaline or colloid degeneration or calcification. (8)



FIG. 10. CAVERNOUS NEVUS. Babe 6 months old. Growth not noticed at birth, but grew rapidly. Removed by excision.

Diagnosis.—An angioma located upon the surface, or beneath the surface, unless its integuments are very thick, shows the color of the blood which it contains, whether capillary, venous or arterial. Any variety of angioma excepting the capillary is increased in size and tension by laughing, crying, straining, and the like, or by placing the patient with the tumor dependent. The capillary angioma heightens its color from the same causes. An angioma can be decreased in size or temporarily obliterated by pressure with the fingers, but returns immediately when the pressure is relieved. A plexiform angioma upon the surface usually pulsates. In the cavernous, sometimes tortuous vessels can be felt. An abscess or inflammatory swelling or some other variety of tumor may, if placed over a large artery, appear to pulsate like a plexiform angioma or an aneurism. But aneurism is rare in the child; and the angioma may be differentiated from the inflammatory swelling, abscess or lymphangioma, by puncture with an aspirating needle. An angioma located internally could not be differentiated from aneurism in an adult. But a compressible pulsating tumor, located internally

in a child, not in the course of a great vessel, may be considered an angioma.

Prognosis.—Angioma is a benign growth; but it may become plexiform; and it may, as has been said, become the seat of sarcoma. Surface angioma may undergo spontaneous cure from inflammation resulting from the chafing of clothing, etc. But inflammation has all the dangers of septicemia, septic thrombosis, phlebitis or pyemia. One sometimes sees a large surface angioma undergoing an obliterative ulceration or already cicatrized in its central part, while still remaining or even extending at its periphery. (See Fig. 11.)

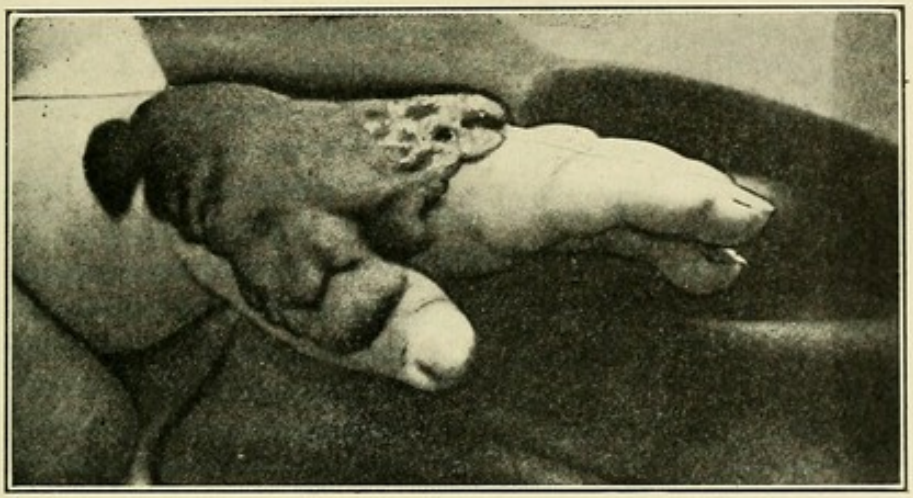


Fig. 11. Nevus of hand, ulcerating.

Either ulceration or an accidental wound may occasion serious hemorrhage. When located near the eye, mouth, palate, tongue, anus, angioma may produce distortion of parts and interference with function. (See Fig. 12.)

Treatment.—The possibility of spontaneous cure of angioma is not to be waited for. Its coming is unusual, and when it does occur it is tedious and uncomfortable in process, and often results in greater scarring and deformity than would proper interference. The minute stellate nevus should be destroyed by the point of the electric needle. The common mother's-mark or port-wine stain can be removed by electrolysis, ethyl chloride (9), or ethylate of soda, acetic acid, ten per cent. of mercuric bichloride in collodion, the Paquelin cautery, or any mild and manageable escharotic. The plan is to produce a shallow eschar, and then under antiseptic dressing, promote healing. If the extent of the morbid process is not too wide the white scar which results will be less of a disfigurement than the deep color of the growth. But if the growth be more than an inch and a half or thereabout in diameter there is small

choice between the stain and the scar. Of course the acids and caustics should not be used in proximity to the eye, and wherever they are used surrounding parts should be protected. Electrolysis is quite controllable in such situations, but is tedious for wide areas. Nevus or cavernous angioma upon the face or conspicuous parts is nicely removed with the galvanic needle. Anesthesia is required. After antiseptic cleansing of the skin, the needle connected with the positive pole is introduced into the growth while the negative pole connected with a wet sponge electrode is applied to any convenient surface of the body. Sufficient current is used to blanch the tissues. The object is to alter the blood-vessels and coagulate the blood. From ten to thirty milliamperes may be required to cause electrolysis. If complete disorganization is desired thirty to fifty milliamperes will be used. If not supplied with a galvanometer, the current can be tested by placing both poles in water. Enough cells should be thrown into the circuit to cause small gas bubbles to form and rise from the point of the needle. Special needles of platinum are best for this work. They are insulated excepting at their points, and are introduced beyond the insulation. If used where slight scarring is not of great consequence, ordinary platinum or even steel needles will give very good results. The needle after being introduced at one point may be partly withdrawn, and cautiously thrust in other directions within the tumor. Two to five minutes of the current usually suffices for one point. After turning off the current to avoid burning the skin, the needle should be withdrawn cautiously, lest hemorrhage follow it. A sterile dressing is applied. It is surprising how little scar will be left after extensive use of galvanism. Pressure, as of a bandage, helps to reduce or even sometimes remove extensive nevi upon extremities.

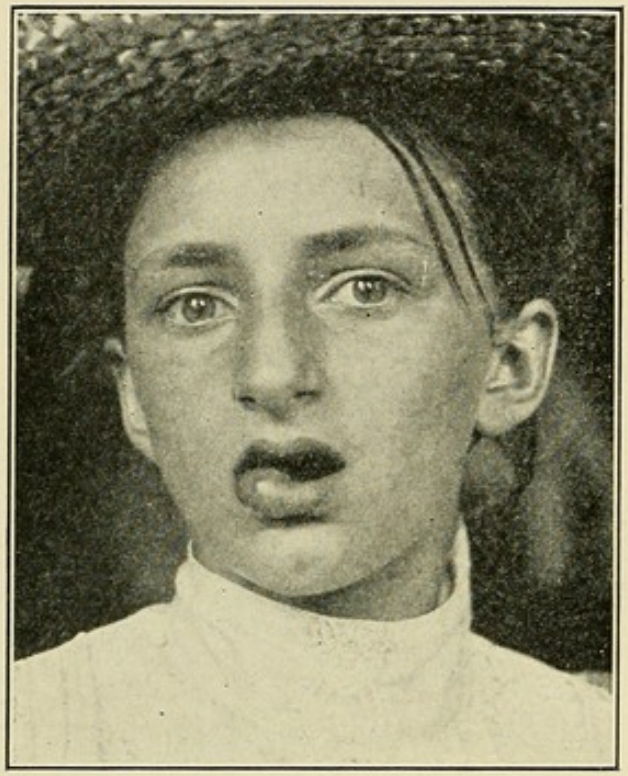


Fig. 12. Nevus of the lip.

The galvanic needle can be used conveniently within the mouth or rectum. Igni-puncture with the needle point of the Paquelin cautery can be used instead of electrolysis. But it cannot be so accurately done and leaves more scar. It is preferable in extensive growths and those situated where excision is impossible, as one can work so much more rapidly than with the electrolysis. In igni-puncture the needle should be heated cherry-red. White heat is apt to be followed by hemorrhage. In using the Paquelin button or point upon the skin surface to destroy capillary nevi, bright red or white heat can be used with the quickest possible touch. The best treatment for angioma on the body and limbs, and also sometimes on the face, is excision. Care should be taken to keep the incision outside the boundaries of the tumor. Cutting into the tumor will cause troublesome or even serious hemorrhage, but a short distance outside of the tumor the tissues are not abnormally vascular. An excellent method of destroying nevi by altering their structure is by injection into them of very hot water. Boiling water is drawn into an aspirating syringe, and the skin about the nevus having been previously surgically cleansed the needle is thrust in through sound skin at its base and a portion of the water injected here and there. Aseptic inflammatory reaction takes place, obliterating the growth. It is reported that radium can be used in the treatment of nevi. (Wickham and D'Egrais, Med. Bull., Jan., 1908.) Plates varnished with a substance with which radium is incorporated are applied, the dose being regulated according to the extent and depth of the nevus. It is claimed the resulting scars are soft, smooth and without color; that the treatment is painless, and can be applied to a child during sleep.

Lymphangioma.—Lymphangioma is similar to angioma, but contains lymph instead of blood. It is not composed of lymphatic glands, nor yet of enlarged lymphatic spaces, but of new lymphatic vessels produced from a matrix of angioblasts lined with endothelial cells. Yet it may be impossible to distinguish in a given tumor whether it is composed of previously existing lymph vessels or is formed from new vessels, or of both. It has no function and may even be located where there are normally no lymphatics. There is considerable confusion in the use of the names for this condition, as well as many mistakes in diagnosis. One finds such tumors described not only as lymphangioma, but as hygroma, cystic hygroma, congenital cystic hygroma, hydrocele of the neck, and confused with lymphoma, lymphadenoma, and branchial cysts. By some, cystic hygroma is used to designate a cavernous hygroma that has undergone cystic degeneration.

The foregoing definition sufficiently indicates its nature. An enlarged and tortuous lymphatic vessel is called a lymph varix.

Lymphangioma may be capillary, cavernous, or cystic. It has no limiting capsule. It is usually, though not invariably, congenital. It is innocent in its nature, but may do harm by pressure upon or displacement of important vessels or organs or occlusion of passages. It may grow rapidly or remain stationary; may be combined with angioma; may undergo inflammation, with all the dangers of extensive infection. It is subject to nearly all the degenerative changes of other tumors. It may occur in almost any part of the body, although favorite sites are the neck, clavicular region, shoulder or axilla, the tongue or beneath the tongue, the lips or cheeks, or, more rarely, upon the abdomen. (See Fig. 13.) It has been found in the groin or upon the buttocks or extremities. When occurring in the tongue it produces macroglossia.

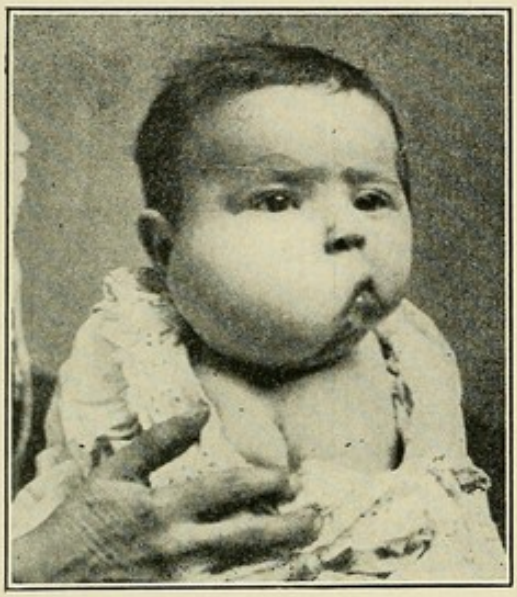


FIG. 13. LYMPHANGIOMA OR HYGROMA.

Diagnosis. — Lymphangioma is usually congenital. The skin overlying the tumor is normal or paler than normal, unless there is inflammation. Lymphangioma is not compressible like angioma, unless containing also blood-vessels—making it a hemo-lymphangioma. If in doubt, the aspirating needle may be used. If clear lymph is drawn, the tumor is a lymphangioma; if a mixture of lymph and blood, it is hemo-lymphangioma. Very rapid growth raises the suspicion of implication with sarcoma; but that point could only be settled by the microscope. If a lymphangioma bursts or is lanced a lymphorrhea may result and prove a serious drain.

Prognosis.—Gradual growth is common; rapid growth less common. Unless containing sarcomatous elements it is only dangerous to the degree that it presses upon important organs or interferes with function.

Treatment.—If favorably situated, excision is the treatment. In planning excision it is well to understand that the growth may extend to unknown depths. For example, apparently superficial upon the supraclavicular region, it may extend beneath and around the great vessels and nerves in the triangles of the neck, and, having no capsule, very nice dissection will be necessary. Mr. Owen has remarked upon the ragged and insignificant appearance of the

collapsed tumor after it is removed. If the hygroma is cystic he recommends tapping the cysts, or repeated tappings, and waiting for spontaneous changes. Tapping may be useful in single or thin-walled cysts, but it is useless in the multilocular forms. (Power.) Setons were formerly used, but are unsurgical and unsafe. If so located that complete excision is impossible, partial excision is permissible; or injections may be used to produce fibrosis and shrinking. Iodine has been recommended; also carbolic acid. One case in which I tried iodine did not succeed very well. A 10 per cent. solution of chloride of zinc or a weak solution of bichloride of mercury are better. Large lymphangioma, involving a whole limb, can be treated by a combination of injection and pressure by bandaging.

Cystoma.—As representative of the cystoma in children there is a group of cysts in connection with the jaws. One form is multilocular, due to an epithelial infolding upon the alveolar margin, which produces the cyst. Dentary cysts comprise another form. They are either follicular, arising from the tooth follicles, or they are dentigerous, which originate with misplaced teeth, either of the temporary, more often of the permanent, set, and contain, besides the erratic tooth, a fluid which may be clear, watery, colored, glairy, possibly purulent. An enlargement of the jaw, sometimes with distinct egg-shell crackling, situated where a tooth has failed to appear, raises strong suspicions of the nature of the trouble. When an opening is made and the fluid and tooth are removed the case is settled.

Congenital Tumors of the Spinal and Sacral Region.—Turning now from our histological nomenclature, let us consider a group of tumors which are always congenital and always located in the region of the spine, and most frequently near the sacrum. They are not cases of spina bifida; and did not all arise in the same manner as spina bifida, although that condition in several kinds is often classed with this group.

They constitute a class sometimes loosely called "false spina bifida." It has been stated, in speaking of teratoma, fibroma, lipoma, sarcoma, and angioma, that any of them may occur in the region of the sacrum and with some of them this is a favorite site. They may occur as simple tumors, but more frequently as growths compounded of more than one kind of tissue, and some of them, especially nævoid tissue, may be combined with spina bifida. A form of cystic hygroma, lymphangioma, may occur in this region as either simple or multiple cysts of obscure origin.

Any of the tumors in this region may be suspected of having attachments to the spinal cord or its membranes or within the spinal canal, but are distinguished from true spina bifida in that

they have no cavity connecting with the cavity of the spinal canal, nor of an expansion of the central cavity of the cord, and contain no portion of the cord.

Fig. 14 is from a photograph of a congenital tumor of the spine, taken when the boy was fifteen months old. The tumor is in the median line, in the region of the second and third cervical vertebræ, of the size of a small hen's egg, and has a pedicle two and a half inches in circumference. It is said not to have varied much in size, excepting to keep pace with the growth of the child. The surface of the tumor is bluish over the fundus, has a dimple or pucker which shows in the photograph, and is supplied with hair like the scalp in a circle toward the base. It feels quite firm and fibrous, both in the body and in the pedicle. One cannot be certain whether the pedicle distends when the child cries, or whether that appearance is due to the movements of the muscles near its attachment, as at times it seems to vary with position. This raises the question whether position may not occlude or open a passage from spinal or meningeal cavity to tumor. Although the tumor appears in the region of the second or third cervical vertebræ, its real origin may be from the foramen magnum or through the atlas. (See Section on Meningocele.) It is impossible to tell whether there is a connection with the cranial or spinal meninges, or to be sure whether there is a cavity within the tumor. Its hairy scalp-like covering gives it the appearance of a cranial rather than a spinal meningocele; but spina bifida and other tumors, even low upon the spine and elsewhere, may be hairy. Operation advised, but declined.

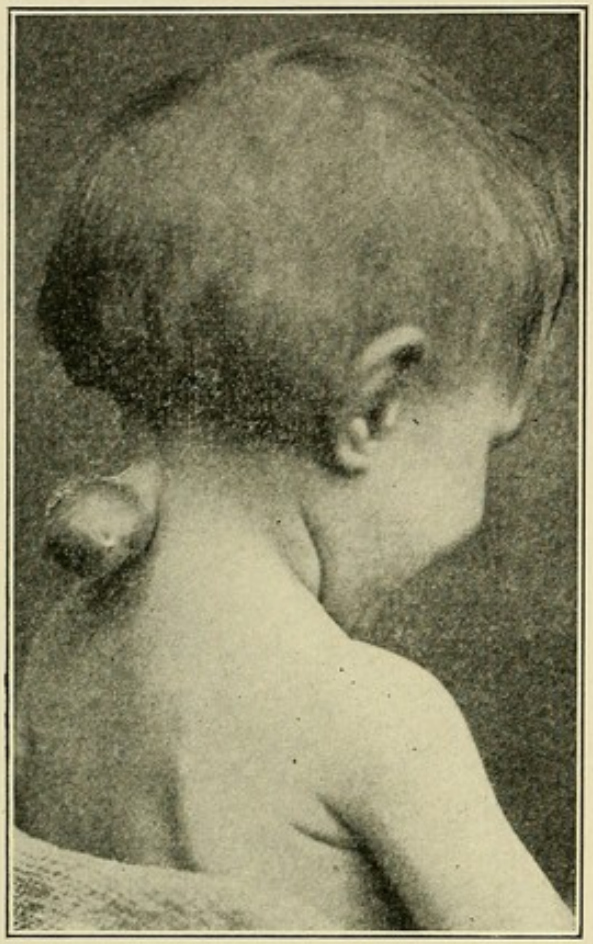


FIG. 14. CONGENITAL TUMOR, described in the Section on Congenital Tumors of the Spinal and Sacral regions. Boy 15 months old.

The coccygeal tumors, so called, spring from the anterior surface of the sacrum or coccyx, and, while they may develop inside the body, occupying the space between the sacrum and rectum, they are likely to appear externally in the perineal region. They may be as small as a nut or a lemon, or attain a size much larger than the child's head. Senn quotes Sutton's explanation of the embryological origin of these tumors, as follows: "In the early embryo the central canal of the spinal cord and the alimentary canal are continuous around the caudal extremity of the notochord. This passage, which brings the developing cord and gut into such intimate relations, is known as the 'neurenteric canal.' When the proctodeum invaginates to form part of the cloacal chamber it meets the gut at a point some distance anterior to the spot where the neurenteric canal opens into it; hence there is for a time a segment of intestine extending behind the anus and termed, in consequence, the 'post-anal gut.' Afterward this post-anal section of the embryonic intestine disappears, leaving merely a trace of its existence in the small structure at the tip of the coccyx, known as the 'coccygeal body.'" The tumor called "congenital cystic sarcoma," and those considered by Braun, Albert, and others as arising in Luschka's coccygeal gland, are thought by many modern pathologists to arise from the remains of the post-anal gut (Senn). Some of them are thyroid dermoids containing cysts lined with columnar epithelium and filled with mucus. Some of these coccygeal tumors consist of a fibrous layer, covered by integument and containing a granular sarcomatous mass. Sometimes they resemble dermoids in containing cartilage, bone, or sebaceous matter, hair or teeth. Some have also sarcomatous tissue.

A different variety of abnormal growth in this region is an increase in the size or number of the bones of the coccyx, forming a tail. Or the coccyx may have as an appendage a lipomatous tumor.

RETENTION CYSTS

We must pay some attention to a form of tumefaction which differs from the true tumors and also from the inflammatory swellings, namely, the retention cysts.

A retention cyst is a swelling caused by obstruction of the outlet of a gland or the retention of its secretion or excretion in a preexisting space. The mechanical obstruction which causes the retention cyst, Senn classifies as follows: (1) Inflammation, (2) cicatricial stenosis, (3) tumors, (4) flexion of a duct, (5) valvular closure, (6) altered secretion, (7) impaction in the duct of a foreign body, a concretion, or a parasite—the first, those due to inflammation and its consequences, being far the most frequent.

As would be expected on a moment's reflection, certain varieties

of these retention cysts are practically unknown in childhood—for instance, hydrometra, hydro-kolpos, hydro-salpynx, galactocele, cysts of spermatic tubes, and of Bartholin's gland, and hydrops of the gall-bladder. Cyst of the pancreas is rare at any age, and I at least have never met cyst of the thyroid in a child, although goiter is not uncommon. Retention cysts of the sebaceous glands are not found in children; and the smallest of the sebaceous cysts, the comedos and the lesions of acne, which are inflamed comedos, are reserved for the annoyance of adolescence.

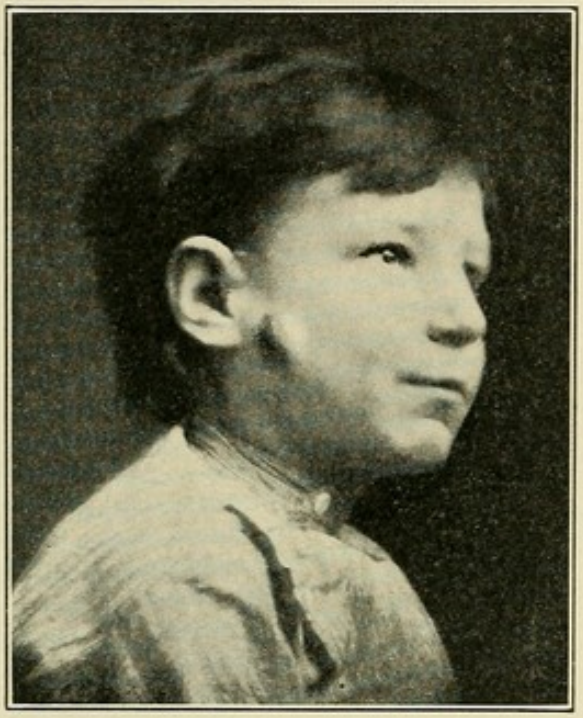


FIG. 15. CYST OF THE SOCIA PAROTIDIS.

Retention cysts of the ducts of the sub-lingual and sub-maxillary glands occur and are described under the name ranula. One has seen them of the size of a hickory-nut, filled with glairy fluid. If opened the incision rapidly reunites. A seton, made of a small loop of silver wire, establishes a permanent opening for drainage, and cures the cyst.

Occasionally an extra or disconnected lobe of the parotid gland develops a cyst. (See Fig. 15.)

Congenital cystic kidney is one of the not infrequent affections of infancy. A nephritis occurring in the fetus may cause a plugging of uriniferous tubules by hyperplasia of connective tissue, by débris or clots, in the same manner as occurs in the adult. Or disease of the fetal kidney-pelvis, or a developmental failure of union between the renal and collecting tubules, may be the obstructing cause. The result is the same as sometimes occurs in interstitial nephritis of the adult—the obstructed tubules dilate and form cysts. One or both kidneys of the infant at birth may be small, composed of connective tissue and numerous small cysts; or the distention of the cysts may, by pressure, obliterate the renal tissue and expand to such a size that the abdominal walls can hardly contain them. The fluid in the cysts may contain urinary salts, or these may have disappeared, leaving only serum. Cystic kidney causes the death of many fetuses. Children born alive with double cystic kidney gen-

erally die of uremia soon after birth. If but one kidney is affected the infant may live; but the cystic kidney may require operation on account of its size and pressure on other organs.

Another form of retention cyst is hydronephrosis. Any chronic obstruction of the urinary passage may so dam the urine that distention of the whole urinary apparatus above the obstruction will take place. If the cause is phimosis, or a narrow or impervious urethra, the bladder first will feel the effects, but later the ureters and then both kidneys. If one ureter only is obstructed, that portion of the passage above the obstruction and the pelvis of the kidney

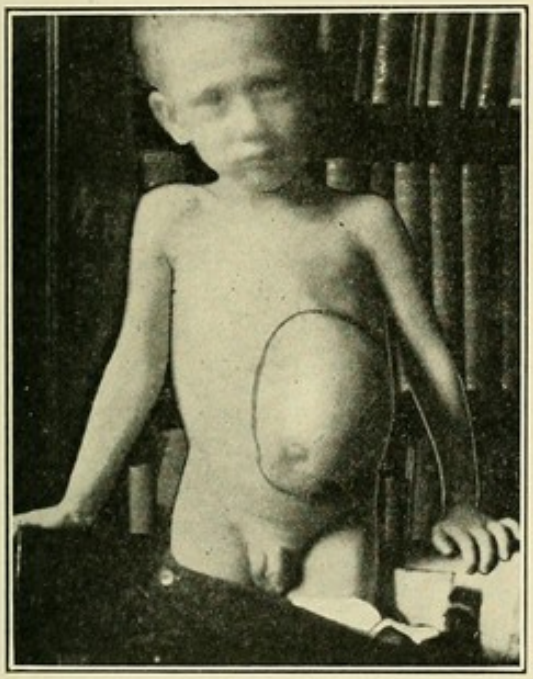


FIG. 16. HYDROPERINEPHROSIS FOLLOWING TRAUMATISM. Dark line outlines the percussion dullness. Operation, recovery. Boy aged 3½ years.

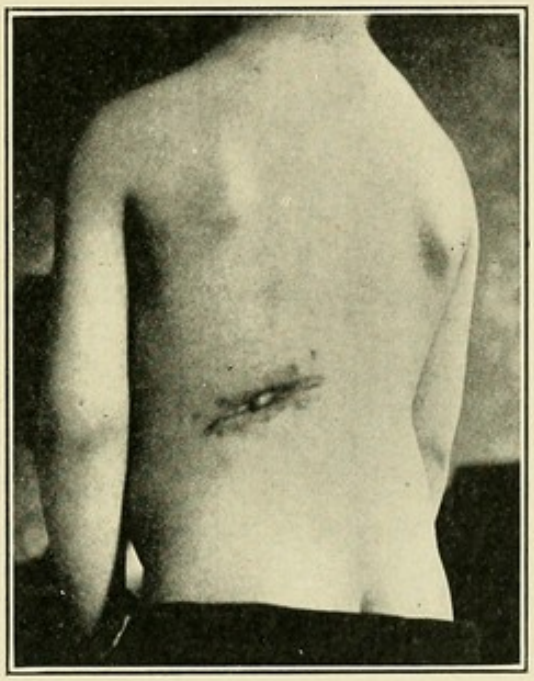


FIG. 17. Same case after operation, showing the line of the incision.

dilate, sometimes enormously and with destructive effects on the gland tissue from pressure, as before described.

A similar, though more rare, condition called pseudo-hydronephrosis—but for which I have suggested the better name of hydroperinephrosis—occurs when the cyst forms in the cellular tissue just outside of the kidney. Figs. 16 and 17 are from a case of this kind. The patient was a small boy of three and a half years, weighing 29 pounds. He was run over by a wagon, taken to a hospital, dismissed as well after the first week, and was brought to me seven weeks later. He had a tumor in the abdomen, scanty urine, and distressing gastric symptoms from pressure. Diagnosis,

hydro-nephrosis or hydro-perinephrosis. On nephrotomy I found the cyst, which contained several pints of fluid, was not the dilated pelvis of the kidney, but was outside of the kidney, although having an opening into the kidney-pelvis. The boy made a good recovery and the kidney resumed its function.

Retention cysts, in connection with the urachus and with the vitello-intestinal duct, also occur.

Diagnosis.—The retention cyst is located in the situation of a secreting or excreting gland. There are usually evidences of lessened secretion or excretion from the affected gland. Pain is present if there is rapid distension of the retention cyst, or if it becomes infected and inflammation results. In some situations, exploratory puncture is permissible.

Prognosis depends on the vital importance of the organ obstructed and whether it is located deeply or near the surface. The danger of infection has a bearing on the prognosis. In case of retention cyst within the abdomen there is danger of its rupturing into the abdominal cavity.

Treatment indicated is to remove the cause of the obstruction if possible. If the duct is plugged by concretion the same should be removed, or if by inflammation the inflammation should be treated; if by flexion the duct should be straightened. If the obstruction is of such a nature that it cannot be removed, the indications are to withdraw the retained fluid and establish drainage. If the outlet is destroyed the cyst should be removed. If adhesions have rendered that impracticable, its lining should be exposed and cauterized and packed with gauze and allowed to close by granulation.

CONCLUDING REMARKS

Neither encephalocele, meningocele, spina bifida, giantism, nor acromegaly are properly classed as tumors. However, it is necessary to bear them in mind in making a diagnosis. Recalling now the varieties of tumor we have found most prevalent in children, it is at once apparent that the most of them belong to the class of new growths arising from the mesoblast—the connective tissue series. This we might almost have expected when we consider the intense activity of the connective tissue cells during the rapid-growing time of childhood. The same law is in evidence in the increased number of dermoids which make their appearance about puberty, when structures arising from the epiblast receive such a wonderful new impetus in their development.

But if the matrix of a carcinoma, arising also from the epiblast, is present at birth, what is the inhibiting power that prevents its development in so many cases until middle life or past? It is

true that babies and even youths have not experienced the traumatisms and irritations which help to produce tumor growth and induce malignancy. Children have not followed dusty or irritating occupations, such as chimney-sweeps, millers, charworkers, et cetera; nor have they so frequently acquired scar tissue, either by wounds through normal tissues or by the attempted removal of benign growths with caustics, which only partly remove them and leave a part, together with irritated or depressed surrounding cells. Children are less apt to have syphilitic ulcerations, lupus, chronic ulcers, old sinuses, which are prone to develop carcinoma. Their genital organs have not undergone repeated congestion nor inflammation nor irritation, as those of adults. How much have these facts to do with the scarcity—the almost entire absence—of epithelioma and scirrhus in the young? And how much is due to that physiological resistance of normal cells entrenched in their proper surroundings against the invasion and development of foreign or of abnormal cells? Very interesting studies, for example those of Tyzzer [1] tend to show that in the experimental production of tumors by the inoculation of tumor tissue, it is the growth of the transplanted cells and not the introduction of a virus that produces the tumor. With certain kinds of tumors the continuation of the growth is not dependent upon peculiar conditions in the tissues to which they are transplanted. With other kinds peculiar conditions are essential; for the tumor will grow if transplanted into other parts of the same individual, but not if transplanted to other individuals. The nature of a tumor growth depends upon the biologic character of its cells, just as in Cohnheim's experiments before cited, normal cells, dislocated, still tend to produce their kind. Remembering the power of normal cells to resist abnormal or heterogeneous growth, and the remarkably great reproductive power of embryonic cells, as shown by Cohnheim and Maas, it would be of extreme interest to perform a series of experiments to ascertain whether the physiological resistance to such foreign cell encroachment is different in the young subject from what it is in the old.

There is another field for further study in the pathology of the tumors of children. Are they more or less subject to infection, to ulceration, or do they behave differently under irritation or traumatism than the same variety of tumor in the adult? Are the degenerative changes different in the young subject? Compare calcification, ossification, caseation, amyloid, colloid, mucoid and fatty changes in the young with those in the old. Is there any different behavior of the lymphatic system toward tumors in the young? Are their tumors more or less liable to interstitial hemorrhage or thrombosis?

[1] Tyzzer. Boston Med. & Surg. Jour., 1909, 161, p. 103.

CHAPTER III

CONCERNING CERTAIN CONSTITUTIONAL DISEASES

HEMOPHILIA—RACHITIS OR RICKETS—INFANTILE SCORBUTUS.

HEMOPHILIA

HEMOPHILIA is an hereditary disease in which there is a tendency to bleed persistently from the slightest wound. Alarming and fatal hemorrhages have occurred after operations upon or injuries to "bleeders," as those afflicted with this disease are called. Hemophilia may sometimes be traced through seven or eight generations, descending to the males through the females, the females themselves being seldom affected. But it often skips a generation, or follows only one branch of a family in its descent.

The following cases from among those which have come under my own observation occurred in two generations in the S. family. They so well illustrate the characteristics of this peculiar disease that I beg leave to introduce them at this point.

Mrs. S. knows of no bleeding tendency among her immediate ancestors; and, although she had four brothers and two sisters, who, in the aggregate, were parents to thirteen children, seven boys and six girls, none of them of either sex have yet shown hemophilia. The disease has followed this one branch of the family. Mrs. S. herself has several times had hemorrhage after slight injury—for instance, bleeding three days, in spite of remedies, whenever she had a tooth extracted. She flowed abundantly, but not dangerously, at each menstrual period and childbirth. She was married twice, by the first husband having one daughter, and by the second, two sons and one daughter. The girls were never affected by hemophilia. But the boys, from the second or third year on, showed extensive contusions from the slightest bump, and at about their eighth year got joint swellings, especially of knees and elbows. These swellings were accompanied with pain, tenderness, discoloration, and loss of function, each attack lasting ten to fourteen days and then subsiding somewhat. But the joint attacks finally disabled them from walking or work, extension of either legs or arms being impossible on account of swelling and tenderness. (See Fig. 18.) When H., the elder brother, was eighteen years of age, a surgeon tried to straighten the right knee by tenot-

omy. The hemorrhage, although not profuse at the time of the operation, was very obstinate. The first dressing was left on three days. Then the leg and thigh were found black and swollen, and removal of the bandages was followed by a gush of blood. This was repeated, regardless of all remedies, and he died eleven days after the operation. The younger brother, G., gradually grew worse. In his seventeenth year his knees were flexed to nearly a right angle, and could be moved, the right about thirty and the left, fifteen degrees. Elbows movable thirty-five degrees, all with great pain. Suffered severe pain at these points and in right shoulder. Was morose, peevish and shy, and addicted to morphine. A slight injury to the right arm now produced an immense swelling, extending nearly from shoulder to elbow. After five weeks the swelling became tense, black, and oozed blood, then opened and bled three days, when he died.

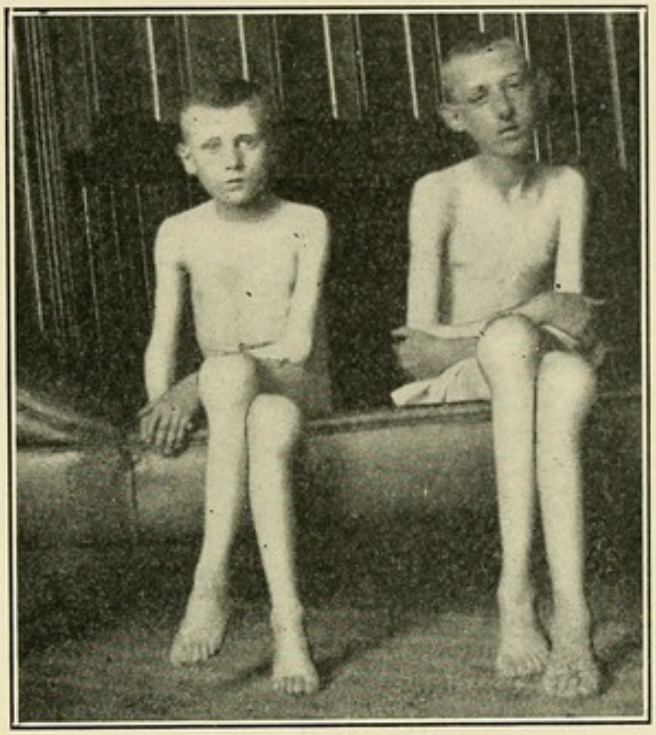


FIG 18. HEMOPHILIAC BROTHERS. Complete extension of knees or elbows impossible on account of swelling, tenderness and hemorrhages. The elder brother, aged 18, died eleven days after an injudicious attempt to straighten one knee by tenotomy. The younger brother died at 17 years from repeated spontaneous hemorrhages. These two brothers are uncles to the hemophiliac boy shown in Fig. 19.

Mrs. S.'s daughter (by first husband, as before stated, thus proving transmission by the mother) married and had three children. The eldest is a boy, B. B. (See Fig. 19, taken when he was eleven years old.) He first got swelling and tenderness of joints at one and one-half years and early showed the tendency to acquire contusions, which would appear four or five days after injury and remain swollen, discolored, and tender for weeks. When two years old a slightly cut finger bled four days. At four years he accidentally bit his tongue and bled three weeks. A small punctured wound of the chin bled nine days. A few years later a small cut on the brow, received while coasting, was repaired with

two sutures. Six days later immense hemorrhage took place. A surgeon who was called in "did not believe in 'bleeders.'" He enlarged the wound to search for a supposed bleeding vessel. The hemorrhage which followed could not be controlled even with forceps, which were left in the wound, but which broke away, bringing sloughing tissues, ligatures, and sutures. All known styptics were used, but oozing continued to saturate dressings for five days, when the boy was nearly dead. The hemorrhage stopped spontaneously and the wound healed, leaving the scar seen on the temple in Fig. 19. He was a tall boy at eleven, standing 59 inches. Observe the large knee joints and the discolored contusions upon the legs. His younger brother, H. B., at the age of six years, has never shown anything abnormal, even after cuts and bruises. The third child, a girl of three, has had injuries, but showed no symptoms of hemophilia.

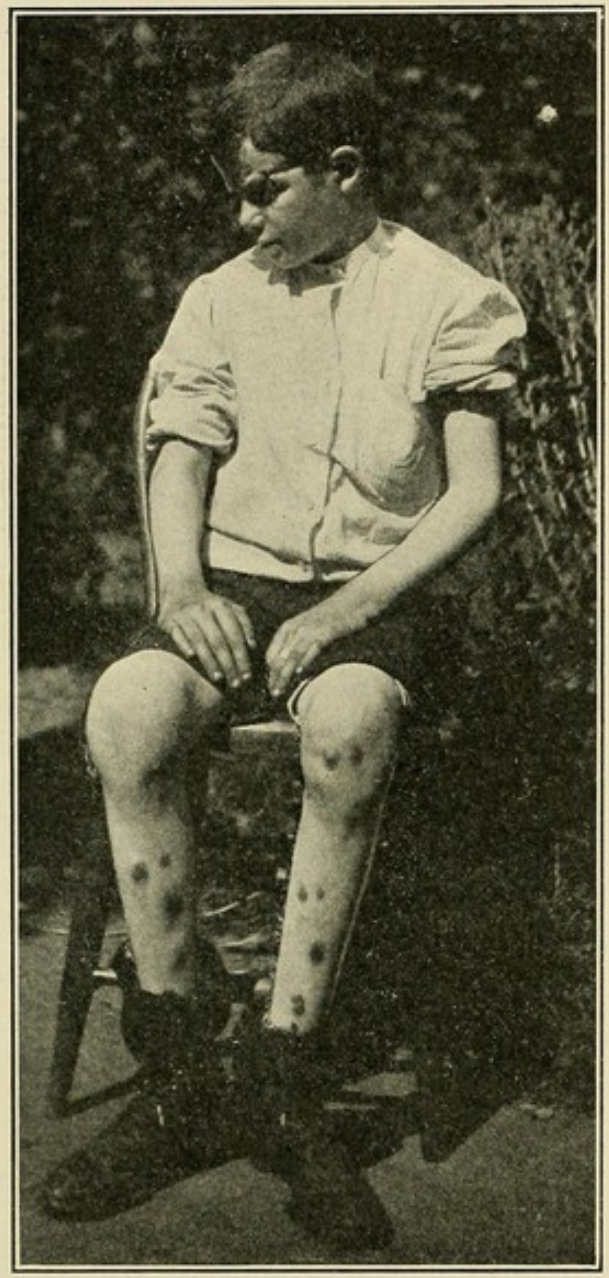


FIG. 19. HEMOPHILIAC BOY. Nephew to the hemophiliac boys shown in Fig. 18. The deep scar on the brow came from a slight injury which nearly cost him his life. The large knee joints and right elbow and the discolored contusions upon the legs are well shown.

The nature of the disease is unknown. Suspected changes in the blood or on the blood-vessels have not been proven. This disease is not to be confounded with the hemorrhagic disease of the new-born, the various forms of purpura, the hemorrhages that sometimes appear in hereditary lues, nor with scurvy. It does not

usually make its appearance till in the second year, and the tendency to bleed may be finally lessened in those cases that survive to adult life. The arthritic inflammations resembling rheumatism are common accompaniments. Some patients bleed periodically. (10)

Treatment.—The ordinary means for hemostasis may be tried. Pressure forceps or ligatures, compression, heat, cold, tannin, alum, Monsell's solution, cupric sulphate, collodion, adrenalin, and other styptics. The persistent hemorrhage seems to be capillary and to defy stasis. Ligatures and sutures are apt to slough secondarily. Internal medication has little or no effect. Many drugs have been tried, including tannic and gallic acids, lead actate, ergot, hamamelis, calcium chloride, adrenalin, and even thyroids and many others old and new, hydrastine hydrochlorate, stypticin (Fischer). But the hemorrhage, when it ceases, usually does so spontaneously. (11)

RACHITIS OR RICKETS

This is a constitutional disease sometimes classed as a disorder of development, sometimes as a disease of the bones, but more correctly a disease of nutrition affecting not only the bones and teeth, but the nervous system, the muscles, aponeuroses and ligaments, the mucous membranes and the lymphatics, and to some extent the internal organs, especially the spleen. The direct effects upon the skeleton attributable to rickets, and its indirect influence in the causation of hernia and lymphadenitis, which are not so obvious, are the principal reasons for its place as a surgical disease. Also its resemblance to other acute and chronic diseases of bone, periosteum and cartilage, and to diseases of development.

Etiology.—The exact etiology of rickets is obscure. Its production is probably a complex process. Broadly speaking, the cause is found in faulty diet, and especially in a diet lacking in fat and proteid elements, the lack of fat being the more serious of the two. For a time it was claimed that an excess of carbo-hydrates was the cause, acting by producing excess of lactic acid, which interfered with the assimilation or the deposition of lime salts. But it is probably the lack of essential elements rather than an excess of any one element. But besides the effects of faulty diet there is undoubtedly a causative relationship in bad hygienic surroundings, especially overcrowding, lack of sunlight and fresh air, and, as it seems to me, lack of warmth—not merely warmth of climate, but warmth by clothing. As might be expected after these premises, rickets is most frequently found in infants artificially fed, although it can occur in the breast-fed; and in the children of the poor in large cities, although it may occur under opposite circumstances. Rickets prevails most in the temperate zones. It is exceedingly common in England and quite common in the United States, especially

among the immigrant classes and their immediate descendants. Our most marked cases are among the Negroes and Italians, though slighter degrees will often be found, if looked for, among Americans. Heredity has probably nothing to do with the direct causation of rickets, but, like alcoholism, tuberculosis or syphilis, it may produce offspring of poor resisting power, although Siegert has drawn attention to rachitic and non-rachitic families living in exactly the same unhygienic conditions. The presumption that rickets is but an evidence of remote syphilis is negatived by the fact that the earlier children of a family show most evidence of a syphilitic taint, while with rickets it is the later children who are most apt to have the disease.

Lesions.—The lesions are most marked in the bones. The rachitic bone is abnormally flexible and soft if examined in the active stage of the disease, before "eburnation" begins. The long bones are too smoothly cylindrical, somewhat lacking the well-defined borders, tuberosities, processes, and surfaces which mark the normal bone. The periosteum is thickened and hyperemic. The epiphyseal cartilages are enlarged, especially those at the lower end of radius and tibia. One of the peculiar features of rickets is that there is no certainty as to which bones will exhibit the most severe lesions, those of the upper or lower extremity, the ribs, or the cranial bones. The enlarged epiphyses result from an excessive proliferation of cartilage cells deposited in imperfect histological arrangement, the hyperemic periosteum also proliferating bone. But in neither situation is the transition to normal bone effected, the amount of calcium salts it contains being reduced from 30 to 50 per cent. Meanwhile, the medullary canal has been increased in size by absorption of its inner layers, and the bone marrow is reddened with an increase of red blood cells. The epiphyseal cartilage is thickened to sometimes four or five times its normal thickness and widened as much as a fourth or half beyond its normal width, is softer than normal, and the zone of growth is darker and bluish in color. The line of the junction between cartilage and diaphysis, which normally is straight, here presents an irregular or indentated appearance. When examined with the microscope it is seen that this border line of the process of calcification, which should be straight, is interrupted by projection through it into the cartilage areas of calcified ground substance or osteoid foci, in which medullary spaces are being formed; and on the other side, islands or foci of calcified or decalcified cartilage are seen. Thus the bony and cartilaginous tissues are irregularly intermingled across the epiphyseal line. The osteoid tissue—that is, newly formed bone, which is still decalcified—is thicker than it should be, the trabecular spaces remain large, and the bone spongy and never properly cal-

cified. The flat bones—for example, the frontal protruberances or bosses—present the same process as has been described as taking place beneath the periosteum, namely, excessive formation of osteogenetic layers upon the surface of the bone, the deposition of osteoid substance, and deficient deposition of calcium salts, so that the bony trabeculæ, while calcified within, are lacking calcium at the periphery and remain soft, causing the characteristic flexibility of the bone with its visible hyperemia on section. The pathologists have not yet decided whether these changes are of the nature of inflammation or merely of faulty nutrition. In the course of three to fifteen months the condition of inflammation, if it be such, or the process of irregular proliferation, comes to an end and is replaced by a process of ossification. The vascularity subsides, and calcium salts are deposited, in some cases being substituted for cartilage. The bone resulting is condensed and hardened to a density exceeding that of normal bone, though never having the normal structure. In the meantime various deformities may have been produced, which will be described in the section on symptoms, and various lesions of tissues other than bone cartilage and periosteum have been present in varying degrees. The ill-nourished muscles have become relaxed or atrophied. The bronchial mucous linings and the lungs show the effects of repeated catarrhal inflammations. The lungs may also have become impervious where pressed upon by the collapsed thoracic walls. The spleen has been enlarged, but not degenerated, and subsides with the cessation of the disease. Chronic catarrhal inflammation of the gastro-intestinal organs, with over-distension of weakened musculature, has caused dilatation. The lymph nodes are enlarged.

Lamellar cataract is claimed by some to be a result of rachitis, although such a relationship is denied by Hutchinson. The eruption of the teeth is delayed and they appear irregularly as to time and as to position in the alveolar process. Occlusion is imperfect. The teeth become prematurely discolored and carious. Their surfaces are grooved and striated. Their edges rapidly erode, often being notched thereby. (See Figs. 20 and 21.)

Age of Incidence.—The age of incidence most frequently is between the sixth and fifteenth month, according to Holt, but one is sure it may come somewhat earlier or later. Cases of congenital rickets and of late rickets, beginning between the sixth and tenth years, have been reported, but must be very rare. In twenty years' dispensary service I do not recall a case in which it was proven to have begun after the period of childhood. Possibly some cases of knock-knee or bowed legs from relaxed ligaments or other causes have occasionally been attributed to rickets.

Early Symptoms.—The early symptoms should be mentioned

separately, because the early detection of the condition is important. Almost always the first symptom noticed by the mother is either restlessness at night and kicking off the bedclothes, or else head sweating during sleep. The reason for this kicking of the clothes is unknown. Some have thought it due to the frequent indigestion and reflex disturbances. The profuse sweating of the head has been attributed to the habit of rolling or rubbing the head upon the pillow, which seems improbable. The restlessness and head-sweating may continue for weeks or months before any other symptoms are noticed. Beading of the ribs almost always is present as an early sign, but is not always present in a marked degree. Constipation is present in most cases, but is so common a symptom in other conditions as to attract little attention toward the rachitis. Cranio-tabes is among the early signs.

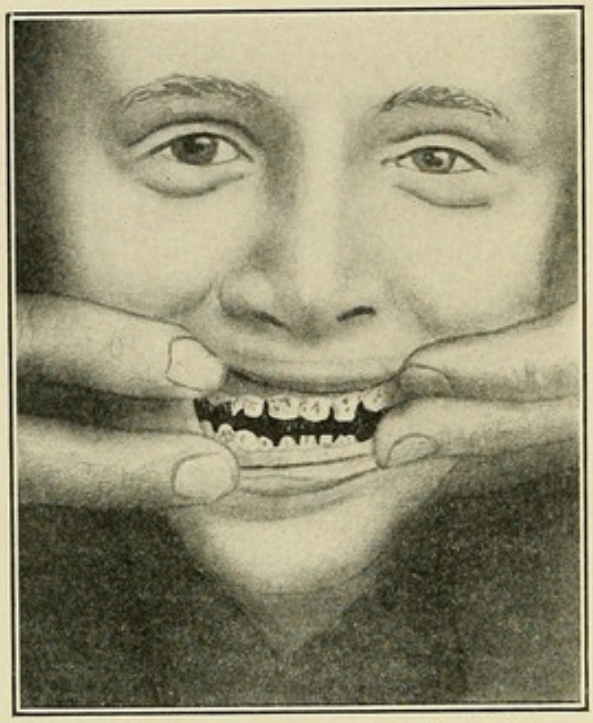


FIG. 20. RACHITIC TEETH.—Dr. I. A. Abt.

Other Symptoms.—Besides the restlessness at night there are other nervous symptoms, such as a predisposition to general convulsions upon the slightest provocation, such as disorder of the digestive organs, laryngismus stridulus or tetany, or local muscular spasm. Pain or tenderness are mentioned, but belong rather to scurvy. The mucous membranes suffer with repeated and easily induced attacks of catarrhal inflammations, such

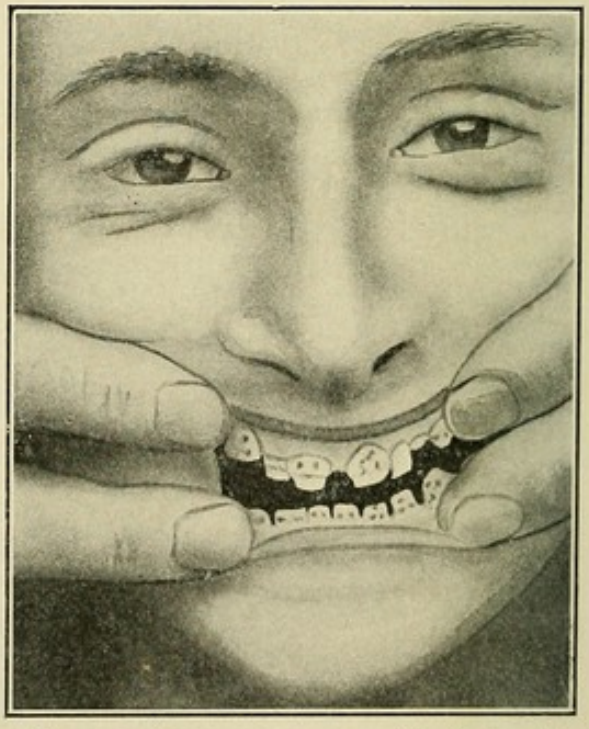


FIG. 21. RACHITIC TEETH.—Dr. I. A. Abt.

as croup, bronchitis, broncho-pneumonia; or of gastric and intestinal catarrhs. Such attacks are not only easily induced, but obstinate to treat.

General Condition.—The general condition is not always that of emaciation. Many cases appear fat, some are marasmic, all poor in muscular tissue. Practically all are anemic. Any of the usual forms of anemia may be present, and worse, according to the severity of the case. Hypertrophied tonsils and adenoids are very common in rickety children; and the obstruction they cause adds greatly to the general debility and increases the deformities of the chest. (See Chapter on Obstructions of the Air Passages.) Enlarged lymphatic glands of the neck are common accompaniments.

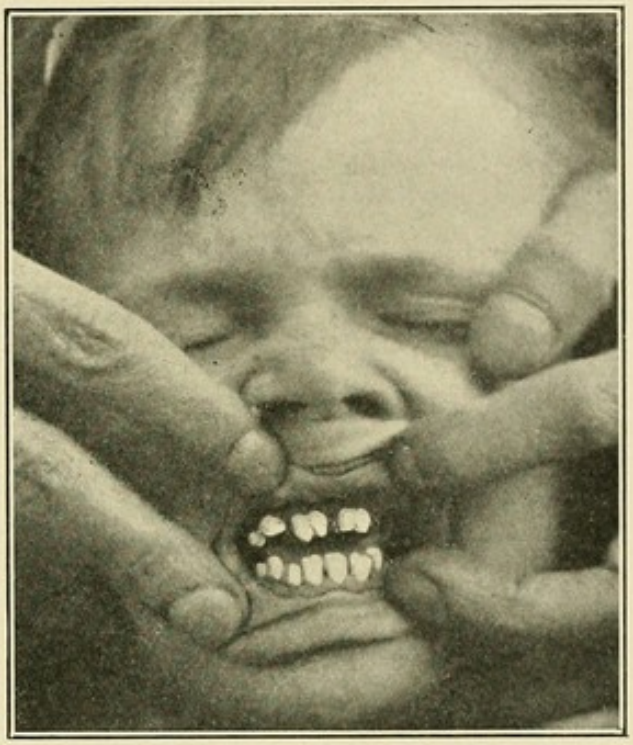


FIG. 22. TYPICAL TEETH OF HEREDITARY SYPHILIS (Hutchinson teeth). Also shows the bossed frontal bones and the flat nose. Had snuffles and specific rashes when a babe, and family history of syphilis. Girl aged 8 years.

Deformities. — The deformities of rickets are very numerous. They are not all always present, nor do they always appear in the same degree of deformity in equally severe cases. Thus, in three cases of equal severity, one might have the worst deformity in the chest, another be most marked in the upper extremities, and the third show the disease most strikingly in deformity of the lower extremities. Some cases may present all the known evidences of the disease. Several of them may be seen in Fig. 23, seventeen months old. Observe the large head, the narrow chest, the distended abdomen, and symmetrical deformities of the extremities, namely, bowed forearms, enlarged radial and lower tibial epiphyses, and the tibiæ curved convex anteriorly. We will consider the deformities separately.

The head appears too large; but this may appear more so by comparison with the chest, for it may not be so large by measurement. Some actual enlargement is usual. This is not due to expan-

sion from within, as in hydrocephalus, but to the thickening of the cranial bones, which is most marked upon the frontal and parietal bones. These enlargements, together with a flattening upon the top and behind, give the head a somewhat square shape which is different from the globular enlargement of hydrocephalus. The anterior fontanel may remain open until the second or third year, and when ossified remain flattened or even depressed. The sutures may remain open more than a year, and when closed still be very perceptible. Craniotabes, a parchment-like crackling or wrinkling sensation under slight pressure by the finger-tips over the occipital and parietal bones, may be present. It is due to a thinning of the bones in spots, and is not pathognomonic of rickets, being found also in hereditary syphilis. The veins of the scalp may be prominent, but not to that degree usual in hydrocephalus. The head retains to a great degree its characteristic deformity after recovery, although the swelling of the bones diminishes somewhat. Dentition is delayed, especially if rickets begins early before teething has begun.

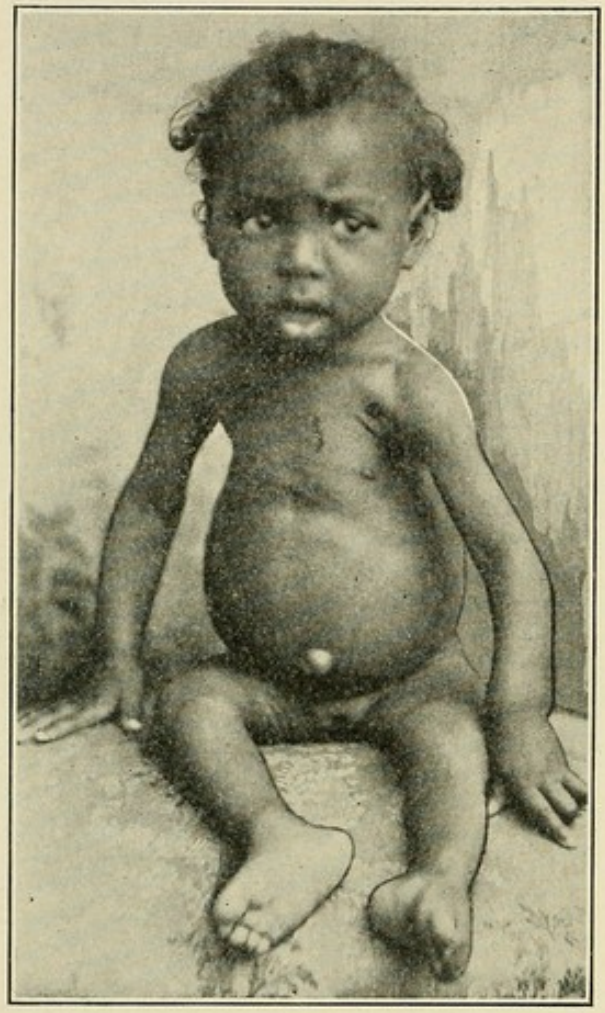


FIG. 23. RACHITIS. Large head, narrow chest, distended abdomen. Symmetrical deformities of extremities, namely, bowed forearms, enlarged radical and lower tibial epiphyses, and the tibiæ curved convex anteriorly. 17 mos. old

The most constant sign upon the thorax is the "rickety rosary"—beaded ribs—an enlargement of the epiphyseal cartilages at the costo-chondral junctions. They are well shown in Fig. 26, which is a very marked case in a babe fourteen months old. Beading is by no means always so prominent. It may be discovered only by palpation. Beading takes place upon the inside, as well as upon the outside, of the thorax, or only upon the inside. The most serious deformity of the thorax, so far as its effect upon health is

concerned, is the flattening in of its sides. This is produced by atmospheric pressure upon the yielding chest walls, which are softest just where the ribs and cartilages join, but present more resistance in the sternum which stands forward. A frequent deformity is a flaring outward of the lower part of the thorax, caused by the distension of the abdomen, and often persisting in cases long recovered from active rickets. The " rachitic girdle " is a groove or depression extending across the chest from side to side, just above its lower border. The " funnel-chest " is seen in Fig. 180, thirteen months old. The clavicles may be enlarged at their ends and the normal curve forward exaggerated at the inner third. This, with the curving of the spine, causes the neck to appear short.

Distension of the abdomen is a common and pronounced symptom in most cases. " Pot-belly," or " potato-belly," comes early. It is produced by the faulty digestion, with formation of gases, and the constipation, or alternating diarrhea, which act upon weakened and toneless muscular walls and stretched-out aponeuroses. They, like the stomach and colon, become permanently dilated. The enlargement is uniform and tympanitic. The linea alba stretches to a thin, wide ribbon between the two recti, and umbilical hernia is common. It may be seen in Figs. 23, 24 and 26.

The characteristic rickety deformity of the spine is well seen in Fig. 24. It is a rounded kyphosis or posteriorly convex curve, extending usually from the mid-dorsal region to the top of the sacrum. It will be further described in the chapter on the spine. It is not present in all cases, even in children who sit or stand.

In the upper extremity the most common deformity is swelling of the radial epiphyses, especially at the wrist. Bowing of the forearms with the convexity on the extensor side is frequent. Fib 25 is a good example, also Fig 24. Fig. 25 also shows a characteristic attitude of the rickety child, sitting cross-legged and leaning forward on the hands, thus bending the forearms, and also putting curves in the spine and the legs, and sometimes in the thighs and pelvis. This case also exhibits the big belly and the beaded ribs. Such children do not want to be moved or changed to any other position. The humeri are not so frequently bowed, yet they may be so, or enlarged at their epiphyses. Deformities of the upper extremities are apt to be symmetrical. Bowing may partly disappear. Enlarged radial epiphyses are apt to show through life. The lower extremities also yield to muscular tension and to weight, besides exhibiting the swelling of the cartilages. The thigh and leg bones yield in various directions, producing the bow-legs, bandy-legs, saber-legs (with the tibiæ convex anteriorly, as seen in Fig. 24), or the corkscrew-legs, which are bent in several directions. (See also chapter on Rickety Deformities.)

Rickets runs a chronic course, and recovers unless complica-

tions prove fatal. The active condition continues, according to Holt, from three to fifteen months. It ceases when the conditions which caused it are changed. Often it is weaning or a change to more suitable food and more outdoor life that terminates the disease. The symptoms subside in somewhat the same order that they came, the nervous manifestations first and the deformities last if at all. There is usually some deformity which requires mechanical interference. With this we shall deal in the appropriate section.

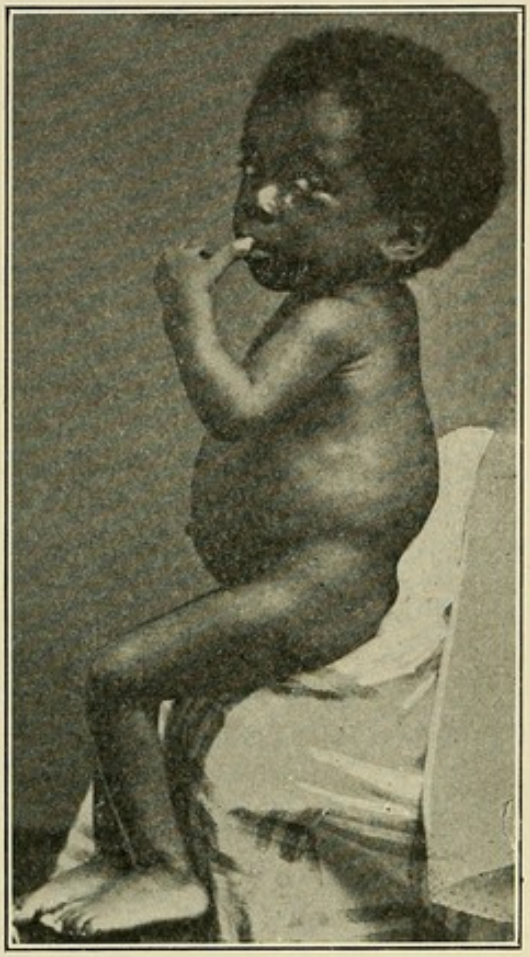


FIG. 24. TYPICAL RACHITIS. Large square head, big belly, rounded kyphos, enlarged radial epiphyses, and bowed tibiæ.

Diagnosis. — The diagnosis is easy in a typical case; but in the slighter cases and early stages it may be necessary to examine for all the symptoms that have been here enumerated. By the time the case with bony changes is brought to the surgeon the nature of the difficulty should be distinguishable.

The enlargement of the head may be mistaken for hydrocephalus. But this latter has the head globularly expanded, with the eyes depressed in their orbits, or strabismus, and often symptoms of brain pressure, and the fontanels not only open but bulging. Rachitis has a square head with flat vertex, and craniotabes; and no signs of intracranial pressure. The rickety curved spine may be mistaken for the kyphosis of tubercular spinal disease. But the rickety spinal curve is rounded and disappears, or almost disappears, with the flexibility test. The kyphosis of caries is angular and rigid, not yielding with extension or backward flexion. Rickets and scurvy may be confused. Scurvy has the greatest tenderness at the epiphyses of the lower extremities, ecchymoses in the skin, hemorrhages beneath the periosteum, and spongy gums. Rickets presents no marked tenderness excepting about the ribs, and no gum lesions. Achondroplasia may be mistaken for the more common disease, rickets. But achondroplasia is congenital; the head

is dwarfed at the base, besides being expanded above; the long bones have failed to grow in length, are not curved, and widen abruptly at the epiphyses. Rickets comes in the second six months of life, with its nervous, catarrhal and bone-deforming train of symptoms. Syphilitic osteochrondritis, the pseudo-paralysis of hereditary syphilis, may be taken for rachitis. But the former comes usually in the first few weeks of life. It presents a swelling of perhaps one lower epiphysis of femur or humerus. The swelling is painful. Separation of the epiphysis may occur. Late syphilis, corresponding to tertiary, affects the shaft rather than the extremities. Rickets, as has been said, seldom comes before the second half year of life; the bone lesions are apt to be multiple and symmetrical, and almost painless. In syphilis and in scorbutus the therapeutic test is generally conclusive.



FIG. 25. CHARACTERISTIC ATTITUDE OF RACHITIC CHILD, sitting crosslegged and leaning forward, resting weight upon the arms which has caused the forearms to become bowed. This position often curves also the legs and the spine, and sometimes the thighs and the pelvis.

The differentiation of rickets from some forms of paralysis should be alluded to, especially with respect to the common forms, poliomyelitis and paraplegia. The apparent paralysis involves many muscles, there is no rigidity or coldness. The reflexes and muscle reactions are present. In paralysis from poliomyelitis the paralysis is limited to certain muscles or muscle groups; the parts are cold, perhaps wasted, and reflexes diminished and reactions altered. With cerebral palsy there is rigidity of the lower extremities, exaggerated patellar reflexes and likely cerebral symptoms.

Treatment.—Many cases coming to the surgeon are past the stage when anything but operative or mechanical means will be of any service, the damage having been done and remaining, al-

though the cause is no longer active. Others may fortunately be brought earlier in the case, when in addition to his osteotomes and osteoclasts, his tenotomes, casts and braces, the surgeon should have recourse to diet, hygienic measures, and perhaps drugs. Briefly, these consist in the withdrawal of the food that has occasioned the disease. If the infant is nursing late it should be weaned. Often it will not feed properly until this is done. The use of carbohydrates, namely, starches and sugars, and all canned or proprietary foods, should be prohibited or limited. In their stead the child

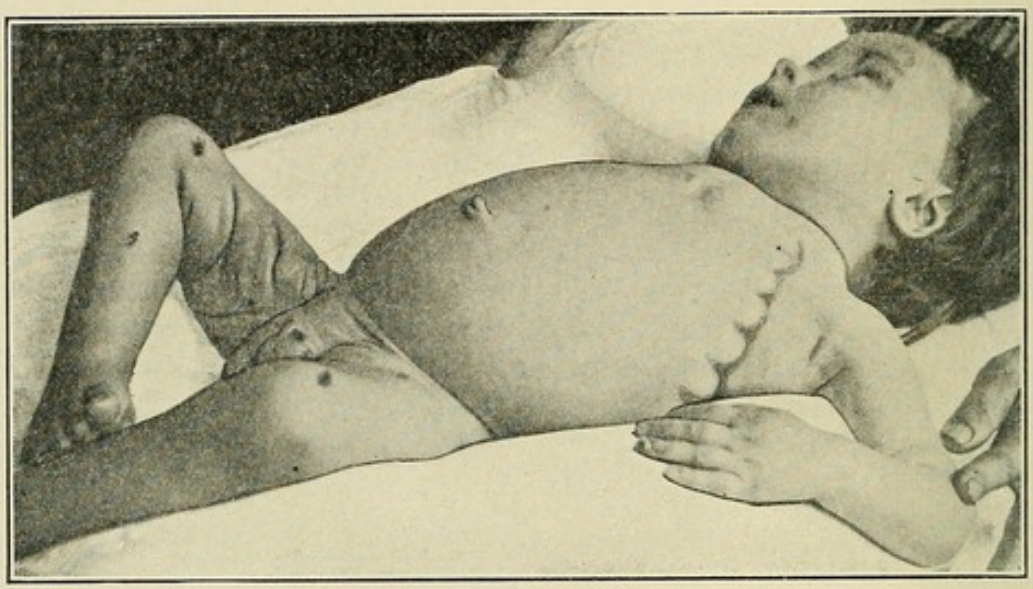


FIG 26. BEADING OF THE RIBS FROM RACHITIS. Note also the flabby muscles, big belly and umbilical hernia.

should have all it can digest of fats and nitrogenous foods, namely, fresh, preferably raw, cream and milk, eggs, beef juice, scraped beef or mutton, fruit juices, and, with older children only, the fruit itself. Fresh air and sunlight, with clothing proper for the season, are demanded. Rickety children improve at the seashore or in the country; many of them do better in the mountains. But few can have these advantages. The present tendency to make more use of roof-gardens in connection with hospitals and city homes has much to commend it in the treatment of rickets as well as tuberculosis. If we paid more attention to providing sun and air parlors, and free ventilation of hospitals and homes for children all the year around, they would derive quite as much benefit as to send them for a brief season to seaside or country. Sufficiently warm clothing is requisite to prevent chilling of the extremities. In England many hospital wards and poor homes are too cold; and children are, besides being poorly fed, more thinly clad than in this country, their legs often exposed until blue with cold. In this country we go to the other

extreme as to heating of hospitals and homes, and invite catarrhal attacks upon the slightest exposure to a change of air. Cold sponge baths every morning, followed by brisk rubbing till reaction is established, and also, if not at the same hour then later in the day, the employment of systematic massage, are among the most useful means to invigorate the patient, to increase the resistance to cold, to improve the muscular tone and the circulation, and hasten metabolism in the tissues.

Of the drugs used in rickets, cod-liver oil stands first. The question is still disputed whether it acts as a drug or as a food. In this disease certainly one would prefer the oil to any extract made from it. Phosphorus was much used for a time, and is by some still, in doses of 1-200 to 1-100 t.i.d. It seems to do some good early in the case, especially in cases with tenderness of epiphyses somewhat resembling scurvy, and in the nervous cases. Hypophosphites, iron and arsenic are much in use in rickets as in other states of " debility," that is, lowered vitality with malnutrition. These drugs may be used singly or in various combinations, also with cod-liver oil. The iron and the arsenic are certainly useful for the anemia. The cod-liver oil is given as the stomach will tolerate it, The hypophosphites, whether of much therapeutic value or not, serve as a vehicle. In those cases accompanied with the lymphatic enlargements the iron in the form of the syrup of the iodide is useful. This, in combination with cod-liver oil and syrup of the lactophosphate of lime, has been a stock preparation, inelegant but efficient, for dispensary use for many years. The mechanical treatment of rachitis will be discussed with regional surgery. (12)

INFANTILE SCORBUTUS

Infantile Scorbutus (*Scurvy; Barlow's Disease; Scurvy-Rickets; Acute Hemorrhagic Rachitis.*)—The fact that many surgeons have cut down upon scorbutic bone under the impression that they were dealing with an acute periostitis or an osteomyelitis or even sarcoma, emphasizes the necessity of keeping a knowledge of this disease before those who essay to treat children surgically. Infantile scorbutus is by some considered not to be identical with scurvy of adults. However, with the " infantile " prefixed it makes a satisfactory name. It was long confounded with rickets, from which it is distinct, though often co-existent, and the synonym scurvy-rickets is unfortunate. It is called Barlow's disease by the English, after Dr. Barlow of the Great Ormand Street Hospital, who wrote upon it. The resemblance in scurvy and rickets is in the bony changes, in the age at which they occur, and in their dietetic origin. But the hemorrhagic features of scurvy never appear in rickets, and

the special treatment so successful in scurvy has no effect in rickets.

Infantile scurvy is a constitutional disorder produced by faulty nutrition. The great majority of cases occur in the second and third half years of life, though it can occur earlier or later, most often at the eighth or ninth month.

Etiology.—Scurvy may occur in a breast-fed infant, but the constant and prominent cause is found in food that is not fresh, especially the proprietary foods, condensed milk, and sterilized milk. It appears that the disease results not only because the food is low in proteid, fat, sugar or salts (this may or may not be the case), but because it has been cooked, heated or dessicated; it lacks the quality of freshness; and because its use has been continued for weeks or for months.

Morbid Anatomy.—Hemorrhages take place beneath the periosteum of the affected bones, and in fatal cases the periosteum of the entire skeleton may be somewhat loosened. The lesions are most severe in the legs and thighs, the bones of which may be entirely denuded of periosteum. Extravasations of blood may also be found between muscles and in cellular tissues. Separation of the epiphysis from the shaft may occur, more frequently at the lower end of femur or tibia. The joints are usually not affected. Hemorrhages or small extravasations may be found upon any of the mucous membranes, beneath the pleura, pericardium, peritoneum, or the skin, or into lungs or kidneys and bone marrow, and there is marked hemorrhagic gingivitis. The microscopic bone alterations resemble those of rickets.

Symptoms and Course.—In a majority of the cases the first symptom to attract attention is tenderness of the legs upon handling, though the infant may have been considered puny for some time previously. This tenderness may be hard to localize, but, as it appears to be near the joints, is apt to be mistaken for rheumatism, which is uncommon at this age. On closer examination it may be demonstrated that the tenderness is not in the joint itself. This tenderness increases, and the babe dreads to be moved or even touched, and becomes very unhappy and much distressed. The gums are swollen and turgid, bleeding readily. This condition may continue for days or weeks, with fretfulness, loss of appetite, weight and color. Or the disease may advance to greater severity. Pseudoparalysis of the lower extremities appears, due to the extreme tenderness, or sometimes to separation of an epiphysis. This has often been mistaken for the paralysis of poliomyelitis, which has no tenderness or swelling. The tenderness is greatest at lower ends of femur or tibia, and extends along the shafts of the bones. Swellings appear in the same situation, and discoloration of the skin over the swellings, due to the hemorrhage beneath. Swelling and tenderness

may appear also near the other joints of lower or upper extremities, and even the ilium or the ribs. The swelling about a knee may be so large and discolored as to resemble a sarcoma. But most often both limbs are affected. The discoloration has the appearance of a bruise, as in hemophilia. Hemorrhages beneath the skin give some resemblance to purpura. The gums and mouth resemble mercurial stomatitis, but with less salivation. The gums become immensely swollen, of a dark purple, and hemorrhage takes place, not only from the gums, but from the roof of the mouth or the pharynx. Hemorrhage may also occur from the nose, bowels, kidneys, or stomach. Hemorrhage in the orbit may cause protrusion of the eyeball. The child may fail greatly in its general condition or not appear so badly off, excepting as to local conditions. Complications may end the case; or, if untreated, it may die of exhaustion or heart failure, the course of the disease in fatal cases averaging two to four months.

Diagnosis.—After this description it hardly seems necessary to say anything further upon diagnosis. A mistake could scarcely occur if only this disease, with its characteristic features, be borne in mind and looked for.

Treatment and Results.—The treatment consists in discontinuing the food that has been in use and using fresh cow's milk, modified to suit the babies' digestion, and fed raw. If milk of proper modification, but sterilized or pasteurized, had been in use, the heating should be discontinued. This would result in cure in time. But it is much better to use, also, orange juice, from a few drachms to a few ounces a day, in divided doses between meals. The juice of the lemon, lime or other fruit will do. Fresh raw beef juice is useful. Older children can take, also, potato with benefit, and other foods. This treatment shows remarkable effects, and usually promptly. Mild cases show improvement in a few days. Many cases, even though severe, recover in a few weeks, unless there are complications which give trouble and cause delay. Local treatment to the affected limbs should be employed. Hemorrhages are increased and fractures or epiphyseal separations are produced by slight accidental force, such as ordinary changing of the clothing. The limbs should be protected and kept at rest by bandaging them to softly padded splints and the patient laid upon a pillow, mattress or stretcher, which can be carried about as necessary without disturbing the patient.

It is remarkable how soon and from what serious conditions scorbutic infants will recover, once the proper treatment is instituted. The tenderness, the spongy gums, the swellings, the extravasations, even the periosteal and bone lesions, clear up in a way that seemed impossible. The periosteum resumes its attachment to the bones; fractures and separated epiphyses reunite.

CHAPTER IV

VARIOUS INFECTIONS AND THEIR EFFECTS, AND NON-INFECTIOUS GANGRENE

TUBERCULOSIS — SYPHILIS — SAPREMIA—SEPTICEMIA—PYEMIA—SURGICAL SCARLET FEVER—DIPHTHERIA AND PSEUDODIPHTHERIA—ERYSIPELAS—CELLULITIS—ACUTE DIFFUSE CELLULITIS—TETANUS OR LOCKJAW—OTHER INFECTIONS—ACTINOMYCOSIS—GANGRENE, INFECTIOUS AND NON-INFECTIOUS.

TUBERCULOSIS

THERE is abundance of evidence, both statistical and clinical, in the hands of every practitioner, to prove that tuberculosis is very prevalent in the early years of life; and, although the present widespread organized and scientifically conducted effort to stop its ravages will lessen to a marked degree the number of cases and the percentage of deaths, it is not probable that the disease can, as the sanguine hope, be entirely banished from the earth. At the best, we in the present generation will be obliged to deal with it clinically, as well as prophylactically.

Heredity.—Modern investigation has almost laid the ghost of heredity, which pointed to the early doom of all whose ancestors were tuberculous; but has given very alarming warning against the danger of infection. It is now held that cases of direct hereditary transmission of tuberculosis from parents to offspring are exceedingly rare. That infection of the fetus in utero can possibly occur is proven (Schmorl and Birch-Hirschfeld), but the fact that Virchow never met with a case of congenital tuberculosis indicates its rarity. In such cases as are on record of tuberculosis being transmitted, or of its being present at birth, it is believed, upon clinical and experimental evidence, that the infection came from the mother. The father may have tuberculosis, even that of the genital organs, with bacilli in the seminal fluid, and not transmit the disease. It is undeniable that tuberculosis in the family greatly increases the chances of house or contact infection of the child.

Diathesis.—It remains uncontroverted that the parents, or either of them, may transmit a constitution peculiarly vulnerable to tuberculosis—the "tubercular diathesis," as it is sometimes called. This inherent diminished power of resistance to the invasion of the tubercle bacillus and, perhaps, of other germs was for-

merly called "scrofula," and is sometimes still called "struma," or the strumous constitution. Our predecessors included in struma many conditions which we now regard as incipient, or quiescent, or local, tuberculosis, such as enlarged lymph nodes and chronically inflamed joints, cold abscess and dactylitis, besides the tendency to catarrhs and pyogenic infections of the mucous linings of the upper air passages and the skin and adjacent lymphatics. With the closer study following the discovery of the bacillus of tuberculosis, came the suggestion to discontinue the use of the term "struma." However, it has been retained as useful, but with its meaning limited to be a diathesis, rather than any disease *per se,* or to include only certain mild manifestations. Independent of any marked diathesis, the resistance to infection varies greatly in all individuals.

Predisposing Causes.—Resistance may be lowered, and tissues locally rendered more favorable to the reception or the activity of the infection by various diseases which are very common in infancy and childhood; notably by measles, whooping-cough, chronic inflammations of the naso-pharynx and the ear, of the bronchi and lungs, of the gastro-intestinal tract, and the lymphatic glands. These tissues very often furnish the infection atrium. Any debilitating disease may be a general, and any local lesion a local, predisposing cause of tuberculosis. Lack of nourishing food, of fresh air, or of sunlight predisposes to this disease.

The Sources of Infection are sputum or other discharges containing the bacilli, and these are conveyed in the air or in drink or food. The bacilli being inspired or swallowed, find their way either through the lymphatic system or by lodgment in the lungs or by absorption and conveyance into the blood, and produce their characteristic effects.

Age of Incidence and Clinical Manifestations.—The effects of the tubercle bacillus are the same in the child as in the adult as to the deposition of tubercle, the production of toxines, the destruction of tissue. But the distribution of the disease in the system, and, consequently, the clinical form which it takes, vary widely from those in the adult, and vary at different ages in the infant and child. Tuberculosis is rare under three months, uncommon under six months, more common in the second six months, and extremely prevalent and fatal in the second year of life. Under two years the lesions are most frequent in the bronchial lymph nodes, the lungs and the meninges; after that age the cervical and the abdominal lymph nodes and the bones and joints. If you mention tuberculosis to the physician accustomed to adult patients, he at once thinks of pulmonary phthisis as the most common clinical form of the disease. Mention tuberculosis to a pediatrist and his mind runs on glandular, miliary, meningeal, diffused, lung, bone and

joint and peritoneal forms of the disease. Tuberculosis of the lymphatic glands, bones and joints and meninges are more prevalent in the first ten years of life than ever afterward.

To the manifestations of this disease in the bones and joints, in the pleura, the peritoneum, the lymphatics, and the skin I shall devote some further attention under appropriate headings. It should be added to this general consideration of the subject that this disease may be acute or chronic even in a young child. That if it is acute it is more apt to be general than in an adult, and if at first local, more apt to become generalized, either spontaneously or after surgical interference. If the disease is chronic it may be either general or local. But if chronic and local, there exists that same proneness to become generalized upon slight provocation.

Surgical Treatment.—The characteristic just mentioned has led to the interdiction of inconsiderate surgical interference in tuberculosis, but to the most scrupulous and careful thoroughness of operative work when in the selected case it is decided upon. The surgical treatment is then, in the main, much more conservative than it was among our preceptors, but in case of interference it is more radical.

General Treatment.—The general treatment of tuberculosis will be considered under the headings air and climate, sunlight, exercise, rest and other hygienic measures, diet, drugs, tuberculin, and induced hyperemia.

Fresh air and climate are as important in the treatment of tuberculosis of bones, joints, glands, or other forms of the disease amenable to surgery as in pulmonary phthisis. A change from indoor to outdoor life, or from vitiated to pure air will as surely bring a beneficial result in one class of cases as in the other. Improvement may not be as promptly noted, for the course of tuberculosis in bone or joint or glands is very chronic, and alterations are slow to appear. A change to the seaside or the mountains or to the country is beneficial; and yet one has seen improvement quite as striking result from placing bed-ridden, house-confined children out of doors, or even from removing window blinds and windows and keeping them indoors. Of course, in northern climates extra clothing is to be provided, so that this open-air life can be carried out with comfort and safety; but it is perfectly feasible. There would not occur that languishing through the fall, winter, and spring which one has seen in some hospitals and homes, nor that imperative necessity for a trip to the country or the seaside, if hospitals and homes were arranged to admit fresh air and sunlight all the year round. There are no contra-indications for the fresh-air treatment; not even cough. The patient should never be exposed to inclement weather, and should never be without sufficient pro-

tection of clothing or bedding to be perfectly comfortable. Exercise and oil massage of such limbs or parts as are not placed at rest, and baths also, are excellent measures for improvement of the general condition of all these patients, even those confined to bed with joint and bone disease. Exercise should not be indulged in if it raises fever temperature. Massage in the neighborhood of the diseased part is not advised.

Diet should be carefully watched, lest indigestion be produced, but all the food that can be assimilated should be administered. Milk, cream, and eggs are especially good articles of diet. Some children take olive oil well. Some, who cannot take any kind of oil without disturbance of the digestion, can use bacon or fat beef or mutton, when well masticated with bread.

Drugs.—Cod-liver oil is a valuable article—whether we class it as a food or as a medicine does not matter. Creosote is a useful drug, and may be given in various mixtures or in pill form, or in the cod-liver oil. Guaiacol is useful and may be taken in the same way, or by inunction of an ointment containing guaiacol, lanolin, and lard. Arsenic is a tonic of great value, which seems to rouse the system to resistance to the infection. Iron, especially in the form of the syrup of iodide, has given great satisfaction. The hypophosphites are recommended by most writers. I have never been as sure of positive benefit from this drug as I have from the others mentioned. Any of them must be persisted in for a long time to get effects.

Tuberculin, which was so enthusiastically tried by everybody immediately after its discovery, was warmly praised by some and as vigorously condemned by others, and later restricted, for the most part, to diagnostic uses. More recently its use began to be resumed by a few in a more careful manner by giving, at intervals of a week or two, doses so small as to cause no perceptible reaction. Still more recently, the action of the opsonins, in connection with the phagocytic action of the leucocytes, has been discovered; and it has become possible to test the capability of the blood plasma (or, rather, of the opsonins which it contains) to prepare the bacteria for destruction by the phagocytes. By means of such tests it is practicable to ascertain whether the "opsonic index" of the blood is positive or negative, and to what degree; in other words, whether it is capable of reacting to the inoculation of a bacterial vaccine. In the light of these new facts it would appear that the unfortunate results in the use of tuberculin were probably due to using it when the blood was not in condition to respond to it, and that with present knowledge of the subject, such results could be avoided by testing the blood before the administration of the tuberculin. If by this means it shall prove that the remarkably beneficial effects

claimed by some can be procured invariably, tuberculin will assume a very important place in the treatment of tuberculous bone, joint, and gland, or other surgical affections. In localized tuberculosis, especially that of the bones and joints, as in other infections, mechanically induced hyperemia by the Bier-Klapp method has been used, with good results. It is thought to act by increasing local leucocytosis and phagocytosis, and so causing the destruction of bacteria, by retaining locally to some degree the products of the metabolism of the bacteria, which thus destroy themselves, and by increasing locally the alkalinity and the bactericidal power of the blood. Bier claims, also, that processes of resolution and absorption and of regeneration are stimulated by the hyperemia. (See, also, Section on Septicemia.)

SYPHILIS

Syphilis in infancy and childhood is either acquired or inherited.

Acquired Syphilis is much less common of the two. Yet it should not, because of its comparative rarity, be overlooked. It may be acquired from the mother in the act of birth, or later; or by nursing a syphilitic wet nurse; or by kissing, or other accidental contact of the infant with a syphilitic visitor, relative, friend, or stranger; or through the medium of a nursing bottle, toy or the like; or by ritual circumcision; or by vaccination. I have never seen a case acquired in these two last mentioned ways; probably because that part in the original rite of circumcision requiring the priest to put his mouth to the wound is seldom now employed. The act substituted for it, that of squirting a mouthful of vinegar or wine upon the wound, leaves still room for improvement. Vaccino-syphilis must be practically unknown since carefully prepared bovine virus is used, and in this country is almost invariably applied by physicians. Formerly, when the arm-to-arm method or dried scabs were used, and that often by the laity, there is no doubt syphilis occasionally occurred, along with other infections, and gave argument which anti-vaccination erratics still employ upon the ignorant. Syphilis is not always acquired in ways so innocent. Numerous cases are on record of syphilis in precocious children under ten years of age, acquired by intentional contact with the opposite sex. Also by contact with vicious nurse-maids, servants or others. Acquired syphilis presents the same symptoms in the infant and child as in the adult, but runs a more acute and severe course, and more often terminates fatally than in the adult.

Hereditary Syphilis, the more common form in the young, has received an immense amount of study, and many facts about it are established, while some questions are still unsettled. Syphilis

is more often transmitted by the father to the ovum by or simultaneously with the spermatozoön. The mother may transmit the disease if she is syphilitic before she becomes pregnant; or if she become infected during pregnancy and the maternal and fetal placenta be involved. If the child was infected by transmission from the father it cannot infect its own mother, because she became immune during the pregnancy. ("Colle's law," to which, however, there are exceptions.) If both parents are syphilitic, the disease can be transmitted by only one parent, because the previously infected germinal cell is immune against a second infection. The more recent the infection of the parents the more prompt and the more severe will be the syphilitic manifestations in the child. Yet it is possible for parents who have recently had syphilis to produce a healthy child, because the infection is facultative, and it might occur that neither the spermatozoön nor the ovum contained the syphilitic poison. Thus a series of syphilitic children may be interrupted by an apparently healthy child. Ordinarily, a series of children of syphilitic parentage receive the infection in a decreasing virulence, as the virulence subsides with time in the parent. There are often first one or more abortions, then a premature birth, then the birth of a dead infant with severe lesions, then an infant born alive, but surviving only a short time; then one with milder and less promptly appearing lues, and, finally, apparently healthy children. Such a history is by no means invariably obtained, as the disease may have been at a later stage in the parent, or treatment may have modified its virulence.

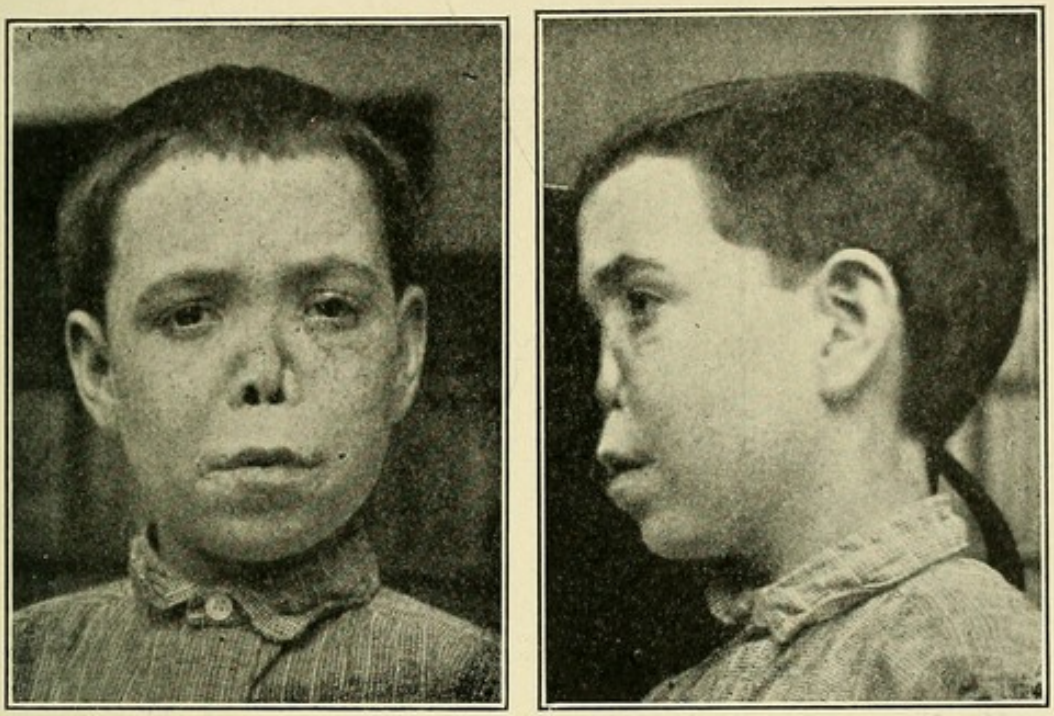
Symptoms.—The infant may be born dead. It may be alive, but a shriveled, wrinkled, mummified manikin, with a rasping squeak for a voice, and perhaps with bullæ containing discolored serous fluid upon its muddy-looking skin, especially that of the palms and soles of its scrawny legs and arms. Its nails are misshapen, friable or claw-like. It is pitifully weak, and subnormal in temperature. Or it may be as plump and smooth-skinned as a healthy babe. Lesions or other symptoms may not appear for days, or even months, generally not more than two months, after birth, and then may first manifest the disease by an unaccountable sleeplessness at night, probably due to persistent pains; or by a progressive emaciation without evident cause. But in most cases the first symptom is "snuffles." This is an inflammation of the Schneiderian membranes, dry at first, but soon discharging muco-pus, sometimes bloody, which excoriates and encrusts the nostrils and upper lip. This inflammation is often the earliest and the most persistent symptom. A roseolous eruption is one of the early signs, and this is most marked where there is most moisture and irritation, namely, about the buttocks and genitals,

where it may become inflamed and excoriated. But it does not stop at the margins of the wet diaper. Pemphigus, or bullous syphilide, before referred to as sometimes present at birth, may not show for some days afterward. The lesions are pea- or cherry-sized, and occur most on the palms and soles—less thickly on the extremities, yet more here than on the body. The babe may show fissures radiating from mouth or anus, which, on healing, leave permanent scars. The skin eruption may be macular, with small dark red or copper-colored spots upon the palms and soles and all over the body. Later in the case, papules, or a scaling of the skin, or pustules rarely, may appear. Mucous tubercles or condylomata may come at the perineum and groins, at the flexures of the limbs or neck, or at the corners of the mouth or eyes. They may appear in the mouth or throat; or in the larynx, producing hoarseness. Occasionally there is deafness, or, about the fifth month, iritis or choroiditis; and frequently at some period, stomatitis. Syphilitic osteo-chondritis (also called -chondrosis and -peri-chondrosis) is an important symptom. It affects the epiphyses of the long bones, chiefly the femur, tibia, humerus, and also the clavicle, sternum, and ribs. There is a ring-like smooth swelling around the bone at the situation of the cartilage. Sometimes there is a sudden loss of function so complete as to resemble paralysis. The trouble is apt to be symmetrical, but may affect but a single bone. At times there is no other symptom to be found. There is more tenderness than in rickets. In a very few cases the osteo-chrondritis may cause separation of the epiphysis. Enlargement of the spleen and liver are found in perhaps half the cases of hereditary syphilis. Cranio-tabes—soft spots in the occipital and parietal bones, similar to that described with rickets, or a more general thinning of these bones—are found, and by some ascribed to the syphilis, rather than to rickets. The condition occurs in both diseases, and also occasionally in infants, in which other evidence of either of these diseases is wanting. (13)

About the period of the second dentition, or sometimes not until puberty, the patient develops the late manifestations, syphilis hereditaria tarda. Occasionally there have been no evidences of lues in infancy, and the question is raised whether the case is one of hereditary or of acquired syphilis. The symptoms now appearing correspond to the tertiary stage of acquired syphilis as the earlier symptoms did to the secondaries; now, also, may appear serpiginous eruptions, ulcerations of the nose, throat and hard palate (Figs. 27 and 28), gummata, nodes, visceral disease, certain nervous disorders, meningo-encephalitis, cerebral arteritis, deafness, periostitis and ostitis, sometimes necrosis and caries, and the "notched and pegged teeth" described by Hutchinson. Some of these symptoms will be described more in detail here, while those

pertaining to the lymph glands, and periosteum, bone and cartilage will receive attention in the chapters devoted to those subjects.

Interstitial keratitis, a characteristic symptom, is a chronic inflammation in which a spot upon the cornea takes the appearance of ground glass, and this, spreading, produces an opacity, sometimes, though rarely, accompanied with an inflammation of the iris,



FIGS. 27 AND 28. HEREDITARY SYPHILIS. Destruction of nasal cartilages and bones, a late manifestation. Scars at the angles of the mouth, and near eye, resulting from ulcerations. Boy aged 9 years.

resulting in adhesions that remain and distort the pupil even after treatment has controlled the inflammatory process and cleared up the cornea. There may be several spots or flecks instead of only one, and the condition may affect one or both eyes. (Fig. 29.) The middle ear often suffers a low, but long-continued inflammation, and the internal ear, also, is involved, with resulting auditory nerve atrophy and incurable deafness affecting both sides.

Diagnosis in a marked case of hereditary syphilis is very easy, but in other cases it may be very difficult. Snuffles may readily be considered an ordinary coryza. But the ordinary coryza usually has some other symptoms of a cold, such as laryngeal or bronchial catarrh, and perhaps fever, and it does not persist and become chronic in the infant like syphilitic coryza. There may be congenital hypertrophy of the nasal mucous membrane, but other symptoms of lues are absent. Luetic rashes, though red at first appearance, change to the characteristic brownish-red or copper color after

a few days. A syphilitic rash shows, also, elsewhere than upon buttocks and genitals, where irritation may have increased it. Pemphigus vulgaris does not involve the palms and soles as syphilitic pemphigus does. In the former, snuffles would be absent, also the enlargement of the liver and spleen, the dirty-colored skin. The thin transparent shining skin of the palms and soles of the atrophic or premature infant need not be mistaken for the thick, diffuse infiltration and desquamation of the specific case. (14)

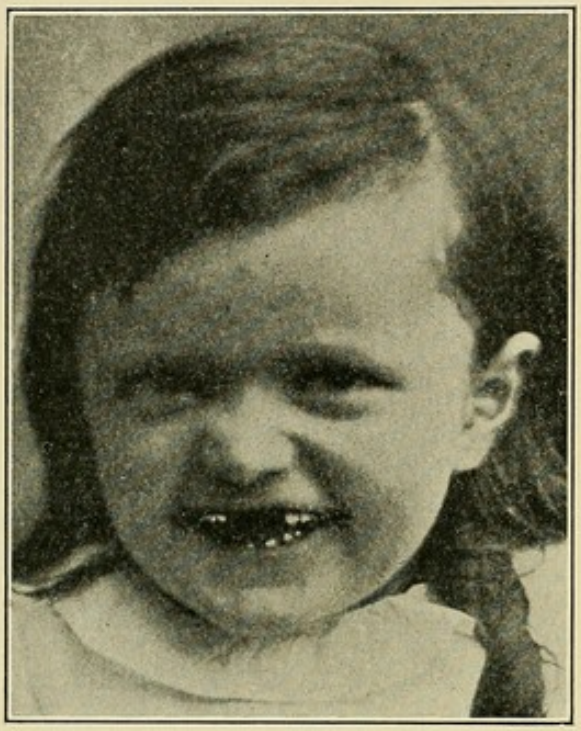


FIG. 29. HEREDITARY SYPHILIS, M. M. Female aged 7½ years, born at 7 months. Facies of hereditary lues. Large square forehead from bosses on the frontal bones. Low bridge of nose. Too mature in expression. Interstitial keratitis. (Upper incisors of temporary set not yet replaced by permanent teeth.) Lost her sight and partially lost her mind between her 12th and 14th years. Afterward became insane and died of obscure brain disease in her 17th year.

The teeth which Jonathan Hutchinson first described as the test teeth for hereditary syphilis are the two central incisors of the permanent set. When typical they slant toward each other, though it may be otherwise, and are often irregularly placed. They may be discolored from lack of enamel, and each has in its edge a broad notch. (See Figs. 22 and 30.) The lower teeth may be peg-like, or incisors notched, and either the test teeth themselves or others may be irregularly shaped or dwarfed. The teeth are usually somewhat pointed—that is, narrower at the cutting edge than next to the gum—and frequently the enamel is irregularly deposited and of poor color and quality. Erosions of teeth, discoloration of teeth, irregular placing, or early decay are none of them, singly or all together, evidence of luetic taint; nor is the absence of the Hutchinson teeth proof of freedom from it. These three symptoms, diffuse interstitial keratitis, labarynthine disease, evidenced usually by deafness without otorrhea, and the typically marked teeth are called Hutchinson's triad.

The Diagnosis of Syphilis from the Blood.—Syphilis may be diagnosed from the blood of a patient afflicted with this disease by means of a test known as the serum reaction for syphilis (Wassermann).

The principle of this reaction depends on the fact that there are substances in the blood of syphilitics not contained in the blood of non-syphilitics, which have a strong affinity for substances contained in extracts made from syphilitic or normal organs, as liver.

When the serum and extract are brought together in a test tube they unite and take up another substance known as complement, which is contained in all fresh blood serum. As this, however, is unattended by any physical change in the mixture of serum and extract, the union could not be recognized. There is, however, a certain method adopted to demonstrate that this union has taken place as follows:

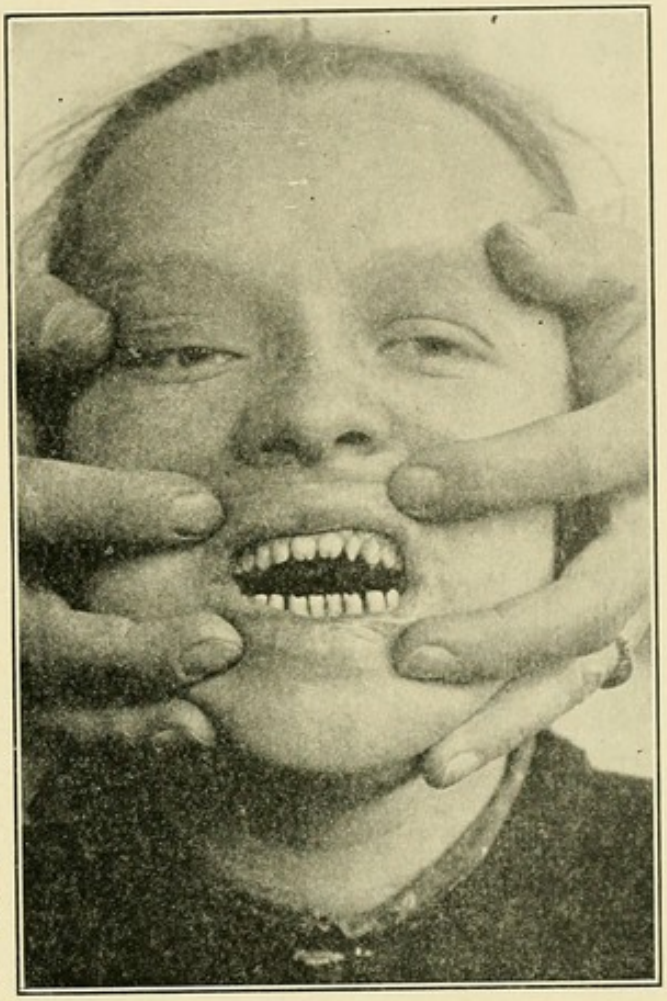


FIG. 30. HUTCHINSON TEETH. Complete family history of syphilis.

It is found that if you inject animal A, for example, with blood corpuscles of animal B, animal A will react against the injected blood corpuscles by producing an anti-body known as hemolysin, which will dissolve the corpuscles. It will be found that if you now mix the blood serum of A with the corpuscles of B in a test tube, the latter will be dissolved. This depends on two factors:

First.—The serum of A contains an anti-body, or amboceptor.

Second.—Complement, which is present in all fresh sera.

The amboceptor has an affinity on the one hand for corpuscles of B and on the other for complement. When this union occurs the solution of B's corpuscles follows. The complement contained in A or any other serum can be destroyed by heating it for one-half hour at 56 degrees C. This leaves only amboceptor behind in the case of serum A, which alone will not dissolve the corpuscles, consequently the mixture of corpuscles and serum will remain turbid. This is called an inactivated hemolytic serum. If,

however, you add any fresh serum, which will, of course, furnish complement, solution will occur. Destroying the complement means inactivating the serum. To demonstrate in the first instance that syphilitic serum and liver extract unite and take up complement, both serum and liver extract are inactivated before bringing them together in a test tube. Some fresh serum (guinea pig serum, for example) is now added, and the mixture allowed to incubate for one hour. If the suspected serum was from a syphilitic patient, the substances in the extract, the suspected serum, and the added complement will unite. That this has taken place can now be demonstrated by adding the above inactivated hemolytic serum. It will be found that the mixture will remain turbid because the blood corpuscles remain undissolved, as the complement necessary to the solution was taken up by the union of extract and inactivated syphilitic serum. If the suspected serum was not from a patient having syphilis, the complement will have remained free and will be taken up by the inactivated hemolytic serum, causing solution of the corpuscles and making a clear transparent red fluid.

The substances necessary in performing the reaction are as follows:

1. Organ extract.

Take part of the liver of a dead syphilitic new-born, place in mortar with some sterilized sand. Grind thoroughly. For each gram of liver used, add five c. c. of alcohol (95%). Pour mixture into sterile flask. Heat in water bath for one hour at 60 degrees C. Filter into sterile bottle. Keep at room temperature, ready for use.

2. Blood serum of suspected patient.

Draw two or three c. c. of blood from a finger or vein.

Allow the serum to separate. Remove it by a pipette. If not clear, centrifugate, and the supernatant serum is removed and inactivated at 56 degrees C. for one-half hour.

3. Complement.

Guinea pig serum is used. Secure blood from the animal's heart by a hypodermic needle. Allow it to coagulate and collect separated serum.

4. Hemolytic amboceptor.

Inject into the vein of a rabbit, once a week for three or four weeks, five c. c. of a 5 per cent. suspension of sheep's blood corpuscles.

One week after the last injection, bleed the animal, allow serum to separate, remove, and inactivate at 56 degrees C. for one-half hour.

5. Blood corpuscles.

Sheep's blood is obtained from the carotid of a sheep, defi-

brinated and washed with salt solution three times, the solution being removed after each washing by a pipette. Enough salt solution is then added to make a 50 per cent. suspension of blood corpuscles. All material, except organ extract, when not in use, should be kept on ice. Complement is unreliable after the third day.

Performance of reaction.

Before beginning the test, ten drops of salt solution are added to all tubes used.

Two test tubes are required for each serum. To one of these one drop of serum and one of extract are added, and to one only a drop of serum. To a control tube, two drops of extract, without serum, are added. To all tubes a drop of complement is added. Shake tubes and place in incubator at 37 degrees C. for one hour. Remove and add one drop of diluted amboceptor (twice the strength of amboceptor necessary to dissolve a drop of a 50 per cent. mixture of sheep's corpuscles, with one drop of complement in one-half hour, is used), and one drop of 50 per cent. suspension in salt solution of sheep's corpuscles. If in the tubes containing extract and serum, solution of corpuscles has not occurred, the reaction is positive, and means that the patient has syphilis. If complete solution has occurred the reaction is negative.

Several syphlitic and normal sera are used as controls in each test made.

This test is specific for syphilis, whether congenital or acquired. From 90 to 95 per cent. of patients with symptoms of syphilis will give a positive reaction. Over half of the latent cases give a positive reaction. In about 70 to 75 per cent. of the post syphilitic affections the blood will show a positive reaction. It is a valuable differential diagnostic measure in bone and joint lesions of uncertain etiology, in ulcerative lesions of unknown cause, in lesions of the liver, nervous system, etc. It is not, however, an organ or tissue diagnostic measure. It signifies when positive a systemic infection. Whether a given local or organic lesion is caused by the syphilitic infection, other clinical facts must decide.

Prognosis.—Many of the cases born with bullæ, or with visceral lesions, or with other severe lesions, or showing them soon after birth, die early. The later after birth the symptoms first show the more favorable the prognosis. Hereditary syphilis is much more grave in its prognosis than the acquired disease. All babes born with the disease are lowered in their vitality and apt to succumb to marasmus, anemia, enteritis, pneumonia, nephritis, or some septic disease. The mild cases, taken early and treated with mercury, respond as if by magic and recover, at least for the time, probably to have recurrences a year or several years later. Late syphilis

generally does well under treatment, although nothing can eradicate the scars or stigmata or supply tissues that have been destroyed.

Treatment.—The first consideration is for a supply of heat and nourishment. The luetic infant is feeble in organic power and subnormal in temperature. It may nurse its own mother without danger to her, although she may give no evidence of syphilis. But it should not be allowed to take the breast of a healthy nurse, even though it may show no lesion of mouth or nose. A nurse's milk may be pumped and fed in a bottle. There is some dispute as to the degree of contagiousness of hereditary syphilis in the infant, and undoubtedly the virulence of the contagion varies at different times; but the danger is too great to take any chances, by nursing, kissing, handling with abraded hands, or the like.

Drug treatment consists mainly in the use of mercury in some form. Other drugs are used to meet special indications or as adjuvants. One of the best forms of mercury for this purpose is the gray powder, hyd. cum cretæ. An infant takes half a grain a day and thrives on it. After a time he may take a grain twice a day. If it affect the bowels too much, a little opium can be combined with it, or tannic acid, or tan-albumin or bismuth sub-gallate. Some use hydrargyrum protoiodide; others use calomel. Some use mercurial ointment by inunction, smearing the skin in a new place with a piece the size of a bean once or twice a day. For rapid effect, baths of corrosive sublimate are used once a day, ten grains to a bath, remaining in the bath five minutes, unless the skin is too much excoriated. Still another method, especially good when syphilitic laryngitis is troublesome, is to sublime the mercury, under a tent, in the familiar method used for diphtheritic croup. The oleate of mercury is an effective form. Other methods, by mercury-impregnated aprons, pads or plasters, by hypodermic, et cetera, can be used, but are unnecessary. Luetic children are usually very tolerant of mercury, and yet its effect should always be watched, and at any signs of gingivitis or stomatitis it should be discontinued. Mercurial stomatitis is not only painful and troublesome at the time, but may be followed by bad effects upon the teeth, especially those that are in the formative process and not yet erupted. If no signs of overdosing appear, the mercury is to be continued till the eruption, snuffles or other special symptoms disappear, and for about two weeks afterward. Time of treatment averages about six weeks. Iron, the saccharated carbonate, in doses of half a grain to a grain, or later, the syrup of the iodide of iron, two to ten drops at a dose. Arsenic also is useful in combatting the anemia and cachexia which is apt to be present. (15)

Local Treatment.—The moist eruptions, tubercles or condylomata, should be dusted with calomel and bismuth, equal parts, or

sometimes simply with boracic acid when mercury is being used otherwise. The coryza may be treated by a solution of silver nitrate, one to five hundred, or even one to one hundred; rhagades and other ulcers may be brushed with silver nitrate solution of two or three parts to the hundred of water. The incrustations about the nose and corners of the eyes should be removed and the parts smeared with ointment of the yellow oxide of mercury.

In the treatment of the late manifestations, potassium or sodium iodide is the main reliance, to which is added mercury. The iodide may have to be used in very large doses and continued a long time, perhaps for months, before any effect can be obtained. The iodide and the mercury can be combined in a solution by using the latter in the form of the bichloride. Some prefer, again, to use inunctions or gray powder, or the protoiodide of mercury; or to use the iodide in solution, one grain to the minim. This is merely a matter of convenience; the effects are practically the same. The necessity of tonic treatment in these cases should not be overlooked, as it sometimes is. Iron in some form should usually be given at intervals. The syrup of the iodide is a very useful form. Some use the ammonio citrate, others the tartrate of iron with potash, or the albuminate, or dialized, or other preparation, often in combination with bitter tonics and stomachics. The necessity of the most nourishing food must be insisted upon, and the digestion well attended to in order to secure the desired results, not only in the general condition, but in the healing of lesions.

Local treatment for the late lesions usually consists in the application of ointment of iodoform, or of the yellow oxide of mercury or the white precipitate, or dilutions of citrine ointment; or solutions of silver nitrate or of argyrol, five to ten grains to the ounce. Some use the ointments to skin and the solutions to mucous membranes, such as nares and throat or mouth, while some prefer ointments in the nares. One generally uses solutions where secretion is abundant and the surface not too sensitive, and ointments when the parts are too dry, or over sensitive and in need of protection.

SAPREMIA

By sapremia we understand a fever and accompanying morbid phenomena caused by the absorption into the system of toxines produced by putrefaction of material confined in contact with an absorbing surface. The absorbing tissues themselves do not undergo any putrefactive change. They merely absorb. Children are fully as susceptible as adults, if not more so, to this form of intoxication, and with them the resulting symptoms are apt to go to the extreme.

Symptoms.—The symptoms often begin with a chill, followed by fever of one, two or three degrees, a dry tongue, constipated

bowels, a flushed face, anorexia, headache, drowsiness, or, if the case be allowed to go on, delirium, vomiting, purging, and possibly coma.

Treatment.—The treatment consists in getting rid of the pent-up poison, drainage of the wound or other containing cavity, thorough cleansing and antiseptic dressing. At the same time the bowels should be promptly emptied by calomel, followed by a saline purge. Other symptoms should be met by appropriate remedies, the weakness combatted by stimulants, and especially should the kidneys and skin be kept active by free use of water. Ordinarily the trouble will subside in a couple of days.

SEPTICEMIA

The tissues of the young human animal furnish a most favorable medium for the propagation of microbial organisms, and we find them by no means immune to the germs of putrefaction and pus production. When these germs become implanted and effect their destructive changes in living tissues, resulting in the formation of toxines and the absorption of these into the circulation, we have a dangerous condition to deal with. The intoxication may be so rapid and so profound that the system succumbs before there is any clinical evidence of pus formation or local destruction of tissue. Or if the poison be absorbed in smaller doses, or be less virulent, or the vital resistance of the organism be greater, the patient survives, while his tissues undergo abscess, ulceration, gangrene, in the parts attacked by infection. The point at which the infecting agent gained entrance is not always known, or it may appear insignificant, entirely out of proportion to the effects produced. Sometimes, unfortunately, it is the operation wound; or a compound fracture, an accidental puncture, a burn, a cut, a scratch, or the bite of a pet animal; or the umbilicus in the new-born. But less obvious sources of infection should not be overlooked, such as the throat, mouth, teeth, nasal cavities, the middle ear, or an old sinus. This process of invasion by septic micro-organisms and defense against the invaders gives rise to various phenomena, both local and general.

Symptoms.—There may first be malaise and some fever; or the trouble may commence with a chill, followed by a degree of prostration, with loss of appetite, headache, and a typhoidal condition, but with irregular fluctuations of temperature. The pulse is rapid and weak. Rashes make their appearance upon the skin. These eruptions may be erythematous, or petechial, even pustular or hemorrhagic. By blood examination a marked leucocytosis, and by cultures the invading organism may be found. Diarrhea and enlargement of the spleen are common. Endocarditis or pericar-

ditis, bronchitis, or pneumonia may appear. With disintegration of the blood corpuscles, jaundice appears. If the infection atrium was upon the surface, purplish-red lines often show the path of the poison along the nearest lymph channels or adjacent veins. The lymph channels lead to the lymph nodes, which become enlarged and tender. In unchecked cases, redness, swelling, extension of a brawny swelling, purulent discharges, and sloughing or gangrene complete the picture at the wound site; and prostration, exhaustive sweats and diarrhea, with delirium or coma, end the scene.

Treatment.—At first appearance of the case an effort should be made to prevent further absorption, and to limit the extension of that already in the system. If a foul wound or abscess be already present, opening and cleansing of the wound, the use of a knife or scissors, curette or cautery, the removal of sloughs and of all hopelessly diseased tissues, even of a hopelessly diseased member, are in order. Continuous immersion in or continuous irrigation with hot water or hot antiseptic solutions, such as bichloride of mercury, 1 to 1000 to 5000, according to the size and situation of the wound. Park recommends as a local application, resorcin, 5 parts; ichthyol, 10 parts; ungt. hydrarg., 40 parts, and lanolin, 45 parts. This I have often used with great satisfaction, sometimes substituting iodine for the resorcin, or changing the proportions of the ichthyol and the ungt. hydrarg.

The Bier-Klapp Hyperemia Treatment.—If there is no gross morbific material to be first removed, one may proceed at once to aid nature in her method of defense by inducing local hyperemia, according to the method of Bier and Klapp. When a pathogenic organism gains access to the tissues, the flow of blood to the part increases, and there takes place an exudation of leucocytes and of serum into the tissues. If the vital forces are reacting properly the serum contains antitoxins which neutralize the toxic products of the bacteria; also opsonins which prepare the bacteria for destruction and absorption by the phagocytes and the leucocytes and the clearing away of the wreckage from the battleground. By increasing the supply of blood to the diseased part and causing further exudation of serum and leucocytes, we may aid nature in this necessary congestion, limiting the extension of the noxious agents, and furnishing in greater abundance the means for their destruction, and for the neutralizing of their poisons. If the area attacked be upon an extremity the object may be accomplished by constriction above the diseased portion by a rubber bandage, or by cupping; if it is upon the trunk, neck or face, the cups are available. Sufficient and yet only sufficient constriction or suction should be used to produce a red and warm swelling. There never should be coldness or blueness of the part constricted or cupped. Neither pain nor numb-

ness should be caused by the treatment. The elastic constrictor should encircle the limb above the inflamed area. A cup should be of such size and shape that its margins rest upon sound tissue outside of the active zone of the disease. In neither method should there be enough manipulation or pressure to disturb the surrounding protecting wall of the leucocytes. If there is abscess it should be opened by a small incision. The cup, large enough to surround the inflamed area and rest upon sound tissue, should then be applied and the discharge of the pus aided by suction. If there is no abscess the cup is applied and suction used for five minutes. The cup is removed and a period of rest for three minutes is allowed, permitting a portion of the blood to escape into the circulation. The suction is again applied during five minutes, and again there is a rest period of three minutes; and so on for twenty to forty-five minutes daily, or, in severe cases, twice daily. Thus there is an increased amount of blood supplied to the part, while the flow of blood from the part is only slightly retarded. According to Wright, the blood which returns into the circulation carries with it a vaccine which stimulates the production of antitoxins. At the end of each treatment the part is gently bathed, and any pus, exudate, slough, or detritus that is loose may be removed, and a simple wet dressing applied. In ordinary infections, splints are not used, and the patient is encouraged to use the part. If the inflammation is seen early there is no haste about making an incision, as resolution is expected. If the hyperemia is to be produced by the constricting band, this is applied just sufficiently tight to slightly impede the venous return, but not to interfere with the arterial supply; is never painful; never causes blueness, coldness, or numbness. The bandage is left on for an hour to two hours, once or twice daily. One of the difficulties encountered in applying the Bier treatment has been that of securing just the right degree of tension in the Esmarch. Wilson (Jour. A. M. A., Apr. 4, 1908) controls the pressure by the use of Cook's modification of the Riva-Rocca sphygmomanometer. He has found that (in adults) a pressure of 10 mm. less than the systolic pressure induces a hyperemia that fulfills the conditions defined by Bier, namely, warmth, cyanosis and enlargement, and not blanching nor coldness below the constriction, and no pain.

The effects of the induced hyperemia are relief from pain, and an increase of the vital resistance to the infection and its effects, so that the disease is materially shortened, rendered less severe, and tissues and perhaps the life which otherwise would have gone to destruction are preserved. This form of treatment is eminently applicable to children.

The general treatment is very important. It is altogether supporting and stimulating. No "antifebriles," such as coal-tar deriv-

atives, nor aconite, are admissible. But the liq. ammon. acet., more used by our preceptors than nowadays, promotes elimination by skin and kidneys, without depressing. The temperature should be controlled by use of sponge or tub baths, or wet-sheet packs. Again I must insist on the importance of maintaining the nutrition in this as in all exhausting conditions of childhood. The intense cell activity, the rapidity of the metabolic processes characteristic of this period of life, make a constant supply of nutriment necessary or the vitality cannot be maintained, much less any defensive or reparative process. Stimulants are in order, and first in the class stands alcohol. It is astonishing what large amounts of alcoholic stimulants a child in a bad septic condition can take with benefit, and without the slightest symptom of alcoholic intoxication. Whisky or brandy, well diluted, are the best forms. Quinine is useful; whether it acts as a stimulant or as an antizymotic I do not know. It can be used by suppository if necessary. Strychnia may be used. Many recommend naphthalin and other intestinal antiseptics, such as salol. The latter I am afraid to use freely in children. Calomel in small repeated doses seems to do the work. Bismuth is the most useful remedy in the diarrhea, and enough opium should be used to control pain.

Opsonins, Opsonic Index, and Vaccine Therapy.—There are certain protective substances present in the blood serum which show the peculiar property, when brought in contact with bacteria, of so acting on them as to render them easily taken up and digested by polynuclear leucocytes. These substances are known as opsonins. They appear to be specific for different organisms. They are essential to phagocytosis, and if they are not present, the polynuclear leucocytes will not exhibit phagocytic powers to more than a minimal extent. The opsonins and phagocytes acting together form a defense or immunity apparatus of the organism against bacterial infection. (16)

In conditions of health, the opsonic power of the blood, by virtue of the presence of opsonins, is approximately the same for different individuals. Under circumstances of bacterial infection, the opsonins are drawn on to a greater or less extent in the immunizing effort of the body against the infection, thus causing a lowering of the normal opsonic power. The cells of the organism, however, react against the bacteria and their products, resulting in the production of specific opsonins, which may periodically raise the opsonic content of the blood. The resulting depressions and elevations in the opsonic content of the blood, which are detectable by a method described below, are referred to as " waves of immunity," which in turn constitute the variable degree of defense or resistance offered against the infecting bacterium or bacteria.

The technique of the method devised by Wright for determining the opsonic power of the blood for any given organism is as follows:

Materials necessary—

(1) Blood from the patient to be examined.

(2) Blood from the normal individuals who serve as controls.

(3) Washed blood corpuscles.

(4) Bacterial emulsion.

(1) The bloods are obtained in glass capsules, curved at one end, through which the blood is collected from a needle-stick in the end of a finger, which has been constricted by a small rubber tubing or bandage. The opposite end of the capsule is now sealed in a flame. After some time the blood clots in the capsule, and the serum separates, usually along the side. When ready to use the capsule is cut with a file at a point removed from the blood, and broken off. The serum is now accessible to the tip of a glass pipette.

(2) Washed corpuscles are obtained by pouring several drops of blood secured from the finger, in the manner above described, into a small glass tube, which has been about two-thirds filled with 1½% Citrate of Soda solution. This prevents the blood from clotting. The tube is inverted a few times, the open end being closed by the finger, to mix it. It is then placed in a centrifuge, with an appropriate balance consisting of a similar glass tube filled with the same quantity of fluid. The corpuscles will be thrown down after some time. The supernatant fluid is now pipetted off and physiological salt solution is added and mixed with the corpuscles as above. They are again centrifuged in order to wash them a second time to remove all traces of serum. The salt solution is thereafter completely removed, and the corpuscles are ready for use.

(3) The emulsion is made from a culture of the particular organism, causing the infection for which you wish to test the blood. The culture should preferably be young, not more than fifteen or twenty hours old. In case of tubercle bacilli dry cultures are used. In using moist cultures, one or several loopsful of the growth are mixed in physiological salt solution thoroughly by drawing in and pouring out of a fine pipette for several minutes in order to break up clumps. It is then placed in a small tube ready for use. An emulsion of tubercle bacilli is made with some difficulty. The dried bacilli are first ground up in an agate mortar for half an hour, and then a 1½% solution is added drop by drop until a smooth milky mixture is made. This is then placed in a tube which is sealed and the tube and contents heated to 60° for one hour. This is done to prevent contamination. It is usually neces-

sary before using it to centrifuge in order that any clumps of bacteria may be thrown down.

The three essentials necessary in performing the work being prepared, take glass pipettes which are made by heating pieces of glass tubing about three inches long and ¼ of an inch in diameter, in the flame of a blow-pipe, the tubing being gently turned all the while and the flame directed on the middle of the tubing. When it reaches a red heat it is pulled out to a caliber of about 5mm. and divided by heating the drawn-out tubing in the flame. The ends are cut at right angles to the tube by a file and broken off. A blue line is marked across the pipette by a parafin pencil about ¾ of an inch from the small end. On the opposite or large end a snug-fitting rubber teat is placed and an equal volume, as indicated by the blue line, of the washed corpuscles, emulsion and serum, is drawn up into the pipette, allowing an air bubble between each. They are then mixed on a glass slide, in the same manner as the emulsion was mixed, and then finally drawn up into the pipette, removed 1½ to 2 inches from the small end, which latter is sealed in a flame. The teat is removed and the pipette placed in an incubator or opsonizer, which is a modified incubator made expressly for this purpose, for ten to twenty minutes. Whatever time is decided must be observed for all sera, each being examined separately.

On bringing bacterial products in contact with the cells of the organism, as by hypodermic injection, the cells react against these substances, producing antibodies or opsonins, which thus raise the resistance as measured by a rise in the opsonic index against these bodies. The bacterial products, or killed bacteria, are termed vaccines, and treatment with them is known as vaccine therapy.

After removing from the incubator, the sealed tip is broken off and contents are again gently mixed on a glass slide, using the lips in place of the teat. Then a drop is blown on to one end of a glass slide, which has been rubbed with emery paper on the convex side, the drop gently drawn toward the opposite end of the slide by a glass spreader, which is made by breaking a glass slide transversely, after it has been nicked by a file. The broken surface of one part must have a very slight concave edge to be available. Either tip of the broken end is removed by filing and breaking. It is sometimes necessary to break a dozen slides before securing a desirable spreader.

The smeared slide after drying is now covered with a saturated solution of $HgCl_2$ and allowed to stand for several minutes to harden the specimen. It is then washed off and stained. In case of tubercle bacilli, carbol-fuchsin with counter stains of

methylene blue is used. With other bacteria, carbol-thionine or methylene blue may be used.

After staining and drying, the slide is examined under the microscope. If the spread was well made, it will be found that the leucocytes are all along the edge of the smear. The bacteria contained in fifty (50) polynuclear leucocytes, by which they were taken up, are counted. No discrimination is made in selecting cells for counting, as all polynuclear leucocytes, irrespective of whether they contain bacteria or not, are counted.

Two or three normals are similarly counted, an average of the latter are taken, which constitute the normal phagocytic count. The phagocytic count of each abnormal is divided by the average of the normals, and the result is the opsonic index for each abnormal. If the result is below 1, which is taken as the index for the average normal, the patient is said to be in a negative phase; if above 1, he is said to be in a positive phase.

It will be remembered from the above that the organism may react against an infectious agent, producing opsonins which raise the opsonic power of the blood temporarily, thus producing a positive phase, during which the patient's resistance, and consequently his capacity to overcome the infection, is increased. These are termed autoinoculations. It is clearly evident if we can raise the opsonic index, and maintain it so—that is, the immunity wave of the patient—he will overcome his infection. This it is possible to do by means of vaccine therapy.

It is necessary first to put through one normal serum. The average number of bacteria per cell in fifty (50) phagocytes is calculated. This gives an exact estimate of the thickness of the bacterial emulsion. An average of three bacteria per cell is a good working emulsion. The emulsion, if too thick, may be diluted with salt solution sufficient to give approximately this average.

Vaccine consists of killed cultures of bacteria, and in the case of tuberculin of the extract of the ground-up tubercle bacilli. There are two varieties of vaccines; namely, those prepared from a culture of the particular organism causing the infection, called homologous or autogenous vaccines, and those prepared from the same organism, taken from stock cultures. These are called stock vaccines.

While it would be desirable to secure an autogenous vaccine in each case for treatment, it has been found that in the majority of infections a stock vaccine proves of excellent service.

Vaccines, with the exception of tuberculin, above referred to, are prepared by making several cultures of the organism concerned, preferably on a solid medium, and allowing it to grow from eight (8) to twenty-four (24) hours. Wash off the growth with salt solution, about 10 cc., pouring it from tube to tube until washing is

completed, pour into sterile test tube and seal. Shake for one-half hour to break up clumps of bacteria. Standardize as follows: Open the tube and drop a drop of vaccine on a slide.[1] Mark the pipette as described above with a blue line to indicate a definite volume. After puncturing the finger, take one drop of blood and one of the vaccine emulsion and one or two volumes of salt solution for dilution. Mix and spread a drop on a slide and stain. Place under the microscope and count 500 red cells. In the same field in which all the red cells were counted, count all the bacteria and note the number of bacteria counted while counting 500 red cells. As there are 5 m.[2] red cells in a mm. normally, there are 5000 m. in a cc.; so to determine the number of bacteria in a cc. of vaccine emulsion, use the following equation—500 cells, No. of bacteria counted:: 5000:X.

In this manner a standardized vaccine is obtained, and the dose is measured by the million.

Various infections have been treated successfully by vaccine therapy, notably infections with staphylococcus, gonococcus, colon bacillus, tubercle bacillus, etc.

The dose of vaccine of different bacteria varies. The particular dose for the patient depends on the response noted in the immunity wave after inoculation as indicated by their index. It is advisable to start with a moderate dose at first, and later increase. An initial dose of 50 m. is a safe dose with most vaccines. The exact dose will be determined by a study of the index, that being the proper dose which gives the best response in raising the index and maintaining it above normal for the longest time, also that which shows a substantial clinical improvement.

As the quantity of vaccine to be administered is best determined by the index, so, too, is the time of administraion; the dose should be repeated before the index sinks below 1. As it is not always practical to follow the index, vaccines may be used without their aid. Under these circumstances they will be best used, however, by those who have learned their administration guided by the index.

In cases of staphylococcus infections which make up most of the acute superficial infections, as boils, furunculosis, carbuncles, the infections of fistulæ, open wounds, etc., they may be treated by a staphylococcus stock vaccine. The first dose should be 50 to 100 m. The dose is repeated every third or fourth day, increasing with each successive dose. It is unnecessary to go higher than 500 m.

In gonorrheal vulvovaginitis, or in gonorrheal rheumatism,

[1] The tube is now sealed and the vaccine heated to 60° for one hour in a water bath.

[2] m. million.

gonococcus vaccine may be used in 25 to 100 m. doses, repeated every fifth or sixth day.

In cystitis due to colon bacillus, the colon vaccine may be used in 10 to 25 m. doses every fourth or fifth day.

All infections of a mixed type require vaccines of the various organisms. Local tubercular infections unattended with autoinoculations are successfully treated by tuberculin. This is particularly true of glandular tuberculosis. The vaccine treatment in tubercular infections is not attended with rapid results, and often requires months to accomplish the desired end.

Certain points are to be remembered in vaccine therapy. The blood rich in opsonins must reach the bacteria, or otherwise they will be unaffected by them. Hence, abscesses under tension should be opened, if only to relieve the tension, so that fresh lymph loaded with opsonins may pour into the cavity, after the tension being released on its walls.

Necrotic bone is not removed by vaccine, and must be taken out before the vaccine will be effective in eradicating the infection. Large abscess cavities, as empyema, should be drained, and the vaccine treatment instituted.

It would be impossible in this brief section on the subject to cover the wide range of application of vaccine therapy, or the conditions in detail essential to its success.

PYEMIA

Pyemia is, thanks to modern methods of dealing with wounds and infections, seldom seen nowadays. It is not at all common in children, their cases of septic infection more often than in the adult terminating in recovery, or going on to grave conditions other than the formation of thromboses and production of metastatic abscesses. If pyemia follows an injury, it comes later than the usual septicemia.

Symptoms.—The symptoms are those of septicemia, with a greater probability of an initial chill and of repeated chills, and a still more irregularly fluctuating temperature, and complications according to the point of the infected thrombi in lungs, liver, joints, heart, or elsewhere.

Prognosis is very grave indeed.

Treatment.—The treatment is the same as that for septicemia; in addition, opening and disinfecting or extirpating the infected vessels in the neighborhood of the wound, sometimes the ligature of an adjacent vessel, and the opening and drainage of the metastatic abscesses wherever they can be reached.

SURGICAL SCARLET FEVER

It has often been observed by surgeons that wounds, and not only wounds, but wounded patients, are extremely susceptible to scarlet fever. The wound may be attacked, or with a wound to all appearances perfectly aseptic and antiseptically dressed, the patient may be attacked with a fever, followed by a scarlet eruption. There has been many a long argument as to whether this disease is scarlet fever or is some more innocent variety of erythema, or "scarlet rash," safely designated as surgical scarlatina, or some other distinctive title. If the germ could have been identified the argument would have been sooner closed. This disease can and often does, in the surgical patient, as in other patients, vary so extremely in its degree of severity and its symptoms as to be very obscure. Surgical scarlet fever can be communicated to other patients, even to adults, and those not wounded; it can produce desquamation and albuminuria; and it is settled beyond a doubt upon clinical evidence alone that surgical scarlatina is scarlet fever, and it should be isolated and treated as such.

But scarlet fever may be considered in another sense as a surgical disease especially afflicting childhood, and on account of its close affinity for the pyogenic organisms and erysipelas often gives rise to surgical complications and sequellæ. Common instances are the post-scarlatinal abscesses, adenopathies and arthropathies, which will be referred to later. In case of post-scarlatinal operation, the probability of nephritis and its dangers in relation to anesthesia should be borne in mind.

DIPHTHERIA AND PSEUDODIPHTHERIA

Diphtheria is an acute infectious disease caused by the Klebs-Loeffler bacillus, characterized by inflammation with pseudo-membranous exudation upon any mucous membrane, wound or abrasion, with implication of adjacent glands, albuminuria, heart weakness, and also with great general prostration, anemia, moderate fever, and other constitutional evidences of toxemia.

The false membrane caused by the propagation of this bacillus grows upon and adheres to the tissues, usually not being separable in the early stages without bleeding. It varies from a filmy mucoid coating to the thickness of paper or of chamois skin, and in color is white or grayish white, or yellowish, or brownish, or dirty gray, or blackish. It is composed of a structureless network of fibrin containing in its meshes necrotic epithelium, pus cells, blood and round cells, cocci, diphtheria bacilli and débris. The disease may be found in the throat, nares, pharynx, larynx, upon wounds or abrasions, the lips or buccal surfaces, the palpebral

conjunctiva, in the esophagus or stomach, upon eczematous patches, upon the glans penis or vulva, at the umbilicus or elsewhere.

The bacilli themselves do not enter the blood, but during their growth a ferment is formed which is capable of digesting proteids. These digested proteids or toxalbumins or albumoses when absorbed into the blood act as virulent poisons. The ferment is also present in the blood and is capable of acting on the blood, producing loss of hemoglobin and decrease of erythrocytes, and leucocytosis. But the toxemia may be so great as to overwhelm phagocytic activity and produce leucopenia; there is cloudy swelling, and sometimes acute inflammation and degeneration of the kidneys; changes occur in the liver with cell necrosis and hemorrhages. Degenerations take place in nerve tissues with multiple neuritides, in peripheral nerves, and in the spinal, involving the multipolar cells of the anterior columns.

The toxemia produced by the diphtheritic process is in proportion to the virulence of the infection, the extent of the process, and the capacity for absorption of the tissues where it is located, as well as the resistance of the patient. The effects, general and local, are also influenced by the action of symbiotic organisms, which are almost invariably present with the Klebs-Loeffler bacillus. Among these are the staphylococcus, the pneumococcus, streptococcus, and the colon bacillus. The results of these mixed infections frequently produce adenitis, cellulitis, abscess, not only in parts adjacent to the seat of the attack and during the acute illness, but they not infrequently produce septic and pyogenic processes in these situations and more remote, as abscesses of bone or periosteum, or in lungs, liver, spleen or kidneys, and elsewhere, as sequellæ of the disease.

Diagnosis.—The diagnosis is made upon the appearance of the characteristic adherent false membrane wherever found, without waiting for constitutional symptoms or local complications to supervene. The microscope employed with proper technique reveals the diphtheria bacillus. It is well to remember that if caustics or strong antiseptics have been used locally before the swab was taken, the characteristic organism may not be found. Also that the presence of the germ without symptoms local or general does not constitute the disease. And also that diphtheritic poisoning can occur without the appearance of the characteristic local lesions. Furthermore, that there are other organisms than the Klebs-Loeffler bacillus capable of producing false membranes, for instance, the pneumococcus, streptococcus, staphylococcus, gonococcus, bacterium coli.

Pseudodiphtheria.—The name diphtheria, from the Greek, signifies leather or leathery, and was applied not only to all cases of angina, but to all conditions presenting a leathery exudate

upon the surface. Now the word is restricted to the disease caused by the Klebs-Loeffler bacillus, and conditions accompanied by formation of false membrane or fibrinous exudate are called pseudo-diphtheria or diphtheroid. There is, however, a bacterium closely resembling, morphologically and in its staining qualities, the true diphtheria bacillus, differing from the latter in its toxemic effects and in its sequellæ. It can be differentiated by inoculation experiments. This organism has been named the pseudo-diphtheria bacillus, and the disease which it produces diphtheroid. It would be better if the use of this name were to be restricted to this germ, but at present it is often used to include all the conditions clinically resembling diphtheria with its false membrane, yet caused by other organisms than the Klebs-Loeffler, and is even applied to the fibrinous exudates upon the intestinal and genito-urinary tracts in surgical cases, although they are usually caused by streptococcus or staphylococcus infection.

Prognosis.—The prognosis in diphtheria depends upon the stage at which treatment is instituted, and upon whether the germ is in pure culture or the infection is a mixed one. Also much depends upon the patient's general vigor and upon his surroundings. The situation of the local disease has much to do with the probabilities according to the absorbing surface or to interference with function. Greater toxemia may be expected in the post-nasal than in the tonsillar form, and in either of these than in the laryngeal. In this latter the greatest danger is from laryngeal stenosis. (See Chapter on the Air Passages.) In diphtheritic wounds the same rules apply. In conjunctival cases the results may be especially disastrous.

Treatment.—The treatment is by early and vigorous use of antitoxin, and in mixed infections, wound infections and pseudo-diphtheria by antiseptics used on general surgical principles. Also, and especially in true diphtheria, in the use of alcoholic stimulants and strychnia, rest and forced nutrition in the best sanitary surroundings. (See also Section on Opsonins, Opsonic Index and Vaccine Therapy.)

ERYSIPELAS

Erysipelas occurs in new-born babies and in older infants and children. In the new-born it is apt to start at the umbilicus or a circumcision wound or an abrasion received from obstetric instruments. In older infants it begins from any opening of the skin or mucous membrane, often about the genitals or anus, mouth, nose, or eyes, but frequently, as in the adult, the point of entrance of the germ cannot be determined. The symptoms are the same as in older patients; the same rose color of the skin with the inflammatory thickening following the margin of the reddening. But in

young children it has appeared to me to be more rapid and wide in its extension and less regular in outline than in the adult, and the roseate color to flash ahead of the infiltration. The constitutional symptoms are similar: high fever, great prostration, sometimes chills or convulsions, vomiting, in severe cases bronchitis and diarrhea.

Diagnosis.—The diagnosis is not difficult, yet one has seen experienced practitioners fail to recognize it because of irregular shape of its margins or the extent of the skin implicated.

Prognosis.—The prognosis is bad in cases occurring in the new-born. When beginning at the umbilicus the disease is apt to extend to the umbilical veins and peritoneum, and from the veins to produce metastases. In older infants and in children one has not considered the prognosis so grave, at least in fairly strong patients, as some writers assert; but have thought the disease usually took a milder course than in the adult, and that sometimes the child recovered from a condition more extensively diseased than an adult would have recovered from.

Treatment.—Separation from all surgical and obstetrical patients is imperative, and complete isolation is advisable. Free excretion by bowels and kidneys should be secured. After that, stimulants are called for—quinia, strychnia, and whisky or brandy. Locally, the old-fashioned lead lotion is still good, sometimes with opium. Powdered oxide of zinc, lotions of saturated solution of boracic acid are used, always covering the dressing with oil-silk. But of all the remedies, I know of none better than ichthyol, 10 to 25 per cent., in ointment with lanolin, or the same in combination with the unguentum hydrargyri and resorcin, as is highly recommended by Roswell Park. Ointment of the iodide of mercury with ichthyol has controlled many streptococcic inflammations.

CELLULITIS

Cellulitis is an inflammation due to infection by a streptococcus, or the pneumococcus, or the bacillus coli, or a mixed infection, invading the cellular tissues. It is often called Ludwig's angina, since described by Ludwig, a surgeon of Stuttgart, in 1836. It often accompanies one of the infectious fevers or some lowering disease, very often scarlet fever, diphtheria, or pseudodiphtheria. It may appear in various situations and under various circumstances, as with osteomyelitis, peritonitis, or extending from wounds; but the form most frequently seen in children, and quite typical of the condition, occurs in connection with diphtheria, particularly "mixed infection diphtheria," or with scarlet fever. The lymphatic glands at the angle of the jaw become swollen and tender, as is frequent in these diseases, but the process does not stop with

the glands; it extends into the cellular tissues all about them, causing a brawny, tense edema from the jaw to the clavicle, and sometimes involving both sides. The head is held backward and is almost immovable from the thick inflammatory mass in front. Swallowing is not always more interfered with than it was from the primary disease. There is always increased fever, often delirium, and later, in bad cases, prostration and coma. The swelling is not discolored early in the case, and it does not run to prompt suppuration. In a severe case the patient sinks from the sepsis before there is any external indication of pus formation. But in some of these cases pus would be found by going beneath the deep fascia.

Diagnosis.—From the ordinary lymphadenitis so common in scarlet fever or throat infections, it is easily differentiated by its extension outside of the glands, which cannot be palpated nor moved about, glands and surrounding tissues being in one brawny mass.

Prognosis.—This disease was more often seen when less attention was paid to antisepsis in throat and mouth in scarlet fever, and before the days of diphtheria antitoxin; and was especially dreaded before intubation was put in practice; for in the event of tracheotomy being indicated in a marked case of cellulitis involving the whole front of the throat, it was almost impossible to perform it, or to put a tracheotomy tube in position. Moreover, the cases were usually hopeless even if tracheotomized. Antitoxin does not cure septic cellulitis; but since its use few cases of diphtheria run to such length, and fewer develop cellulitis of that severe type. It is always a serious condition, and often fatal. When less extensive, and properly treated, in a patient not greatly debilitated or toxemic from the primary disease, recovery will follow.

Treatment.—If the Klebs-Loeffler bacillus was suspected of causing the primary disease, or of being secondary in a case of scarlet fever, diphtheria antitoxin should be given. I have so far never been able to derive much benefit from anti-streptococcic serum. The application of ichthyol and unguentum hydrargyri, sometimes with guiacol, has effected some good. When the swelling has become tense and brawny it should be incised, and this probably in several places, with due regard for the large vessels. The incisions should go below the deep fascia, and will serve as a drain even if no pus is encountered. Pus may flow a day or two later. Compresses of bichloride gauze serve as a dressing.

These cases demand all the assimilable nutriment they can take, an abundance of water to drink, and unstinted use of brandy or whisky. Strychnia and heart tonics are generally needed. Baths and the ice cap moderate fever and nervous symptoms better

than drugs. The mouth and inside of the throat should be kept cleansed with pleasant antiseptic sprays or gargles.

ACUTE DIFFUSE CELLULITIS

It has seemed to me that the new-born infant is especially subject to a form of acute diffuse cellulitis or lymphangitis. This is either very mild in its character or else the infantile organism, while a fertile soil for infections, has also peculiar resources for combatting them. For with this, as with some other infections observed in the very young, the malady has pursued a peculiar course. This inflammation of the subcutaneous cellular tissues does

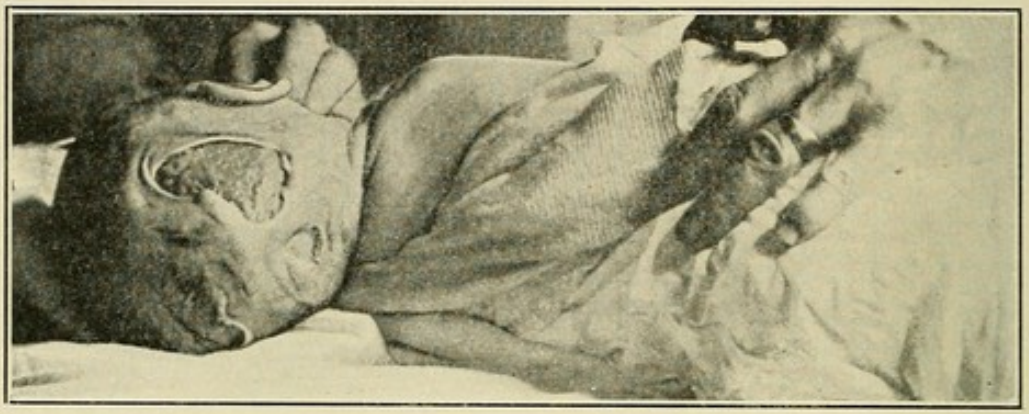


FIG. 31. HEAD OF INFANT WITH SEPTIC INFLAMMATION undermining the scalp and sloughing of the scalp. Recovery. Case seen with Dr. I. W. Bard.

not affect the deeper tissues to any extent, and the skin is affected apparently mostly by the extensive separation which takes place between it and the cellular tissue beneath it, causing it to break down and slough in patches. The inflammation beginning at one point is apparently not surrounded by the usual exudation of fibrin and leucocytes, at least it is not circumscribed, but spreads rapidly beneath the skin, thickening it and giving it a tallowy feeling to the touch. The areolar attachments of the skin are destroyed excepting at their strongest points of adherence, so that extensive skin surfaces floating upon a layer of pus or lymph are tied down at those adherent points, giving such surfaces a "hobnail" appearance. I have seen half the back and both shoulders and neck of an infant in this condition.

Fig. 31 shows the head of an infant in which a purulent undermining inflammation of the cellular tissue under the scalp had resulted in sloughs. Meanwhile there is surprisingly little constitutional disturbance, and after a time the infant recovers from what would seem in an older person a quite extensive infection. The ordinary pus germs are believed to be the causes so far as dis-

covered in the purulent cases. But in those causing the lymphstasis before mentioned no organism was detected.

Treatment is by evacuation of the pus, or lymph, by free openings at different points to prevent burrowing, and antiseptic dressings.

TETANUS OR LOCKJAW

Tetanus or Lockjaw is an acute infectious disease, caused by the tetanus bacillus of Nicolaier (1884) and Kitasato (1889). The bacillus is a strict anaerobe, and abounds in the soil, more frequently, it is thought (Verneuil), in soil mixed with horse-manure. This germ when cultivated in a suitable medium or introduced into a wound in a susceptible animal has the property of generating certain virulent poisons (tetanin, tetano-toxin, spasmo-toxin), (Brieger), which when injected or absorbed into the system produce peculiar and generally fatal spasms. The bacillus of tetanus has the peculiarity that it is seldom found in the tissues far away from the wound where it was introduced, although it has been demonstrated in the blood and in the sheaths of the nerves near the wound and extending toward the cord, and even in the cord itself. But it appears that the toxins are generated at the wound, and travel toward the cord and medulla by way of the nerves. They are found in all these structures, in the cerebro-spinal fluid, and also in the blood, being likewise transported by that medium. Another strange quality is that, although in the laboratory its period of incubation is seldom longer than forty-eight hours, it has in some cases been known to produce its characteristic effects only after a delay of several (Park says eight) weeks later than the infection of the wound.

Pathology.—The wound of entrance may show moderate inflammation; or the inflammatory process may be over-past. The inflamed wounds are those in which there was a mixed infection. The lesions of nerves and nerve centers are merely those resulting from an irritant poison. In the cord the greatest change is seen in the cells of the anterior cornua, with hyperemia of the cord and medulla. Other appearances may be due to the spasms, for instance, small and occasionally large hemorrhages in the meninges, especially at the base, or in the brain itself, and congestion of the lungs and dilatation of the heart.

As to distribution, the disease is endemic in some countries, for instance, Jamaica, the Faroe Islands, India, more frequently in warm countries, being apparently more prevalent in our own Southern States than in the North. But it is not at all uncommon in the Northern States. It seems to have favorite localities for its habitat, the area of one county or township presenting more cases than another. In those countries where tetanus prevails so

extensively the great majority of the cases are in new-born infants. Military field-service in hot climates has tetanus especially to contend with. In this part of the world, while it occasionally occurs in casualty and almost never at this day in elective surgery upon adults, the majority of the cases occur in the new-born and in children, frequently boys, with small wounds of the extremities. Lacerated or punctured wounds seem to afford particularly favorable conditions for this germ, and when the wound is inflicted upon a soiled hand or the foot of a barefoot child the chances are great for the presence and the implantation of the germ. If the wound is so slight as to receive no surgical attention, or if with a punctured wound that surgical attention does not consist in a thorough opening and antiseptic cleansing of the wound, the conditions are at their best for the propagation of this anaerobe and the production of its subtle and powerful poison. For these reasons it is not strange that so great a percentage of the cases occur from the infection of the umbilicus of the new-born babe wrapped tightly in a dressing which is never changed, or in the boy with his fondness for the toy pistol that explodes a tiny bombshell, projecting its fragments beneath his skin; or from the puncture of a sole or palm by a nail or a splinter. Burns also have a bad reputation for opening the way for tetanus.

Tetanus has been variously classified, but the disease by whatever name is always produced by the same infecting agent, and is always introduced by a solution of continuity; and while placing it under different headings may serve to attract attention to the probable atrium of infection and certain modification of the symptoms and course, it should not conceal the identity of the disease. Tetanus neonatorum is of the same nature as traumatic tetanus or "toy pistol tetanus," and idiopathic tetanus is identical with "rusty nail tetanus." The term "idiopathic" should, under such circumstances, as insisted upon by P. M. Pilcher, give way to "cryptogenetic"; and it would seem to me that certain cases of tetanus usually called "chronic" would be more accurately characterized as "sub-acute."

Symptoms and Course.—Symptoms may begin at any time from two days to several weeks after infection. In the new-born it is placed between the second and fifteenth day, though most cases occur in the first week. Usually the first symptom to attract attention is difficulty in swallowing. Nurslings attempt to take the nipple, but cannot. They purse up the lips and thrust the tip of the tongue forward. Older patients' difficulty is opening the mouth. The symptoms of pain or stinging at the site of the wound preceding the onset of trismus is mentioned, and seems probable. But it is not a prominent symptom. The stiffness of the jaws increases, with cramp-like pains in the muscles. The muscular tonic rigidity

extends to the muscles at the back of the neck; the rotary muscles of the neck not being affected. The infant tries to take the breast, but cannot, and older patients are hungry, but cannot eat, and can only drink with the greatest difficulty. Attempts to place anything in the mouth excite greater spastic rigidity of the muscles. An infant will have occasional exacerbations of the tonic spasm, between which there is slight relaxation. The rigidity of the muscles now extends to those of the abdomen and back. The abdomen becomes as hard as a board with this continuous contraction. The arms and legs may be extended and rigid, or with spasm in the pectorals the arms may be held stiffly upon the chest. The spasmodic contraction of the facial muscles, particularly of the risorius, produces the risus sardonicus. (See Fig. 32.) The nerves of sight and hearing and the skin become painfully sensitive to irri-

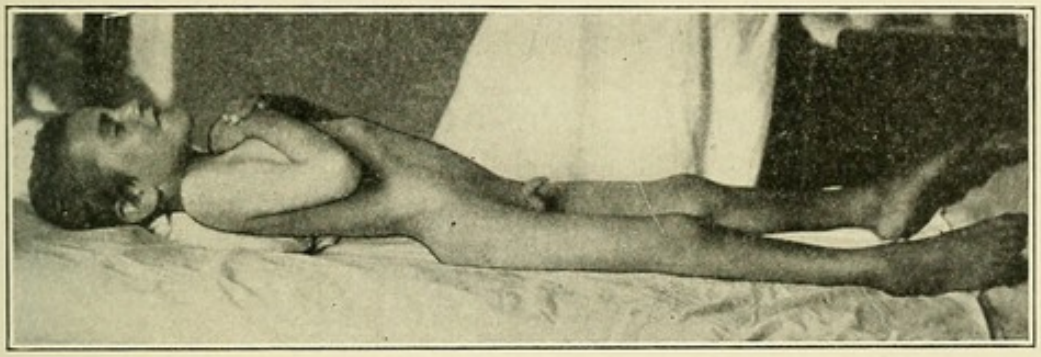


FIG. 32. TETANUS, at St. Clair Hospital. Note the stiffly locked jaw, sardonic grin, tightly closed eyes, the abdominal, back and post cervical muscles in rigid contraction; lower extremities held in extension. In this case the pectorales were contracted, holding the arms as seen. Photograph taken in the interval of convulsions. Infection gained entrance by a splinter of wood in sole of right foot, some five weeks previous to the onset of tetanus. At the time of the illness the splinter was found in a perfectly empty and dry abscess cavity just beneath the sole, with no signs of present inflammation thereabout. Vigorous treatment including antitetanic serum failed to save him.

tation. A loud sound, a bright light, or a current of cold air may be sufficient to excite a more intense spasm of all the affected muscles. Spasms occur at intervals without any special exciting cause and may bow the patient so powerfully backward that only his head and heels touch the bed, his body arched in a half circle (opisthotonos). The contractions may be in some cases forward (emprosthotonos), or latterly (pleurosthotonos), and be so powerful as to produce rupture of muscles. The nervous irritability may be so hyperesthetic that to jar the bed or slam a door will precipitate a convulsion. At the beginning of a convulsion there is often a slight cry or moan forced from the patient by the sudden muscular contractions. The sphincters are contracted, and urine and feces may be retained. Cases of rupture of the bladder have been

recorded. The contractions of the muscles are extremely painful. The patient retains consciousness throughout the sickness, suffers excruciatingly from the spasms, and also from thirst and hunger. Fever is not a marked or characteristic symptom until toward the last, when it takes a rapid and extreme elevation. It may range from normal to 102 for three or four days, and then run up to 105, 106, and, as the fatal end approaches, to 108. It has been known to rise after death to 113. The pulse varies with the temperature, and the respiration with the spasm of the respiratory muscles. Death usually occurs in from one to six days, from exhaustion or asphyxia due to spasm of respiratory muscles. There is great emaciation.

Chronic Tetanus, so called, is a variety which comes after a longer period of incubation, and runs a milder and much more prolonged course. While nearly the same train of symptoms are presented, they are so much modified in degree that the patient may endure them for several weeks or for as long as two months, and may end in recovery or in death from exhaustion.

Tetanus Cephalicus or Tetanus Facialis is a variety following injuries about the head or face. The muscles involved are only those of the face, neck and esophagus, sometimes of the abdomen. It usually runs a milder course, and may end in recovery.

Diagnosis.—The diagnosis when the disease is fully developed is not difficult. A history of trauma, slight or severe, recent or some weeks previous, should be inquired for. In new-born infants there is always the recent trauma of a severed umbilical cord, the most frequent port of entry, and a possibility of some obstetric abrasion. In infants the spasms due to intracranial injury, or from spasmodic laryngitis, or laryngismus stridulus, should be differentiated. This can generally be done by attention to the peculiar grouping of the spasmodic muscles in tetanus. There is a certain amount of resemblance between tetanus and strychnine poisoning. In the latter there is not that contraction of the jaw muscles early in the case, but only at the last. The spasms are quickly repeated clonic spasms, with complete relaxation between, quite different from the continuous rigidity of the affected muscles in tetanus. There is no foaming at the mouth in tetanus. Hysteria of so marked a type as to raise a question of diagnosis would not be apt to occur in a child. I have once seen it in an adolescent hobbledehoy so violent as to raise the discussion. But the symptoms were variable and inconstant, and the mental state pointed to hysteria.[1] In hydrophobia there is almost invariably a well-established history of the bite of an animal, and the muscles affected are first and principally those of deglutition and respiration. In hydrophobia

[1] Case seen with Dr. I. C. Carlisle.

the patient is maniacal and restless, while in tetanus the mind is clear and he keeps as quiet as possible.

Prognosis.—The prognosis has been pretty clearly indicated in the foregoing account. In tetanus of the new-born and acute tetanus of older children it is bad. Anti-tetanic serum may change this. But as yet one does not feel confident in giving much hope of recovery in the well-developed case. As a rule, the later after the infection the disease begins to manifest its presence the better the prognosis. The chronic case of less severe grade, or the cephalic form, may recover even under the older methods of treatment, if they are thoroughly carried out.

Prophylaxis.—In view of the deadly nature of this disease and the terrible suffering it causes, every possible effort should be made to prevent it. Every physician, midwife, nurse and mother should know what disastrous results may follow the lack of asepsis in the care of the umbilical wound, and of any other wound upon the infant, and if a case occurs in the practice of physician, midwife or nurse, practice should be suspended pending a searching investigation followed by rigid antisepsis. Such deadly playthings as the toy pistol should be abolished throughout the country, as has been attempted, in part successfully, in a few cities. In case of any wound, however trifling, especially upon hand or foot, there should be a proper cleansing and an antiseptic dressing. If it be a lacerated or a punctured wound, the greatest care should be taken to lay it open to the bottom, clean it surgically clean, dress it open, and change the dressings until it is healed. Parents and children should be warned that such care is necessary. Some surgeons are advocating the use of immunizing doses of anti-tetanic serum in every "Fourth-of-July" casualty, rusty-nail accident, or wound received in a garden, field or barnyard. Unless the disease were known to be epidemic, or endemic in that locality, this precaution would seem unnecessary if those before mentioned were taken.

Treatment of the Wound.—In all cases of tetanus search should be made for the atrium of infection. In some cases it is only too obvious; in others it may be a forgotten burn or a splinter under the nail. If it is an unhealed umbilicus, this should be thoroughly cleansed with antiseptics, lest more of the poison be generated and absorbed. Possibly it is because of antisepsis that the use of turpentine on the umbilicus has a reputation among the laity in some parts of the South for the cure of "nine-day fits." With the patient under anesthesia, an abscess or a discharging wound should be laid open, cleansed, scraped, excised, or cauterized, as seems necessary to get rid of suspicious tissue. In certain cases amputation may be expedient.

Treatment with Tetanus Antitoxin.—The most recent and most promising treatment is that by anti-tetanic serum. Enough experience of methods, dosage and results has not yet been obtained to give definite directions nor to predict the effect to any certainty. Knowledge will, it is hoped, advance rapidly, and what is now written [1] may be superseded by the time it is read in print. Behring and Kitasato were first to produce an anti-tetanic serum. It is now made and marketed by Behring, by the H. K. Mulford Company, Parke Davis & Co., and other manufacturers. Tetanus antitoxin has no power to destroy the bacteria nor to prevent the production of their toxines, but it has the power to neutralize the toxines. Immunity to their effects has been produced in animals, and cases have been reported of its successful use in tetanus neonatorum, and in traumatic tetanus. One thing is certain, if it is to be useful it must be used early in the case and in very large doses. It is advised to use in acute cases from three to fifteen thousand units every four, six or eight hours. Some advise the use of fifteen to thirty thousand units at the same intervals. An immunizing dose is said to be fifteen hundred units. Others recommend thirty to sixty c.c., and again others 200 to 300 c.c. in twenty-four hours. Inasmuch as the strength of the antitoxin is not universally standardized, these directions become all the more indefinite. It may be used by the familiar subcutaneous method, or the slightly less convenient intravenous method. To come still more quickly in contact with the toxines, it is still better to inject the antitoxin into the spinal canal by lumbar puncture. After allowing from 5 to 15 c.c. of cerebro-spinal fluid to escape, an equal quantity of the antitoxin is injected. To get still nearer to the affected centers Raoux and Kocher have advised injecting it into the brain or lateral ventricles. Those who accept the theory of the transmission of the toxines from the wound along the nerves to the spine, and hold that it cannot travel peripherally, and only slowly in the afferent direction, advocate both intraneural and intraspinal injection of the serum, five or ten minims for a nerve trunk and fifty or sixty for the spinal cord. These doses are for adults.

Other Treatment and General Management are very important. Special efforts should be made to support the patient with food and drink. These may have to be given through a tube passed by way of a nostril into the stomach. This is a much better method than rectal feeding. Medicines can be given in the same way. Subcutaneous injections of normal or deci-normal salt solutions, and of sterilized olive oil or oil of sweet almonds, are valuable. Cold to the spine, as ice-bags, et cetera, has been much recommended. One does not know whether it does any good, and patients

[1] March, 1908.

object to it. When they seem irritated thereby I do not use it. Hot baths appear more soothing; and they promote perspiration, which may be eliminative. The patient should be undisturbed; no light, noises or jars allowed to irritate his nerves.

Drug Treatment.—No known drug has any specific action in this disease, and yet drugs are valuable. All that can be hoped for from them is to control in some measure the morbid excitability of the motor centers and relieve pain. Those most used have been chloral, the bromides, chloroform and ether, and physostigma. Potassium bromide should probably be used first for spinal sedation without cardiac depression. Full doses should be given, four to eight grains every two hours to a new-born babe, and to older children in proportion. A child of six years will take from twenty to forty grains, always well diluted. Chloral in combination with the bromide is much more efficient in relaxing spasm and procuring sleep. But chloral is somewhat depressing. Chloral probably renders safer the after use of physostigma. The latter can and preferably should be used in the form of eserine hypodermically. Chloroform or ether, or the same in combination with oxygen, may be used, intermittently as required, to relieve the intensity of the spasms. Morphine is a valuable remedy in relieving the cramp-like pains due to the muscular contractions. Preferably it should be injected into the affected muscles. If used in infants their extreme susceptibility to this drug should be remembered.

I have no experience with curare, nor with the carbolic acid treatment of Bacelli, Kocher and others. The latter recommends subcutaneously the use of carbolic acid in three per cent. solution, injecting fifteen minims every two hours (adult dose). It is thought to diminish the reflex excitability of the cord, and also to have an antiseptic action, and is said to show no symptoms of carbolic acid poisoning. I should try it only with much caution in a child, in view of the great susceptibility of the young to poisoning by phenol.

OTHER INFECTIONS

There are still other infectious diseases very common in infancy and childhood, not ordinarily thought of in this connection, and yet bearing a relation because of their complications, or sequellæ, or remote effects, to pediatric surgery. For instance, measles, which notoriously leads to involvement of the lymphatics, to otorrhea, not infrequently to croup, and too often to tuberculosis, with its numerous surgical manifestations. The germs of pneumonia are well known as frequent causes of empyema, of joint and bone inflammations, and of abscess formation in many parts of the body. Influenza powerfully predisposes to infection by the pyogenic organisms, and together they bring about abscesses in the

accessory sinuses, otorrhea, mastoiditis, and other bone diseases, and inflammations of pleura and pericardium. Mumps has its special predilection, in addition to the salivary glands, for the testicles and ovaries. Pertussis adds danger to anesthesia, and interdicts operations upon the palate, lips or abdomen. Smallpox has its joint and suppurative complications and sequellæ. Chicken-pox occasionally becomes gangrenous, and vaccinia septic, and either of them when pustular is capable of infecting a wound. Typhoid fever rarely causes intestinal perforation in the young, but besides gangrene, it is capable of producing abscesses, arthritis, and periostitis. Cerebro-spinal meningitis sometimes has articular complications; and, moreover, there is hope that in cases of purulent meningitis a method may be found of attacking it surgically for drainage and disinfection.

ACTINOMYCOSIS

The actinomycis is one of the ray fungi. It is not too small to be seen by the naked eye as a yellowish speck, and looks, under a magnifying glass, something like a tiny yellow chrysanthemum. It can propagate in living tissues, and in man usually is a mixed infection, ordinary pyogenic organisms being also present. It produces chronic, almost painless, swellings which break down and discharge pus in which the minute yellow specks may be seen and may be felt as gritty particles beneath the finger. The fungus affects grazing animals and the human species, being rare in the latter. In cattle, infection about the mouth or jaw is most common, and is known as "lumpy jaw." It sometimes appears in the lungs or intestines, as well as the jaws, or elsewhere, even destroying bone, both in man and animals. Besides the local trouble it causes emaciation and weakness.

Diagnosis.—It has been mistaken for tuberculosis, syphilis, sarcoma or cancer. When there is a discharge, as is almost invariable, the presence of the little yellow fungi, containing the gritty calcium particles, readily establishes the diagnosis.

Prognosis.—The prognosis depends upon the location, as to accessibility for removal.

Treatment consists in radical extirpation.

GANGRENE, INFECTIOUS AND NON-INFECTIOUS

Gangrene may be infectious or non-infectious. It may occur in the child from traumatism in all its varieties, including the accidental strangulation of parts. It may be caused by disorder of the nervous system, as in Raynaud's disease; to the action of drugs, as in ergotism; or to the local action of chemicals, as in carbolic acid gangrene; or to constitutional diseases, as in hemophilia and the diabetes that comes about the period of puberty; or to infec-

tion by the bacillus of malignant edema or other organisms; or to a combination of morbid influences, often including a mixed infection, complicating or following such diseases as scarlet fever, measles, varicella, and erysipelas, typhoid and other fevers. In fact, the possible causes include all those which produce the disease in adults excepting senile changes.

Traumatic Gangrene may occur after fracture or crush of an extremity or the swelling which follows and cuts off the circulation or the innervation. Injuries of or near large vessels or nerve trunks should be very closely watched for such an untoward event. Cases have occurred in which the application, too firmly, of the splint or bandage without allowing for inevitable swelling, has done more than the original injury to produce gangrene. It is very easy in the small, frail limbs of a child to apply the Esmarch bandage too tightly or to keep it on too long, and as a result produce a painful edema of the limb, and perhaps gangrene of the margins of the wound, if not worse. Gangrene of intestine will occur in strangulated hernia, the same as in the adult. The constriction of paraphimosis has been known to cause gangrene of the prepuce, or of the urethra, or of these structures and the glans penis. A metal ring mischievously slipped upon the penis has produced the same result (Owen), and one has averted similar catastrophies from the use of a rubber band and of a steel band only by their timely removal and the use of hot baths to restore the circulation.

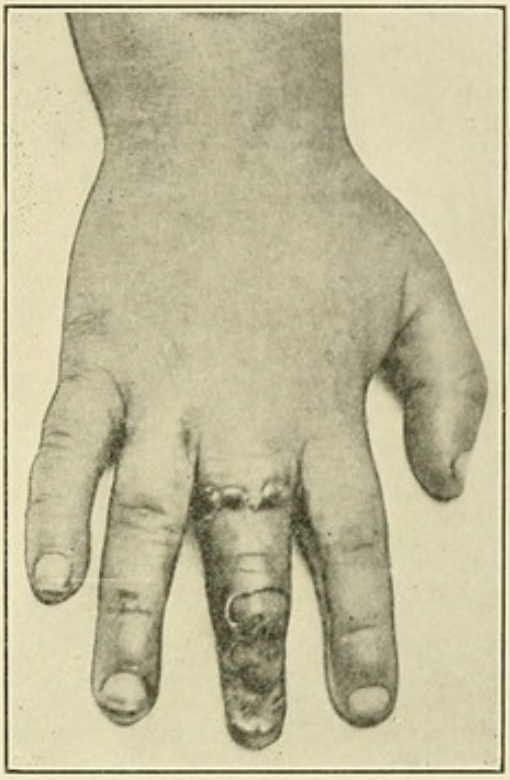


Fig. 33. Carbolic acid gangrene. Boy aged 4½ years, had pinched finger slightly in a door. Officious neighbors advised "phenol." A bandage was applied and saturated with it, result gangrene requiring amputation. Finger mummified. The blebs show the line of demarkation.

Carbolic Acid Gangrene.—This form of gangrene is not uncommon. One has met it a number of times in varying degrees. Other acids, and also alkalies, as caustic potash applied in solution, would produce a similar effect, but not so painlessly. Most of the cases occur from the domestic use of carbolic acid as a dressing for some minor injury. (See Fig. 33.) Quite a large

number of instances are to be found in the literature. "Gangrene may be produced by a 1 per cent. solution of carbolic acid in twenty-four hours (Bruns and Peraire), in twelve hours by a 2 per cent. solution (Lévai), and in three or four hours if the solution is more concentrated (Kortum). Various theories have been advanced to explain these cases. Kortum thought gangrene was caused by the action of carbolic acid upon the trophic and vascular nerves. Frankenbueger showed by experiments on animals that dilute solutions of carbolic acid would produce complete destruction of parts to which they were applied. He thought the action was exerted directly upon the red and white corpuscles, producing stasis and thrombosis. Lévai showed by experiments that the death of the part is due to a direct chemical action on all the tissues." [1]

Hæmophiliac Gangrene.—Hæmophilia, a constitutional disease of unknown origin (see section on Hemophilia), has been reported as a cause of gangrene.

Diabetic Gangrene.—The diabetes of children about the age of puberty is given by D'Arcy Power as one of the causes of gangrene. Diabetes in early life is not a very common disease, and gangrene as a result must be quite rare at this age, most cases occurring past middle life, even past the fiftieth year.

Typhoid Gangrene.—Keen considers the influence of age in the production of typhoid gangrene as not very marked.[2] Of 140 cases at all ages which he collected, there were under 15, 26 cases; from 15 to 25, 64 cases; after 25, 50 cases. This, he considers, will not differ much from the normal age-distribution of typhoid. But Drewitt, as stated by Power,[3] thinks that gangrene, usually embolic in origin, is more frequent in children than in adults; and he offers in explanation the very plausible reason that the young heart is able to hold out to the end in cases of typhoid, where older hearts would fail, and though gray and bloodless, are still able to contract on the half dried-up and clotting blood stream.

Emphysematous Gangrene (*Malignant Edema, Spreading Traumatic Gangrene*) must be extremely rare among children in this country. It is an infection, spreading so rapidly that it may involve a whole limb and invade the trunk in a few hours, with a tense and painful swelling, dark red or purple in color, becoming dusky and mottled, then vesicular, boggy, and crackling under the examining finger, with gases among the tissues. These become a soft black mass. The patient sinks into a very low state and dies

[1] A. C. Wood, Bryant and Buck, Am. Practice of Surgery.

[2] "Surgical Complications and Sequels of Typhoid Fever," W. W. Keen, p. 73.

[3] "Surgical Diseases of Children," D'Arcy Power, p. 15.

from the presence of the gases in the blood, in the same manner as when air enters the veins; or in some cases under treatment he recovers. The disease is attributed to an anærobic bacillus discovered by Koch. Morphologically it resembles the bacillus of anthrax, and also, like anthrax, inhabits garden soil. It is motile and spore-forming in the living body. It is said not to produce gas excepting in company with ordinary germs of putrefaction. Various other anærobic bacilli with pus cocci are capable of producing gangrene with gas formation, which cannot be differentiated clinically. Not all cases of emphysematous gangrene are malignant edema.

Treatment consists in free incisions, or excision of the diseased area, or amputation high above the disease. Antiseptic dressings, and usually heat. Internally, stimulation and supporting treatment.

Raynaud's Disease.—Children are subject to Raynaud's disease, if that be indeed an entity; so many cases are reported which seem quite as probably resultant from some other cause or a combination of causes. Yet some seem to present all characteristics described by Raynaud, excepting perhaps that of symmetry, for the disease is more often bilateral. It affects the fingers and toes, even up to the wrists, ankles or knees, or the tip of the nose, the cheeks or the ears. A period of local syncope is followed by a period of local asphyxia, and this by gangrene, either moist or dry. After a long period of paræsthesia of the part, which becomes cold and either pale, bloodless and painful, or livid and swollen, the gangrene supervenes, either with the formation of blebs or with gradual mummification. The patients often suffer with mental depression and with disturbances of sight, taste, hearing and cardiac action, hemoglobinuria, and neuritis. The pathogenesis of the disease is much disputed, the majority perhaps maintaining that it is due to vaso-motor disorder from central causes.

Treatment.—The treatment of Raynaud's disease is directed to the neuropathic condition, locally to stimulate the circulation by massage, heat and galvanism. Gangrenous parts should be removed, as in any other form of gangrene.

Noma *(N. pudendi, N. Vulvæ, N. Scroti, Gangrenous Stomatitis, Cancrum Oris, Water Cancer, &c.).*—This is a very destructive form of gangrene, attacking the cheek, gum, nose, ear, or the genitals or anus, and extending to adjacent structures, accompanied by great prostration and often terminating fatally. Noma is not a common disease, nor one of long duration, and the opportunities to study it are not of the best. Many theories have been held, but it is now regarded as undoubtedly of infectious origin. No agreement has been arrived at as to the identity of the germ,

though a number of observers have claimed the discovery. It is thought to abound in many places, but in the form of spores which cannot attack tissues unless a previous disease has rendered them vulnerable; for the disease usually follows one of the other infections, notably measles, whooping-cough, scarlet fever or other specific disease. It occasionally occurs in children debilitated and cachectic from various causes. The patients are from three to eight years of age, but may be older or younger. Noma is a spreading gangrene which spares no tissue with which it comes in contact. Power describes two varieties as he sees it among the neg-



FIG. 34. CANCRUM ORIS. Child aged 5 years.—Dr. Stewart L. McCurdy's Case.

lected poor children of London; one which runs an acute gangrenous, and the other a less acute phagedenic, course, the slower being the more usual. I have seen but few cases in this country, and they were rapid in their course, and one which survived was extremely slow in convalescing, and the frightful gap in the face was a long time in cicatrizing.

Symptoms.—The disease often begins in the cheek near the angle of the mouth (see Figs. 34 and 35), on the membranous side, or upon the lip, or the gum; it may be upon the labia-majora or elsewhere. Holt describes a series of five cases in a hospital ward (upon whom the same syringe was used for otorrhea) in which noma began in the deeper structures of the auditory canal. Upon mucous membrane it begins with a small dark spot, which may or may not be ulcerated when first seen; or there may be vesicles which break down and leave an ulcer covered with a yellow secretion. The surrounding parts become greatly swollen and brawny, and turn blackish and necrotic. If upon the cheek the disease now shows through upon the outside. The infiltration fol-

lowed by the edema and by the necrosis extends wider and farther. It destroys soft parts, alveolar processes or bones.

At the genitals it may extend to pubis, thigh or perineum, and as deep as it is wide. After the gangrenous process has gone on for several days, symptoms of septicemia and prostration develop, often with diarrhea. The gangrenous tissue falls away. In fatal cases there is no line of demarkation. The odor is extremely offensive. Fever may range from 102 to 105, or may be subnormal as the end approaches (Holt). Pulse very feeble. The sloughing process goes on, with greater general prostration, perhaps with hemorrhage or septic pneumonia, to the fatal end.



FIG. 35. CANCRUM ORIS in a Chinese child.—Dr. W. H. Kinnear.

Diagnosis.—The diagnosis will present no difficulty if the disease is borne in mind. Its rarity makes it likely to be unthought of until it is far advanced.

Prophylaxis would demand cleanliness and antisepsis in all cases of stomatitis, vulvitis and balanitis, however simple they may appear, with especial attention in debilitated children. A case of noma should be strictly isolated.

Treatment.—As soon as noma is recognized the patient should be anesthetized, and the diseased tissues completely excised, beyond the area of infiltration. The wound should then be cauterized with the Paquelin cautery, or nitric acid, or carbolc acid, afterward neutralizing all excess, and dressing the wound. If the face is the seat of the trouble, the child should be placed in such a position that the discharges will not be drawn into the larynx, and whereever located the wound should be kept well cleansed with antiseptic solutions, chlorate of potash, peroxide of hydrogen, permanganate of potash, iodine, and irrigated with normal salt solution. Diphtheria antitoxin and anti-streptococcic serum have been used by some with alleged benefit. Concentrated food, stimulants, as whisky, strychnia and quinia are indicated.

The resulting scars may call for plastic surgery.

CHAPTER V.

BURNS AND SCALDS

THE subject of burns and scalds is a rather important one, for the reasons that owing to the ignorance, carelessness and helplessness of children this form of injury is very common among them, and that with them the injury is far more apt to be dangerous than with their elders.

The skin and deeper tissues of the child are so much more delicate than that of adults that they are damaged by a lesser degree of heat and in shorter time, and experience has proven that the burns and scalds of apparently equal degrees of severity are more apt to prove fatal in the young.

It seems to make little difference in the effect upon living tissues whether heat be applied in the form of flame or radiant heat or heated substances. Practically the greatest number of extensive burns are received either by the clothing burning or by scalding with water. I once knew a child scalded and blistered from the armpits down by being placed, while having a convulsion, in a bath of hot mustard water. The fatal ending of the case resulted more from the injury than from the disease. Burning by contact of a hot-water bottle with an unconscious or paralyzed child is an occurrence one meets altogether too frequently. (Fig. 36.) As a rule, scalds are more extensive than burns, while burns extend more deeply.

The effects are usually described in three degrees. In the first degree there is simply hyperemia of the skin caused by dilation of the superficial blood-vessels with a slight exudation of serum. This produces moderate swelling but no vesication, and recovers with no trouble beyond the loss of the epidermis. In the second degree the congestion is greater and the serous exudation is sufficient to lift the epidermis from the cutis vera, producing vesicles or blebs. The contents of these blisters are thin at first, but later coagulate and become jelly-like and may become bloody or purulent. If infection does not occur, the result may be in a little longer time as good as in burns of the first degree, restoration without scar. In a burn of the third degree there is damage deeper than the epidermis. Blood is coagulated and blood-vessels destroyed, albumens are also coagulated, connective tissues have their fluids driven out

by the heat. The result is disorganization and devitalization of tissue, shallower or deeper, according to the degree of the heat or the length of time during which it was applied, even to the destruction of bone or an entire extremity. These dead tissues must, if the patient survives, be cast off by the same process as occurs in gangrene or in crushing, and healing must take place by granulation, which cannot occur without the formation of scar tissue with its propensity to contract.

As in any other wound, there is liability of infection, and as in any infection there is inflammation with pus formation and all the

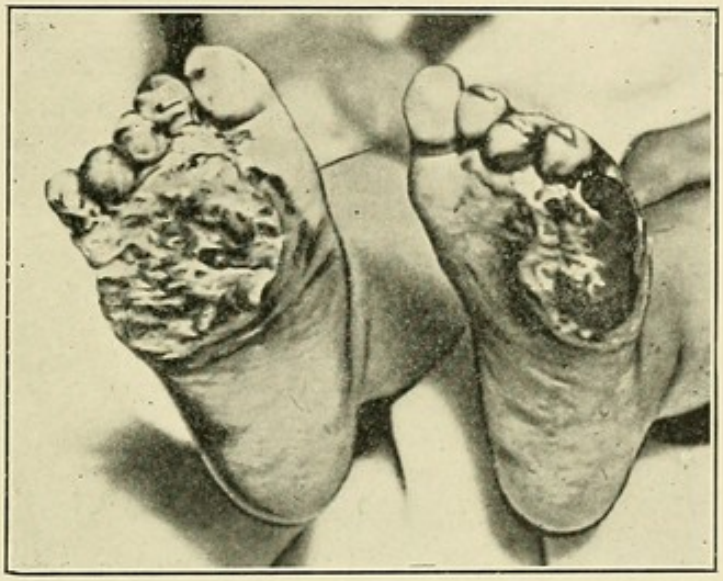


FIG. 36. BURN OF THE FEET caused by applying hot water bottle to an unconscious child. One toe and meta-tarsal necrotic.

dangers of septicemia, pyemia, and that train of evils which follows infections.

The dangers from burns are in shock, putrefactive toxemia, besides the chances of a mixed infection with tetanus or erysipelas; complications in the form of congestions of internal organs, the intestinal tract, lungs or brain; nephritis; ulceration of the duodenum; disfigurement by resultant scars, and further disfigurement and even deformity and loss of function by cicatricial contraction. There is a more remote danger of chronic ulceration, or the growth of keloid or epithelioma in the scar tissue.

Shock is the first and great danger. It is present in proportion to the area rather than to the depth of the burn. Pain is greater if cutaneous nerves are only injured and exposed than if they are destroyed. Of the cases of burns that cause death promptly after injury a large proportion are burns of the second degree. The symptoms may be those usual in shock, the quick and feeble pulse,

cold skin, and subnormal temperature, abated reflexes, depression of the mental acuteness without loss of consciousness. Sometimes a patient is extremely restless and complaining, nearly all are very thirsty, and some vomit. Death may occur by collapse or coma. In case of recovery from shock, fever is apt to supervene, and the subsequent course will depend upon whether septicemia or other complication is present. The fever, the congestions of internal organs, and other evidences of general and local disorders remote from the wound, have received much study and are yet not fully explained. Some claim that the arrest of functional activity of the skin causes toxemia from poisons retained in the system, and point to the fact that the extent of the area burned is a large factor in the case. Others look upon the same fact as an evidence that it is the excessive irritation of an immense number of peripheral nerves that exhausts the nervous system and lowers vascular tension. Others regard resulting conditions as sapremia from the absorption of poisons, non-infectious in origin, at the wound. Some investigators lay great stress on the destruction of red blood corpuscles which takes place with burns, and consequent hemoglobinuria, also destruction of white corpuscles and formation of thrombi in capillaries. On this theory of thrombosis the peculiar ulcerations in the duodenum are explained. Suppression of urine is common both in the stage of shock and of reaction, but although congestions of the kidneys occur actual inflammation is not so common. The congestion of the brain may produce delirium, that of the intestine ulceration, hemorrhage, or diarrhea, and that of the pleuræ and lungs, pneumonia.

Diagnosis.—The diagnosis of burns would seem entirely obvious, yet there may be question as to the production of it, especially in the absence of clear history or in medico-legal cases. Scalds do not destroy the hairs, and are more apt to be equal in degree over a large area. The burn of nitric acid, if recent, is yellow, that of sulphuric acid reddish or rusty, that of carbolic acid white; but any of these, like the burn of caustic potash or of heat, will later appear brown or blackish, or, occasionally, a washed-out gray color. The eschar does not separate from the living tissues for eight or ten days, and then leaves a red and suppurating ulcer with inflamed edges. Burns from electrically charged wires are black at the point of contact, which is surrounded by a paler and drier area. An electric burn may be more severe beneath the surface than would at first appear.

Prognosis.—The prognosis in a case of burn is more grave in the young than in the adult patient. It is usually said that a burn of the first degree will likely prove fatal if more than two-thirds of the skin surface is burned, and a burn of the second degree will

cause death if more than half the skin is damaged. But I believe if the patient is a young child, it is nearer the truth to say that if more than one-third of the skin surface is burned, death will probably ensue. The location of the burn or scald has some bearing on the prognosis. Scald of the glottis gives doubtful prognosis. If the injury be located upon abdomen, chest, or pelvis, the effect will be more severe than if it were elsewhere. The general health and vigor of a patient are to be taken into consideration. Infection of the wound darkens the prognosis, as regards life, complications, and scarring. A moderate sized burn or scald of the first degree will, if fairly treated, get well in a week or two, leaving only redness, which will gradually fade into normal color. A burn of the second degree, if kept germ-free, will do the same in a somewhat longer time. The second degree, if infected, and the third degree, even if uninfected, will result in scarring, but if infected in much worse scarring. Contractions are disastrous if located near an orifice, as mouth or eyes, or at the flexures of joints, as upon hand, front of the elbow or axilla.

Treatment.—The treatment of burns and scalds is local, general, and that of complications or symptoms which arise. It may be truthfully said that the treatment of these injuries has often been faulty on account of regarding them as in some way different from other wounds and not applying to them the same modern surgical principles. Doubtless the humane desire to relieve as speedily as possible the terrible sufferings of the patient has often induced too great haste in covering up with dressings an uncleansed wound-surface. The result is infection with the possibility of all its evils, local and general. The burn or scald should be treated as one would a crushed or lacerated wound. An anesthetic should be given. This at once relieves the pain and helps to prevent shock. During anesthesia the wound should be thoroughly cleansed. An excellent plan is to immerse the burned parts, if necessary the whole patient, in a bath of warm normal salt solution, or sodium bicarbonate solution of the same strength. If the burn is only of the first degree, or blebs have not yet formed, soap may be used, and the water changed for sterile and followed by an antiseptic solution and sterile water again. Some would use ether in this cleansing process. If blebs have formed, or it be an ordinary second or third degree burn, the same process is proper, taking care to remove shreds of tissues and all impurities, washing with a 1 to 40 solution of carbolic acid, and following this with normal salt solution or sterile water. It is not necessary to remove unbroken blebs. They should be snipped open with sterile scissors to evacuate the serum. Sometimes in the healing process the epidermis forming the bleb reunites with the dermis. The cleansing process completed, it

remains to apply a sterile protective and antiseptic dressing. Many hospitals have a stock formula for dressing burns; and the individual surgeons have a favorite preparation, all proven by experience to be useful. Outside of hospitals it often happens that what one would prefer is not to be had in the emergency, so a number of materials and methods will be mentioned. A burn or scald can be treated successfully and comfortably in a continuous bath of salt or sodium bicarbonate solution, or a 4 per cent. boracic acid or aluminum acetate solution, or sterile water at a comfortable temperature. Or, if the surface is not too large, in a one per cent. carbolic solution; or cloths wet in these solutions and kept constantly wetted may be used. A solution of picric acid in water, 1 to 50 or 1 to 100, has been highly praised. The old-fashioned Carron oil, equal parts linseed oil and lime water, is still used with success. Eucalyptol may be added to it with advantage. The oil is applied by saturating gauze in several thicknesses and laying it on. Ointments of boracic acid 1 per cent., carbolic acid 1 per cent., carbonate of zinc any strength, plain vaseline, are all useful. Some prefer dusting powders of boracic acid, salicylic acid, zinc oxide, dermatol or zinc carbonate or bismuth. These powders, excepting perhaps the last two mentioned, are not as comforting to the wound as the wet dressings or ointments. Powders are useful to absorb excessive moisture. Outside of the Carron oil gauze, the ointment or the dusting powder, gauze, cotton, and a light roller should be applied. If none of these are obtainable, lard, molasses, or flour may serve to exclude the air and protect the surface. Dressings should be ample in area. One often sees a dressing, otherwise well done, allow exposure to infection at some small angle where the dressing should have overlapped the wound farther. As soon as the wound is cleansed and covered, and the patient allowed to emerge from anesthesia, he should receive sufficient morphia to soothe his sufferings, and attention directed to the prevention or control of shock by the use of stimulants, hot bottles, et cetera. (See Section on Shock.) Normal saline enemata assist in combatting shock, and also the inordinate thirst which many experience, besides having a diuretic effect which is desirable. In addition to other stimulants I have thought camphor (in full doses hypodermatically in oil) useful in the depression with restlessness which appears in these cases. The suppression of urine must be met with the free use of water and mild diuretics and hot packs, the diarrhea by bismuth mixtures, and the fever with sponging, the delirium with the ice bag or Leiter's coil, and bromides. The dressing should not be changed too soon, but care should be taken if it is a wet or oily dressing to pour in more of the preparation from time to time and not allow it to get dry. At the later dressings sloughs and shreds should

be removed with sterile dressing forceps and scissors, the wound irrigated with a mild antiseptic solution, like carbolic acid followed with sterile salt solution, and fresh dressings applied. In dressing an extensive burn the entire area should not be uncovered at once, but a portion at a time uncovered, cleansed, and covered again. The first few dressings may require brief general anesthesia. Charred or necrotic tissues may be slow to separate from the living in burns of the second and the third degree. These should be removed as soon as possible. At the same time the margins of the wound become red and inflamed and need attention, often requiring wet dressings. Usually the debris is allowed to clear itself away too gradually, then granulations appear, and if the burn is extensive a mistake in the treatment now occurs. There ensues a long period of painful dressings and waitings, with all the chances of infection and of exhausting the patient, or of exuberant or sluggish granulations which have to be restrained or stimulated by touching with silver nitrate. Meanwhile granulation tissue is forming a thick layer which will subsequently contract and form a hard unyielding, disfiguring, sometimes even deforming and impairing cicatrix, with possibilities of ulceration, keloid, or epithelioma later in life. Of course it is advised to maintain the healing surfaces at rest, when necessary immobilizing them with splints, and this in a position of greatest extension; also that adjacent granulating surfaces (for instance between fingers) should be separated; and also that careful passive movements should be persisted in, and when the skin is closed that massage should be employed, and that theosinamine be given a trial; and that if the wound surface is extensive or slow in closing or fails to close that skin-grafting should be resorted to. Now all these are useful measures and should be employed, but the mistake is that they are commonly adopted too late. Especially is the skin-grafting postponed far too long. After the granulating process has formed cicatricial tissue all over the wound it avails nothing so far as subsequent contractions are concerned, to cover its surface with epithelium. The time to do skin-grafting is immediately the necrotic tissue separates from the living or can be separated by surgical means. Then upon a healthy and aseptic surface, Thiersch or Krause or Ollier grafts should be laid and covered with strips of rubber tissue or Cargile membrane, or in some situations generous flaps, one-third larger than the surface to be covered, should be transplanted, accurately adjusted and sutured. Thus avoid contractions. The treatment of extensive burn contractions by plastic operations is one of the most alluring and sometimes disappointing in pediatric surgery. Simple division of contracted bands, as a rule, avails nothing.

CHAPTER VI

THE MUSCLES, TENDONS, FASCIÆ, BURSÆ AND CELLULAR TISSUES

HEMATOMA OF THE STERNOMASTOID—RHEUMATIC MYOSITIS—OTHER FORMS OF WRY NECK (TORTICOLLIS)—PRIMARY PROGRESSIVE MYOPATHY—TENDONS AND THEIR SHEATHS—RHEUMATIC TENDINOUS NODULES—INJURIES OF TENDONS AND THEIR SHEATHS—OPERATIONS UPON TENDONS—FASCIÆ—BURSÆ—CELLULAR TISSUES.

THE muscles of infants and young children are not only smaller but weaker in proportion than those of adults. They have less tensile strength and less contractile power. They occasionally present anomalies in their development. They are subject to nearly all the diseases and injuries which occur in the muscles of their elders. Ossification of muscles (myositis ossificans), does not often occur in childhood, but cases are reported somewhat rarely. Primary tumors of muscle, while rare in the adult, are practically unthought of as occurring in the young. Sarcoma, beginning in muscle sheaths, may involve the muscle itself. Angioma of the cavernous variety may appear in muscle, and also angio-lipoma, and dermoid cysts are not uncommon. Contusions of muscle are common, but severe sprains or strains are probably not as frequent as in older persons. Spontaneous rupture by muscular action is unknown.

HEMATOMA OF THE STERNOMASTOID

There is, however, a muscular rupture that is not uncommon in infants. The little patient may be brought on account of wryneck or on account of a small tumor which is felt in the side of the neck. The tumor may be found about the middle of the sternomastoid muscle or above or below the middle. It is about the size of a filbert or a hickorynut, feels quite firm and is evidently within the muscle-sheath. There is no discoloration of the skin. If the babe is but a week or two old the tumor may be slightly tender to the touch. Later there is no tenderness. The head is held toward the affected side, with the chin turned toward the opposite side. In the majority of cases the tumor is on the right side. In rare instances each side has a tumor. The origin of this condition is a

partial rupture of the sternomastoid during the birth. In the greater number of cases inquiry will elicit the statement that it was a breech presentation; and while it is probable that traction upon the feet or body by the accoucheur in his efforts to deliver the head may have caused the injury, it is no evidence that unnecessary force was used, for cases have occurred in easy labors in which the head was born first, in which no force was used, and some in which no attendant was present. The partial rupture of the muscle causes a hemorrhage confined within its sheath, a slight inflammatory action follows, the blood clot and the inflammatory exudate constituting the tumor. This is partly absorbed or converted into fibrous tissue, and after three or four months in most cases can scarcely be found. In a very few cases it may remain, small but palpable, with some shortening of the muscle, and have a permanent effect on the position of the head, producing a degree of wry-neck.

Most cases need no treatment beyond gentle massage after the tenderness has passed away, and stretching the muscle by movements of the head toward the opposite side.

RHEUMATIC MYOSITIS

This disease occurs in children, either with or without any history of strain or exposure to cold or wet, or of rheumatic symptoms in any other part. The pathology of the trouble is not altogether settled. It may be considered hardly a surgical disease, yet it continually presents for diagnosis from injuries and wry-neck, caries of the cervical spine, reflex spasm from throat inflammation, irritations of the spinal accessory nerve, abscesses, et cetera. So-called rheumatic myositis comes on acutely, sometimes after exposure to cold, with pain and soreness in the muscles at the side of the neck, worse on movement, even to excruciating pain from the slightest attempt to turn the head. It may continue for several days or a week or more, gradually subsiding. It is relieved by fixation of the head to put the muscles at rest; by rest in bed, which partially does so; by dry heat; more promptly by the use of the Paquelin cautery in a small patch over the affected area; by the static spark; sometimes by gentle massage, anti-rheumatic medication, and quinine.

OTHER FORMS OF WRY-NECK (TORTICOLLIS)

Wry-neck may be associated with hematoma of the sternomastoid, rheumatic myositis, caries of the cervical spine (see Sections on those topics); or caused by a congenital shortness of the sternomastoid muscle, and often with it malformation of the cervical spine; by acquired contraction of the sternomastoid or

the trapezius or the splenius muscles and perhaps the fasciæ of one side of the neck; and by muscular spasm through reflex irritation of nerves resulting from inflamed glands, or the like.

In all cases excepting those associated with cervical caries, the head is abducted on the affected side and rotated so that the chin points in the opposite direction. This position may be constant, or in some reflex and spasmodic cases, intermittent.

Treatment.—In all secondary and reflex cases the primary cause should be treated. In the chronic cases, massage, stretching of the contracted tissues by gymnastics, head suspension, carrying weights in the hand of the affected side while the head is held erect, are among the methods of treatment. Corrective apparatus may be worn. This may consist of a belt around the thorax and another around the head, the two being connected by an artificial muscle of rubber or coiled spring attached upon the sound side so as to draw the head over; or it may be in the form of a jacket with head support under chin and occiput, such as is used for cervical and high dorsal caries; or it may be a leather or felt collar resting upon the shoulders and holding the head in position approximating the normal. If the condition does not yield to a fair trial for a few months of these means, the unyielding tissues must be divided. Most often the sterno-mastoid is at fault. Its tendons may be cut, near their clavicular and sternal attachments, by either subcutaneous or open tenotomy. The latter is preferable. The head is then maintained in corrected or over-corrected position by rest in bed with sand bags to the head, by fixation apparatus, usually a gypsum jacket extended to the head, until healing is complete. Apparatus may be, but frequently is not, longer necessary.

PRIMARY PROGRESSIVE MYOPATHY

Pseudo-hypertrophic Muscular Paralysis (*Muscular Pseudo-hypertrophy; Lipomatous Muscular Atrophy*) is very often described with diseases of the nervous system. But all that is yet known of its pathology would place it among the myopathies, an idiopathic atrophy.

Etiology.—Nothing is known intimately of the causation of this disease. There is often a history of heredity, the disease being usually transmitted to the males by the female line. Yet there are cases not hereditary, and families in which girls also are affected. The disease may first be noticed when the infant should begin to learn to walk, or in childhood, or in youth, usually before the ninth year, possibly not until puberty.

Pathology.—The post-mortem findings are all in the muscles. Connective tissue is increased, while muscle tissue has been replaced by fat. The muscles which were at first hypertrophied have

shrunken as the disease advanced. So extensively has the change taken place that the muscles present to the naked eye a yellow color as though composed entirely of fat. The microscope may find remains of muscle fibers and be able to detect in part their striation. The remaining fibers vary greatly in their diameter, and this variation is very irregular, narrow and wider fibers being intermingled in the same muscle. There are no changes found in the brain or spinal cord, nor yet in the nerves.

Pathologists have not agreed as to the nature of the disease. Some consider it essentially an inflammation resembling many interstitial inflammations in which there is a resulting increase of connective tissue with degeneration or atrophy of the other cell elements. Others consider it an expression of faulty development by overgrowth of connective tissue at the expense of the muscle tissue.

Symptoms and Diagnosis.—Slowness in learning to walk, or in older children weakness in walking or in going upstairs, are early symptoms. This condition may continue for weeks without additional symptoms. In fact, the whole course of the disease is chronic, all the changes coming very gradually and persisting for months and years. With the appearance of weakness or after it may be noticed that some of the muscles are enlarging, especially those that seemed weakest. The muscle changes are bilateral. The muscles of the calves are most frequently and most markedly affected, sometimes those of the gluteal region or of the thighs. The spinati, infra- and supra-, are next in order, and the deltoid. The pectoral muscles and the latissimus dorsi are not usually enlarged, though often wasted (see Figs. 37 and 147); but cases have been reported in which the latissimus dorsi also were enlarged; also the biceps, triceps, and sterno-mastoid. It is said that the pectorals are the only muscles, not even excepting the heart, that have never been found enlarged. The muscular hypertrophy is gradually succeeded by a process of atrophy, beginning in the upper extremities and leaving the calves until the last. In some cases the atrophy of certain muscles is present from the first and goes on simultaneously with the hypertrophy of those before mentioned. The atrophy usually begins in the pectorals, and successively affects the latissimus dorsi, the trapezius, the serratus magnus, the extensors of the back, and the thigh muscles. Finally every voluntary muscle in the body may undergo atrophy although the muscles of the hand are generally spared.

The appearance, attitude, and movements of a well-developed case are very peculiar and characteristic, being especially marked in those cases in which atrophy of some muscles is present with hypertrophy of others. The patient stands very insecurely, with his

feet wide apart, his abdomen projecting forward, his spine in lordosis, his shoulders thrown far backward. In walking he brings his center of gravity over one thigh, swings the other limb forward, then sways the body over the other thigh, and repeats the movement. The movements of rising from the horizontal to the erect position are most peculiar and pathognomonic. Owing to the weakness of the extensors of the leg, the patient is unable to raise his whole weight by extending the lower extremities. On account of the weakness of the extensors of the back he cannot raise the trunk by them alone. He divides the weight between the extremities by getting upon " all fours," hands and knees first, then raises the hind quarters by extending the legs. Then to raise the trunk he brings the hands to the ankles and by grasping them and alternately raising the hands and grasping the lower extremities a little higher and higher, he straightens up. Different cases will present variations in movements according to the involvement of various muscles. As the disease advances the patient will not be able to stand, rise, nor even to stand when placed upon his feet. In advanced cases there are deformities as a result of the immovable contraction of muscles. One of the commonest is that the ankles are flexed, holding the foot in a position of talipes equinus. The

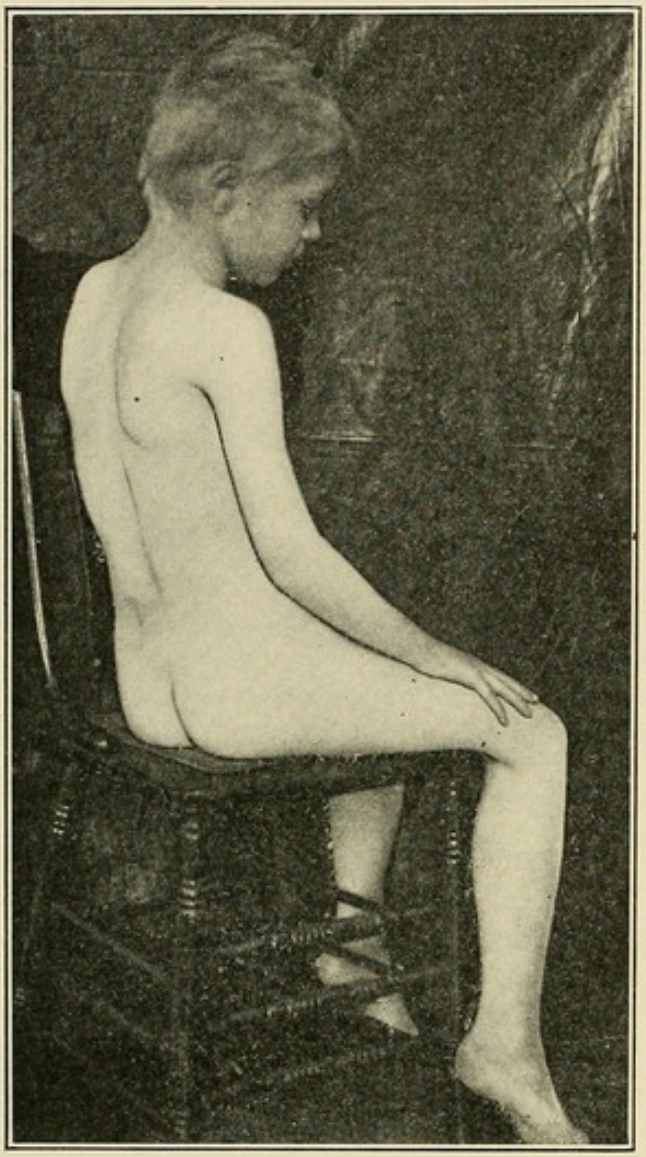


FIG. 37. PSEUDOHYPERTROPHIC MUSCULAR PARALYSIS, well developed in a boy of 12 years. Note enlargement of muscles of the calves, the gluteal regions, and of the infra-spinati, and the wasting of the deltoid and latissimus dorsi. Boy cannot stand nor even rise to the sitting posture.

knees are apt to be bent, fixing the legs at a right angle with the thighs. The biceps may keep the forearm rigidly flexed.

Accompanying symptoms are occasionally reported, such as optic neuritis with atrophy of the disc, myotonia congenita, and epilepsy. Also cranial asymmetry. But there is no constant connection between these conditions and the disease in question. More usual accompaniments are mental weakness or slowness, and imperfections of speech. It is sometimes difficult to tell whether the speech difficulty is from a central cause or from implication of the muscles of the tongue.

The tendon reflexes are but slightly affected at first, but gradually disappear as the disease advances. Likewise the electrical reactions, both galvanic and faradic, are found normal at first, but lessen with the progress of the case. However, they never exhibit at any stage the reaction of degeneration. There are no fibrillary twitchings and no disturbance of sensation. Mechanical irritability is lessened.

In this almost helpless state patients linger for years, increasing in weakness with the atrophy of muscle tissue, and increasing in deformity. The disease may progress more slowly if puberty is reached. Few, if any, ever reach adult life.

Prognosis and Treatment.—The prognosis is invariably hopeless. Electricity has been recommended to possibly arrest the disease, but the results scarcely justify the claim. Massage may somewhat modify the rigidity of the contractions, and gymnastics will aid to retain some use of the disabled muscular system. Tenotomies (followed by plaster casts) may be done if contraction deformities interfere with the comfort or the care of the patient, or if a degree of usefulness of the limbs will be prolonged thereby.

The Juvenile Type and the Peroneal Type.—There are two other forms of primary muscular atrophy, which are so similar to each other and to pseudo-hypertrophic muscular paralysis, that it is not definitely settled whether they may not be only variations of the same disease.

The juvenile type or "Erb's juvenile form," sometimes called the scapulo humeral type, may also be hereditary. It begins in childhood or youth, not congenitally or in infancy. The atrophy is limited to the muscles of the shoulder and upper arm, the gluteal region and the thigh. The muscles of the legs and feet, hands and forearms, remain unaffected or slightly hypertrophied. Thus the distribution of the paralysis is different from that of pseudo-hypertrophic, and also there is generally no marked hypertrophy. There is no reaction of degeneration, and no fibrillary twitching. The knee-jerks are absent or diminished.

Facial Scapulo-humeral Type.—There has been described,

notably by Landouzy and Dejérine, what appears to be a subvariety of the scapulo-humeral type, also called "progressive muscular paralysis of childhood" (Duchenne), and also as the infantile facial type. In this the phenomena are the same as those presented in Erb's juvenile form, with the addition that the muscles of the face are affected. The effect of the disease upon the orbicularis oris is to allow the mouth to remain always open. As the lips are thickened, and all the remaining muscles of the face, excepting the levators of the angles of the mouth, are atrophied, there is a peculiar pouting expression which is called the "tapir mouth."

Peroneal Type.—In this form of progressive muscular atrophy the wasting begins in the extensor longus hallucis, then the extensor communis digitorum and the peroneal group. The small muscles of the foot are next affected, and some think the small muscles even precede the extensors and peroneals in the atrophic process. Some time, perhaps years later, the calf, and especially the thigh muscles, beginning with the vastus internus, waste in a similar manner. After a pause of several years atrophy begins in the muscles of the hand, and then in the extensors of the forearm. Later the pronators and supinators of the forearm are attacked. The supinator longus, the muscles of the arm, shoulder, neck, face and body, remain unaffected. This disease is like the preceding myopathies in that a hereditary influence is apparent, and that more boys than girls are afflicted. Its chronic course, its paralysis and its resulting contractions are also similar. It differs not only in the succession of the muscles attacked and in their grouping, but in the fact that the reaction of degeneration and also in most cases fibrillary twitchings are present. Authorities differ widely in their opinions on the true etiology of the peroneal form. There seems to be a considerable weight of evidence that it is due to changes in the ganglion cells of the anterior horns of the lumbar cord. Some hold it probable that the type is not constant and that there are here grouped cases due to various causes, myopathic, neuropathic, myelopathic. Medical treatment is unavailing. Surgical treatment consists in operations upon tendons for the relief of contractions and the application of splints and braces, as will be described in the sections on tendons, infantile paralysis, and the lower extremities.

TENDONS AND THEIR SHEATHS

Tendons and their sheaths in children are doubtless subject to all the ills that afflict similar structures in older persons, although gonorrheal and gouty teno-synovitis must be very rare. But there are two inflammatory states that are common enough to require special mention, namely, acute teno-synovitis and acute purulent teno-synovitis.

Acute Teno-synovitis is caused by over-use of the tendons, especially with subsequent exposure to cold, and in rheumatic subjects. One has seen it follow excessive piano practice, the game of tennis, and the like. A common seat is the extensor and supinator tendons of the forearm, especially those of the thumb, and the tendo Achillis.

Symptoms.—The symptoms are more or less swelling over the course of the tendon, with tenderness on pressure, moderate pain when the part is at rest, but more severe pain when the tendon is put into action. On moving the tendon there is a "rub" or very fine crepitus noticeable. There is considerable lameness or stiffness after rest, which wears off somewhat during exercise to return again during rest. The inflammation produces a fibrinous exudate upon the inner surface of the sheath, which gives rise to the friction, dry at first, but there may be a considerable serous effusion.

Treatment.—Treatment consists in rest, often best maintained by a light splint applied outside of a wet towel. Hot or cold water may be used as seems most grateful, usually cool water when the part feels hot, and hot compresses and douches later. Liniments of belladonna, iodine, chloroform, or soap may be used.

Acute Purulent Teno-synovitis.—This may take place in any tendon sheath. The same facts concerning the disease and the same principles of treatment are applicable wherever the trouble is located. But it is so common in the hand, and so many hands have been impaired or even ruined for life by it, that by describing purulent teno-synovitis in this member attention will be directed to the importance of what at first seems a small matter. Infection may gain entrance by way of the blood, but very often it results from a wound, a crush, or more superficial infection in proximity to the sheath. Having set up an inflammation in the sheath, there is pain, swelling and tenderness locally in its course, and the usual constitutional symptoms of sepsis. Instinctively the finger or the whole hand is held in the position of semi-flexion in order to relax tension upon the tendons and within the sheath.

The inflammation may extend from one separate tendon sheath to another by involvement of the intervening tissues; but it will spread far more certainly and rapidly along a continuous sheath. Reference to Fig. 38 will be a reminder of the usual arrangement of the sheaths of the flexor tendons in the hand and forearm. The sheaths of the index, middle and ring fingers end near the meta-carpo-phalangeal joint; but those of the thumb and little finger extend into the palm and wrist. Therefore, infectious inflammations of the sheaths of the thumb and little finger are especially dangerous. When infection gains entrance to a tendon-sheath its walls become infiltrated, pus accumulates. The tendon itself

becomes infiltrated and edematous, its inter-fascicular tissue suppurates and separates its fibers. The tendon and the sheath may be

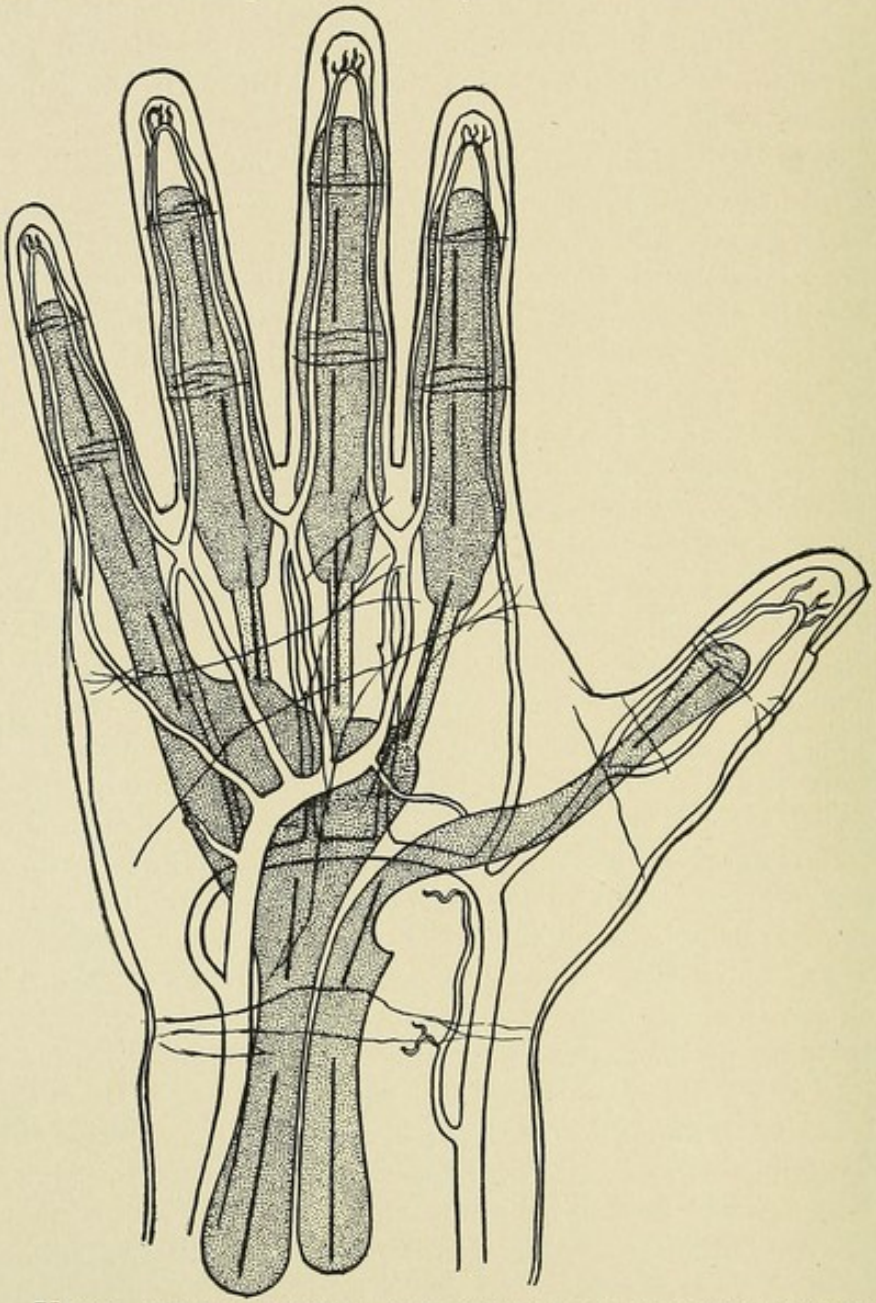


FIG. 38. USUAL ARRANGEMENT OF THE SHEATHS OF THE FLEXOR TENDONS OF THE HAND AND FOREARM. The sheaths of the index, middle and ring fingers end near the metacarpophalangeal joint; but those of the thumb and little finger extend into the palm and wrist, thus increasing the danger of extension of infectious inflammation in these sheaths. The stippled areas show the sheaths. The wavy lines indicate the position of the vessels and with them are the nerves. The straight, heavy lines show where incisions can be made safely and to the best advantage for drainage.

destroyed if left until the pus finds exit spontaneously by bursting through the sloughing tissues. If the infection gets into the palm and wrist it may not even stop there but extend into the forearm.

Treatment.—As soon as the diagnosis can be made, the affected sheaths should be opened freely. In Fig. 38 the double wavy lines indicate approximately the position of the vessels and nerves, and the heavy straight lines show where incisions can be made safely and to the best advantage for drainage. It is not enough that an opening is made into the inflamed sheath; the opening should be throughout its entire extent. The hand should then be soaked in a bath of mercuric bichloride 1-2000, or other antiseptic, and dressed with a hot, wet antiseptic gauze compress surrounded by oil-silk and a bandage, and supported on a splint. If it be the thumb or the little finger that is infected, or if it be in one of the first three fingers and the case is far advanced, the attention should not be limited to the phalanges; the palm of the hand and wrist should also be carefully explored and if infected should be at once opened and drained. It is necessary to drain the entire infected area, even if the openings must go into the forearm. This would only occur in neglected cases or in cases timidly treated, which is the same thing. If the infection has extended through the palm and the back of the hand is swollen and boggy, it must be incised, and a rubber drainage tube passed through. If the abscess is deep in the palm, rubber drainage will be necessary, and will allow of irrigation till the discharge lessens, when cigarette drains of rolled rubber tissue may be substituted and are less likely to press unduly. Even when abscess is evacuated before the tendon has suffered severely and the best treatment is followed, the result will show adhesions of tendons and sheaths, scar tissue and contractions, which will appear disappointing to the patient and his family. However, there will be great improvement with use of massage and passive movements persistently carried out, and the result will be infinitely better than if a Fabian plan of treatment had been followed. Somewhat recently the Bier-Klapp method of inducing passive hyperemia has been applied with good results in these inflammations of infectious origin. (See also Sections on Septicemia and The Treatment of Arthritis.) The hyperemia is induced either by constriction of the limb above the inflammation

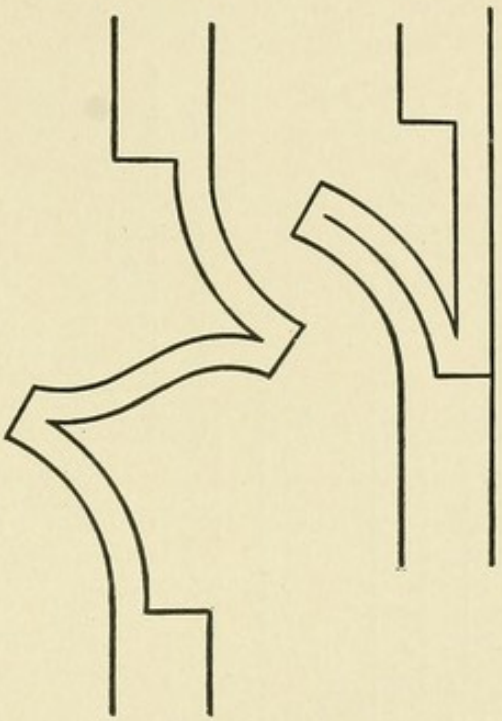


FIG. 39. HIBBS-SPORON METHOD OF TENDON LENGTHENING.

or by cupping. Hyperemia is carried only to the point of redness or slight bluish redness, never causing either blueness, pain, coldness, nor numbness. Constriction for an hour, or suction for five minutes followed by rest for three minutes during twenty to forty-five minutes once or twice a day, is regarded as sufficient. If pus is present or edema threatens necrosis, incision or punctures should precede the constriction or suction treatment.

RHEUMATIC TENDINOUS NODULES

In the hospitals and dispensaries of England, Scotland, and Ireland, one's attention was frequently drawn to small nodules in the line of the extensor tendons of the fingers or hands or about the insertion of the triceps at the elbow. They could also be found upon the spinous processes of the vertebræ, upon the patella, and the subcutaneous tendons near the maleoli. The nodules vary in size from a pin's head to a split pea or even larger, and are quite hard. They are most easily seen upon the backs of the hands and the spinous processes and at the maleoli in a thin child. They are said to be composed of fibrous tissue, and considered a manifestation of the rheumatic condition, coming and going at intervals in company with other rheumatic symptoms. The nodules are usually in numbers and remain for weeks or months and disappear spontaneously or perhaps as a result of anti-rheumatic treatment.

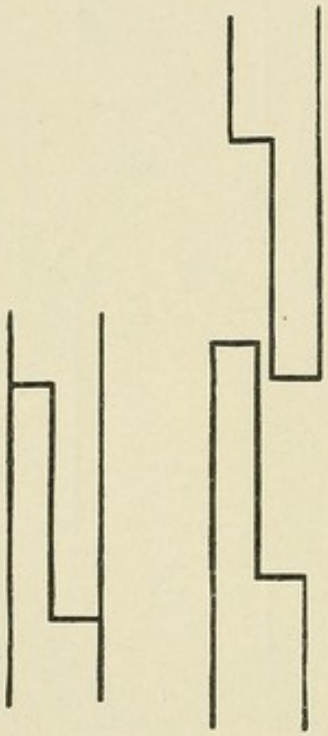


FIG. 40. ANDERSON'S METHOD OF TENDON LENGTHENING, showing the line of the incision and the extent to which the ends may be separated before they are sutured together.

INJURIES OF TENDONS AND THEIR SHEATHS

Injuries of tendons and their sheaths are common and should always receive careful attention. Spontaneous rupture is rare if it ever occurs in children. Division by accidental injuries are frequently met. Such injuries should always be immediately repaired, the severed ends of tendons united, and, if practicable, their sheaths neatly closed, all under the strictest antiseptic precautions. The dangers of in-

fection of tendons and their sheaths is very great. (See Section on Purulent Teno-synovitis.) The repair of injured tendons is conducted upon the same principles as apply in operations of election upon tendons. These are so frequently necessary in the correction of deformities that we will now consider the subject in a general way.

OPERATIONS UPON TENDONS

Tendon Lengthening.—It is necessary to lengthen tendons when from congenital deformity, or injury, or such diseases as paralysis, spastic paralysis, or contractions resulting from chronic joint diseases, they are too short to allow a natural position or function of the parts. Also in the operation of transplanting when a tendon is not long enough to reach the point of implantation. A tendon may be lengthened by simple section within its sheath—linear tenotomy. Lengthening results by separation of the divided ends and the organization of the blood-clot which fills the gap between them. This new portion will be mainly composed of scar tissue and a few fibrils of tendon tissue, and answers the purpose of the tendon. This fibrous tissue in some instances will undergo a degree of stretching; and yet this method of lengthening has yielded satisfactory results in thousands of instances. Tenotomy can be done by two methods, the subcutaneous and the open. In either method strict antisepsis is imperative.

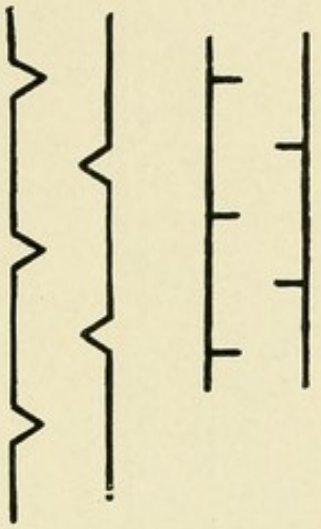


Fig. 41. Poncet's method of tendon lengthening.

Subcutaneous Tenotomy.—Small, narrow-bladed tenotomes are necessary for this operation. They are either sharp or blunt pointed, and straight, bellied, or concave upon the cutting edge. No Esmarch is used. The left index finger or thumb of the surgeon touches the tendon and tests its tension which should be only moderately firm. The sharp-pointed tenotome held flat is inserted at one side of the tendon to be cut, the sheath of the tendon is pierced, and the blade thrust either above or below it at the choice of the operator. The edge of the knife is then turned toward the tendon and the latter is cut through with a careful sawing movement. The left hand as well as the knife-hand feels the yielding of the tendon. The knife is withdrawn at the small wound of entrance. The tendon should not be put too much upon the stretch as the cut is finished. Some operators prefer after piercing the sheath with the sharp tenotome to withdraw it and insert the round-pointed blade

as being less likely to injure a vessel or nerve or to pierce the skin after severing the tendon. Some prefer to cut downward through the tendon, and some to insert the blade beneath the tendon and cut outward. The latter is probably the safer way when there are vessels and nerves in proximity. The wound is immediately covered with a small pad of iodoform gauze and a bandage, and a fixed dressing, usually plaster of Paris, is applied.

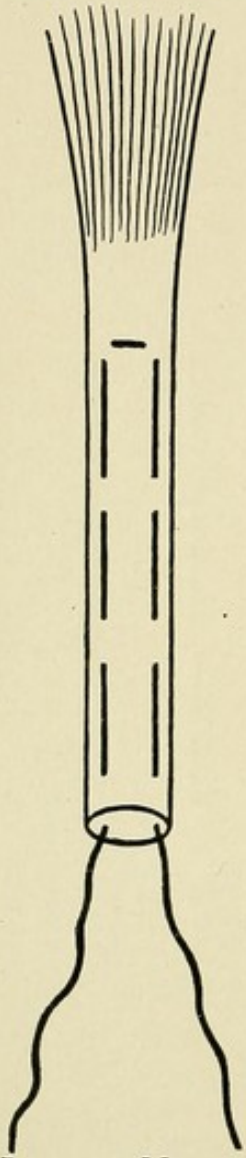


FIG. 42. METHOD OF INTRODUCING STRONG SILK TO ACT AS A TENDON FOR PERIOSTEAL IMPLANTATION, in tendon lengthening.—Bryant and Buck's American Practice of Surgery.

The advantages of the subcutaneous method are that the small wound gives little chance for infection, and there is scarcely any scar to look unsightly, or, what is more important, to contract, to chafe, become painful or break down under pressure. The disadvantages are, the possibility of injury to a vessel or nerve, or other surrounding structure, or of not making a smooth and complete cut of the entire tendon. (17)

The Open Method.—If operating upon an extremity the Esmarch bandage is usually, though not invariably, employed. By this method an incision is made parallel to and a little to one side of the tendon. The sheath is opened and the tendon being exposed to sight by sharp and blunt dissection, is divided. If the tendon cannot be isolated, or it is not desirable to dissect under it, the wound should be retracted so as to expose it plainly to view. It can then be divided carefully by small cuts with the knife. The tendon sheaths and the skin wounds are each closed with sutures. The advantages of the open operation are that it is all under the guidance of the eye, which is safer, especially in certain situations.

The disadvantages are, that with the larger wound there is greater opportunity for sepsis and a larger amount of scar tissue.

Many other methods of tendon lengthening have been devised and practiced, with the object of retaining tendon tissue throughout the lengthened portion, and obviating scar tissue. They are performed through an open wound. Most of them require suture of the split or partly divided tendon. The Hibbs-Sporon method

has the advantage of requiring no suture. (See Fig. 39.) Through an open incision the tendon is isolated, raised upon two blunt dissectors and split with a narrow-bladed knife as shown in the diagram. By the Anderson method the tendon is split, slid and ready to be sutured, as shown in Fig. 40. This is one of the simplest and best methods. Fig. 41 shows Poncet's method—by nicking the sides of the tendon. It allows considerable lengthening, but has a great many points for subsequent adhesion to the sheath. There are many other methods of lengthening by splitting and splicing. There is a method of augmenting the length of a tendon by introducing a cord of silk or chromacized catgut, to reach from the end of the short tendon to the desired point of attachment. This graft, as it is called, constitutes a kind of " false work " upon which a bridge of tendinous and fibrous tissue is constructed by the reparative processes of nature. The silk or catgut finally disappears or is cast off. Fig. 42 shows this method.

Tendon Shortening is indicated in the relaxation which results from paralysis, or a somewhat similar condition from disuse, as in joint disease and the like; or overstretching of tendons from spastic contractures of antagonistic muscles; or in flail-joint, where all the tendons about the joint are relaxed; or in tendons overstretched from injury; or to fit the requirements of the case in tendon transplantation. Tendons may be shortened without sacrificing tendon tissue by simply puckering with a drawstring, or by looping and suturing; or by removing only a part of the thickness of the tendon and then looping and suturing; or by splitting the tendon and then looping each half separately and suturing, as seen in diagrams in Figs. 43 and 44.

Tendon Transplantation may be employed when the function of a muscle has been lost, usually through paralysis in some form, or when one muscle or group of muscles has been overpowered by another muscle or muscle group. Poliomyelitis presents frequent cases. Meningitis and hemiplegia are much less frequent contributors. If ample muscular power is within reach and can be spared, or a part of it can be spared, from its normal situation, tendon transplantation may transfer it to the point of need. Accident may destroy muscle or tendon beyond repair and leave a condition remediable by transplantation. Deformity of joints from chronic inflammations with flexion contractions have afforded opportunities for tendon transference. Also the over-stretching of tendons in congenital club-foot; in syringomyelia and in other more rare conditions. Some advise strongly against transplantation in case of only partial paralysis, considering tendon lengthening or shortening or the use of braces and massage more likely to give good results. In no case should transplantation be considered until all hope of

recovery without it is past. Otherwise the operation, even if successful for the present, is not only unnecessary but positively harmful. Transplantation may also be useful to correct deformity even without restoring function, for instance, when joint disease has resulted in contracture of the flexors at the expense of the extensors. Every case should be carefully studied to ascertain which muscles have lost their function and which can be utilized to substitute them. There is more danger of failure through error in judgment upon the selection of cases for operation or the choice of the tendons which should be transplanted than through sepsis or failure of union. This task of precise examination of each muscle and muscle group is not easy of accomplishment in young children.

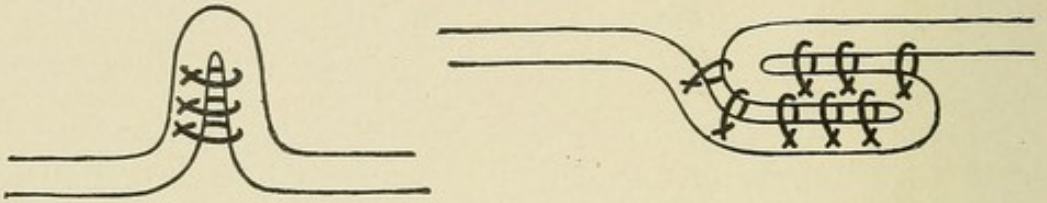


FIG. 43. METHOD OF SHORTENING TENDONS by looping.

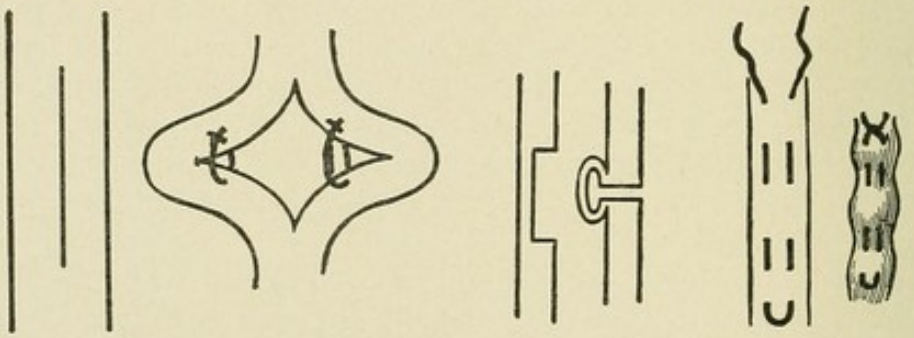


FIG. 44. THREE METHODS OF TENDON SHORTENING.—Binnie's Manual of Operative Surgery.

Electrical tests are practically useless. Infants and children cannot or will not execute voluntary movements at our bidding. We must watch their voluntary movements or play with them in such a way as to elicit the movements which will enable us to judge of the power of individual muscles and groups, and to carefully plan the work that is to be undertaken.

If there is deformity it should be corrected if possible before the transplantation, allowing time for recovery from the operation of correction. But if the correction of deformity necessitates the cutting of tendons that will be used in the transplantation, the operations of correction and transplantation may be done at the same sitting. (Vulpius.)

However, the correction should take precedence, so that the proper degree of tension can be secured for the transplanted tendon in its new situation. The transplanted tendon should be upon the stretch when it is fastened in its new situation.

The donating tendon should take the shortest possible route to the receiving tendon or point of insertion. This route may often be made by tunneling with a grooved director or by a blunt dissector from the incision which exposed the donating tendon to the separate incision at the point where it is to be united with the re-

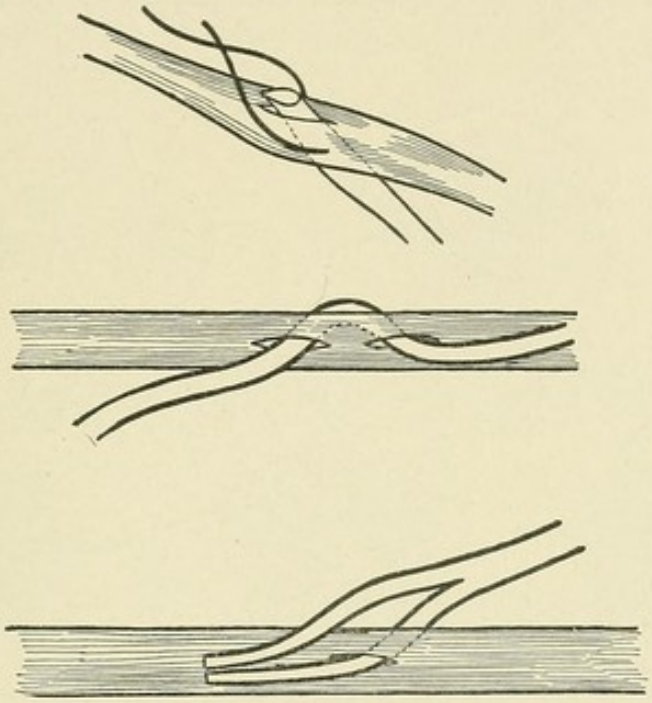


FIG. 45. DIFFERENT METHODS OF TENDON TRANSPLANTATION.—Vulpius.

ceiving tendon. Angles should be avoided. Sometimes the whole of a donating tendon is not transplanted, but only a portion of it is split off for that purpose. And if it is not long enough to reach to the desired point, in certain situations the muscle as well as the tendon may be split (by dry dissection in the line of its fibers), giving each portion of the split tendon that portion of the muscle which belongs to it.

Incisions for the purpose of exposing tendons should never be made directly over the tendon, but at one side of it, and so near that the parts may be slid over the field of the deeper work. Flap formation should be avoided, as it favors the formation of cicatricial tissue and contractions. The incision in the tendon sheath should not be directly under the skin incision.

In splitting up tendon and muscle, the fascia should not be divided near the bone, and it is not necessary to divide the fascia through the entire length of the skin incision. An interrupted in-

cision can be made in the fascia, through the openings of which the dissector can work. This leaves bridges of fascia, which aid in adjustment and in union.

A normal muscle tendon can be transplanted to a paralyzed muscle tendon. Or it can be attached to bone (strictly speaking, to periosteum). The sound tendon can be united to the paralyzed without loosening the attachment of either, or by cutting the paralyzed tendon and attaching it to the sound tendon; or by cutting both and attaching the proximal portion of the sound tendon to the distal portion of the paralyzed tendon; or by splitting off portions of one or both tendons and uniting them. The diagrams in Fig. 45 illustrate various methods of transplantation.

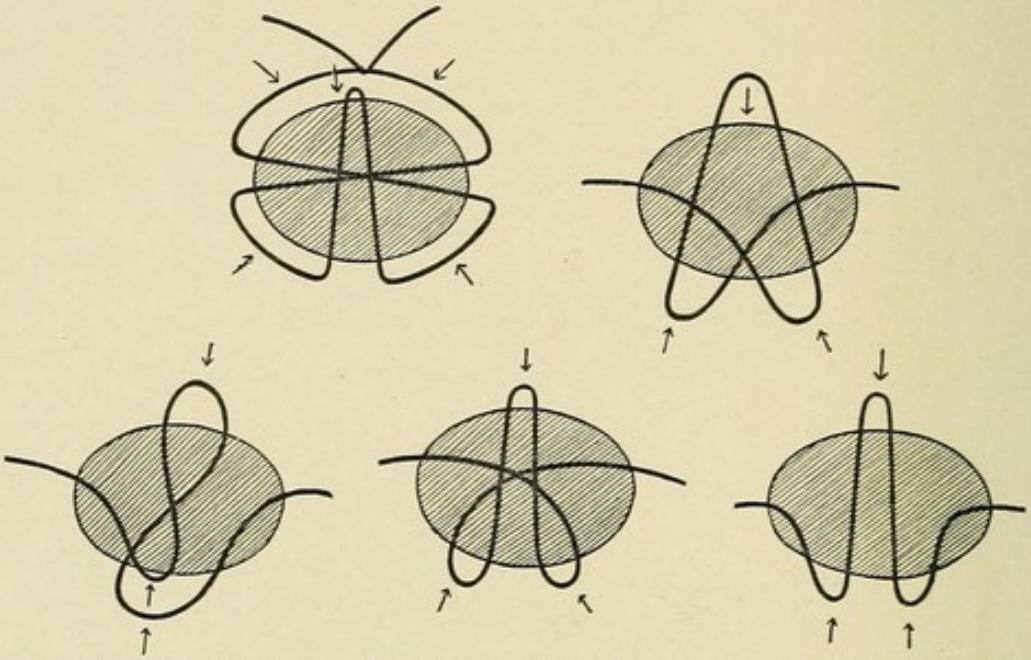


FIG. 46. DIFFERENT WAYS OF INTRODUCING SUTURES INTO TENDONS SO THAT THEY WILL NOT CUT OUT. The arrows show the direction in which the thread should be drawn.—Suter, Archiv. f. Klin. Chir. 1903-4.

TENDON SUTURING.—All operations on tendons should be done under the strictest antiseptic rules, and all open operations with the Esmarch constrictor. Round needles are better for tendon sutures, though any shape may be used. Any of the usual suture materials can be used, but silk and chromicized catgut are most frequently chosen.

As tendons are easily split longitudinally by division of their component fibers, various methods have been devised for using the sutures so as to obviate their tendency to tear out. Figs. 46, 47, and 48 illustrate better than pages of description some of these methods. When the ends of tendons are approximated laterally the final result after union is as smooth as that by end-to-end suture,

If the cut ends of the tendons will not meet, the gap is bridged with a few strands of suture material, preferably chromicized catgut or kangaroo tendon, or silk and catgut both, as described in tendon lengthening.

Tendons may be attached to bone by raising a flap of periosteum at the desired point of attachment and suturing the tendon to that; or by raising the flap of periosteum, guttering the bone underneath it, placing the tendon or graft in the gutter and replacing the periosteal flap with sutures through both the tendon and the periosteum to hold them in place. As a rule, attachment to periosteum is more satisfactory than attachment to paralyzed tendon, as the latter is apt to stretch.

After suturing the tendons, the wound should be closed without drainage. It is not usually necessary to suture the opened

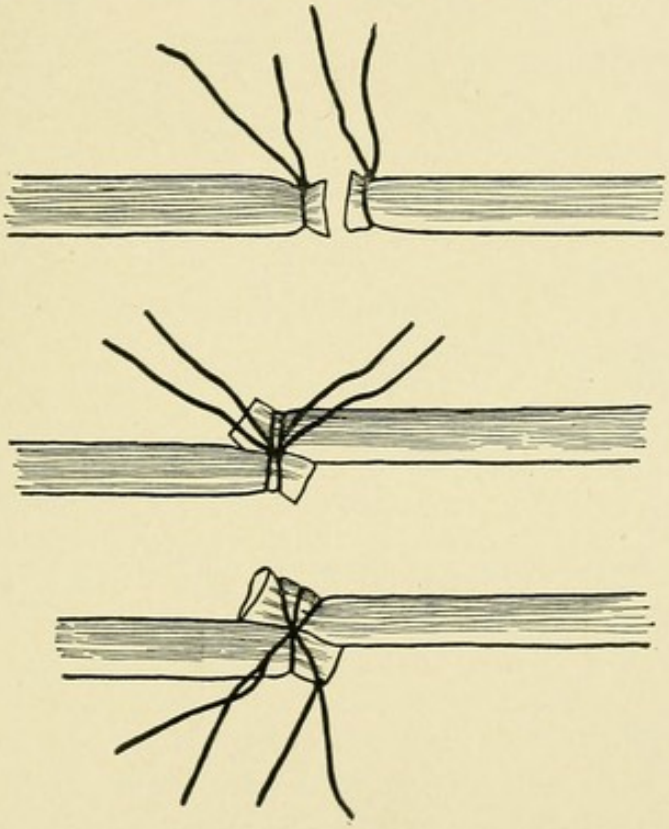


FIG. 47. SUTER'S METHOD OF UNITING THE ENDS OF TENDONS.—Archiv. für Klin. Chirurg. 1903-4.

tendon sheath. Fascia and skin are sutured separately. The skin should not be too tense. Iodoform gauze, sterile gauze and bandage follow, and a plaster of Paris bandage over all, with the parts in such position as to relax the tendon. If all goes well, the first dressing is not disturbed for three to four weeks. If union is satisfactory, massage, and later passive movements will aid in grad-

ually establishing function. The special indications for these operations will be pointed out in the consideration of various deformities.

In general, it may be said of tendon transplantation that although scarring is unavoidable, functional results are good if a wise arrangement of the transplantation is chosen. It is practically useless to expect to get a result that is worth the effort and the risk of the procedure by transplanting a weak muscle to take the work of a once powerful muscle.

Results are most satisfactory when a sound muscle from the same group as that of the paralyzed one is available for transplant-

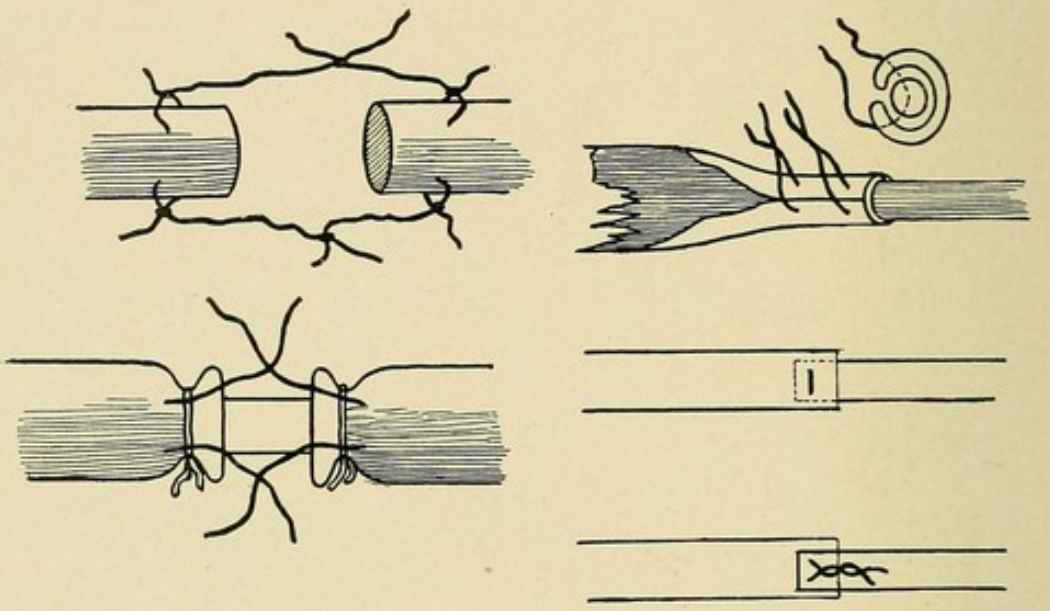


FIG. 48. VARIOUS METHODS OF SUTURING TENDONS. Binnie's "Manual of Operative Surgery."

ing. The result should at least hold the joint midway between flexion and extension, and therefore correct deformity and give movements which are normal in their direction if not in their power or extent. In spastic cases relief from spasm may be expected. It is the opinion of men of experience that transplantation of tendons has been overdone in very numerous instances. However, this is apt to occur in the history of any operation, and one can only insist upon very careful preliminary study of the case before any operation is undertaken.

FASCIÆ AND FAT-TISSUE[1]

Fasciæ are subject to all the injuries and inflammations that affect other tissues. Ordinarily the fasciæ receive less attention than they should in the repair of wounds. Care should be taken

[1] See also Section on Anatomy, Growth and Development.

to approximate severed edges. A breach in a fascia covering a voluntary muscle allows protrusion of a portion of the muscle—a muscle hernia. In suturing incisions or wounds in fascia, its lack of vascularity should be remembered; and also its frailness in the child. Sutures cut out, if placed near the margin of a wound; or if too close together, on account of the poor blood supply of this tissue, they cause pressure necrosis. Continuous suture should not be employed in fascia. As few sutures should be used as will serve the purpose, and they should be placed at sufficient distance from the margin of the wound and not too tightly.

Contraction of the plantar fascia is one of the features of many cases of club foot; and frequently must be dealt with by operation. The fascia is, of course, not the only offender in these cases, but its unyielding nature often makes the division necessary. It is often severed beneath the deep transverse crease across the sole, which usually shows in the cases in which the fascia needs division. Division at several points may be necessary before the foot is sufficiently released. It can also be divided a short distance anteriorly from the os calcis, or farther forward than the deep crease. The fascia is first made tense by the hand of the surgeon while he feels for the worst part of the constriction. The foot is then relaxed while a tenotome, held flat, is inserted at the inner edge of the fascia and passed across the foot between the skin and the fascia. The point of the tenotome should not emerge through the skin at the outer side, but only go as far as the outer edge of the fascia. The edge of the knife is then turned toward the fascia, which is now made tense, and is divided. The tenotome is withdrawn, the wound dressed with a small pad of iodoform gauze over the opening, covered with sterile gauze, bandaged with moderate pressure at the site of the section, and put up, usually in plaster of Paris, in an over-corrected position.

Fascia and Fat in Arthroplasty. Fascia with fatty tissue, have been put to novel use by Murphy and others, in the reconstruction of joints, or rather in the construction of a new joint where one has become ankylosed.[1] Langemak has pointed out that while in the formation of the joint in the embryo there is primarily no cavity, the cavity being formed by a splitting or liquefaction of cartilaginous or connective tissue between the cartilages, the superficial bursæ are made by a similar splitting between fat capsules on aponeurotic mesoblastic tissue. The bursa formation comes about by the absorption of fat from the fatty tissue and the coalescence of the small fat capsules with an increase or hyperplasia of the connective tissue and its degeneration, with the development of collagen. The liquefaction of the collagen in the center produces the

[1] Murphy: Trans. Amer. Surg. Assn., 1906, xxii, p. 315.

fluid in the bursa or hygroma. The cells (in reality transformed connective tissue cells) that line the newly developed cavity appear like flattened endothelial cells. Thus fat tissue readily changes to connective tissue and a part of this, under pressure takes on the appearance and duties of endothelium while a degeneration-product of the fat furnishes a solution which is "fibrinoid" and not a serous secretion. A similar process is seen in the formation of a hygroma in the false joint of ununited fracture (see Section on Ankylosis) (20).

BURSÆ

Wounds of bursæ are treated on general principles. Hematoma of a bursa may be due to trauma, or may arise with or without known trauma in hemophilia. It is usually not necessary to remove a clot unless it becomes septic. Bursæ may become inflamed either from trauma or from internal infection by ordinary pyogenic organisms, or the pneumococcus the gonococcus, the bacillus tuberculosis, the spirochetæ of syphilis and probably by other organisms. The disease may be acute or chronic, simple or purulent, according to the nature of the cause. The symptoms are pain, heat, tenderness and swelling localized at the site of a bursa or reflected therefrom. It is well to remember that bursæ may develop at other sites than those anatomically normal, where long-continued pressure or friction are brought to bear, and that such adventitious bursæ are especially liable to inflammation.

The treatment of the acute forms is similar to that described for teno-synovitis. In the tubercular form the bursa may be dissected out and the wound closed. Or the diseased bursa be entirely curetted out, swabbed with carbolic acid followed by alcohol, packed with formidine gauze, to heal by granulation. Hemophiliac hemorrhages into bursæ may be treated locally as simple inflammations.

CELLULAR TISSUES

The cellular tissues are the seat of ecchymoses and of hematomata as a result of contusions and in hemophilia. Ordinary extravasations from contusions and even some hematomata may clear up with the use of either cold or heat. But if a subcutaneous hematoma of large size does not show evidence of reabsorption in a week or two it should be cut down upon and evacuated, under antiseptic precautions, and the wound closed with the expectation of securing immediate union. If the patient is hemophiliac, operative measures should not be employed. Cephal-hematoma of the new-born requires operation in fracture, compression or suppuration.

The cellular tissues are very often the seat of infectious inflammations. (See Section on Cellulitis.)

CHAPTER VII

RICKETY DEFORMITIES

Genu Valgum (Knock-Knee)—Genu Extrorsum (Genu Varum)—Bow-Legs, Corkscrew and Saber-Legs—Rickety Deformities of the Forearms—Rickety Deformities of the Thorax.

GENU VALGUM (KNOCK-KNEE)

This is a common deformity among children, and when occurring in them, as it is apt to do, between the time of learning to walk and the fourth year, it is generally attributed to rickets. At a later period also, perhaps from the twelfth to the seventeenth or eighteenth year, knock-knee may develop. In this class of cases it is attributed to muscular and ligamentous weakness resulting from the overtaxed vitality of the adolescent period. We should not forget that rickets is a disease affecting the nutrition, not only of bone, but of cartilages, muscles, tendons and ligaments as well, and that it also lowers innervation and consequently muscular tonicity; thus it is not difficult to understand the method of the production of deformities. Any yielding of ligament to tensile stress, or slight overgrowth or undergrowth of cartilage that misplaces a limb from its center of stress, gives opportunity for further deformity when the weight of the body acts upon the deviated support. Suppose that a weak plantar arch, which is not reinforced by strong flexor tendons, allows the inner side of the foot to settle flat upon the floor, the tibia has lost a part of its support upon the inner side. This has a tendency to tilt the knee inward, lessening compressive stress upon the internal and increasing it upon the external condyles. This uneven pressure would cause the internal condyle to grow more rapidly and increase the lateral angulation of the joint. The origin of knock-knee has also been explained as due to obliquity of the attachment of the epiphysis to the diaphysis. Some consider it primarily an in-bend of the upper third of the tibia, or a bend in the lower part of the femoral shaft, and not caused by elongation or shortening of condyles.

It may be that the beginning of the trouble is not the same in all cases, and this is borne out by the fact that knock-knee may result from chronic joint or bone disease. In the usual case we find the inner condyle prolonged, while the lower end of the femur

curves down to it (see Fig. 49), the internal lateral ligaments being elongated. Most cases are accompanied by flatfoot. Sometimes one and again both knees are affected, or one knee may be valgous while the other is bowed. It is usual, too, to find other evidences

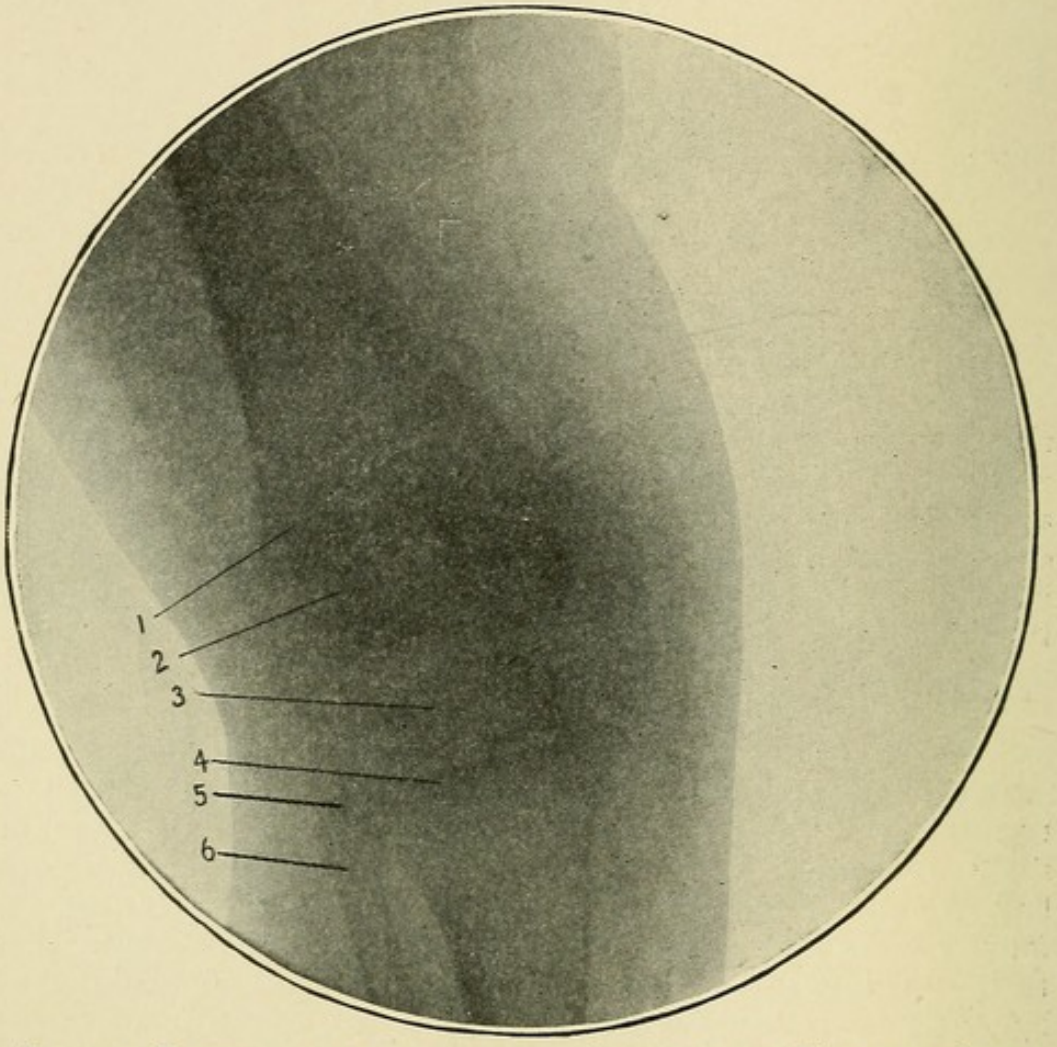


FIG. 49. RADIOGRAPH OF KNOCK-KNEE. Same case as Figs. 51 and 52.

of rickets in some part of the child's anatomy, and other relaxed joints, and to get a history of that plan of feeding and manner of living which induces rachitis. (See Section on Rachitis.)

Complete flexion effaces the valgous deformity, the leg lying directly behind the thigh, while the long projection of the internal condyle is very evident. On full extension the deformity is at its worst; the patella is almost over the external condyle and the excessive lateral motion of the joint exposes its weakness. The child will complain of pain and tenderness over the inner side of the knee, and of being tired, especially after he has been long on his feet.

Treatment.—Before beginning any treatment it is well to make

a record of the degree of deformity in order that improvement may be noted. By placing a large sheet of paper upon the table, laying the child with his limbs extended upon it, with a pencil held vertically, a tracing of their outline upon the paper can readily be made. In lieu of this the knees may be placed firmly together, and with the limbs fully extended the distance between the internal maleoli can be measured.

There are several plans of treatment from which to choose. There is the expectant plan for the indolent and optimistic. But the poor child has to take the unfortunate consequences. Some cases do improve spontaneously. However, the condition is more apt to get worse or remain permanent. So the expectant plan is not recommended. In the choice of treatment one is guided partly by the age of the patient. If he is quite young, say under four years, the deformity can probably be corrected without operation. That depends upon the degree of the deformity, but still more upon the pliability of the tissues under corrective measures and the response of the general health to improved nutrition and hygiene. An extreme degree of deformity may be the result of such soft and yielding structures that if the bones, particularly the inner condyle, have not firmly ossified in their faulty shape, correction may be more easily made than in a less marked deformity with rigid structures to deal with. With structures which are soft and yield readily, the best way to rapidly restore the symmetry of the limb is to take the child entirely off his feet and apply a padded, straight, flat splint to its outer side from the thigh to below the ankle, encircling the thigh, the leg, and especially the knee, with wide bands that by being buckled firmly draw the limb to the splint. If both limbs are deformed the splint may be placed between them or simply a cushion between the knees, and bands of leather or webbing to draw the legs toward the middle line. The bands should not be of elastic webbing. For a time the child may be kept upon his back with the limbs thus splinted and a sandbag or a back-splint to the limbs to keep them extended so that the correcting bands can exert their pressure in the right direction. The limbs and the back should be carefully bathed, oiled and massaged morning and evening, and handled and readjusted several times a day, while the child's diet and digestion and his general health should be carefully attended to. If one can secure faithful and intelligent care the deformity will promptly be removed and the patient can be allowed up and about again, with strength and development so much improved that with proper attention, even without the use of a light brace or of the splint at night, it will not return. The great difficulty in this plan is in securing faithful cooperation of the mother or nurse in following it out. The plea is

made that the child wants to be up and that it is impossible to keep him in bed, though finally the true reason is confessed that "It's too much trouble," and a demand is made for braces. Knock-knees can be gradually straightened by the use of braces, though this method is inferior, especially in young children. The brace or splint must start from a pelvic band of steel, extend down the outer side of the limb, having antero-posterior joints at hip and ankle and a lateral joint at the knee. The lower end is fastened to the shoe. In quite a few of these cases an arched metal insole, or sometimes careful strapping, is necessary to correct the flatfoot. Although in some cases, when once the knock-knee is corrected, the flatfoot, which often was a result of faulty weight-bearing, soon disappears. The knee hinge has a rack and pinion by which its angle can be straightened a little every few days. The thigh-, knee-, and leg-bands should be well padded, and the skin beneath them should be carefully kept sound. (See Fig. 50.) Another style of brace is made without a knee joint. It will probably be necessary to wear the brace a year or two.

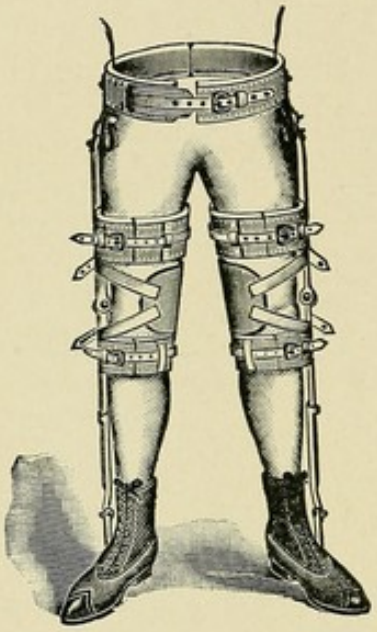


FIG. 50. PLAIN KNOCK-KNEE BRACE.

Instead of using steel braces, the knock-knee may be corrected by putting up the limb in a plaster bandage while it is held in the best position possible during the application of the bandage. The bandage should extend from the ankle to the perineum, and should be removed and replaced every ten days or two weeks. One dislikes to see the child meanwhile walking upon a flat-foot. The flat-foot can be treated at the same time as the knock-knee by manipulating it and, after correction, putting it up in plaster and then extending the plaster on up the limb to the perineum, while holding the limb as straight as possible. The rickety softness of the bones may change to the hardness of eburnation, which is as hard as adult bone, in from two to four months.

Operative Treatment.—In former years, in fact, no longer ago than 1885, when Mr. Edmund Owen wrote his admirable treatise, the *redressement force* of knock-knee was considered admissible under certain circumstances. With the child under chloroform, the surgeon grasps "the thigh in one hand and the middle of the leg in the other, and with his knee near or against the prominent angle of the extended knee of the child he straightents it gently yet firmly,

as he would a stick." Then the limb was put in straight splints. It was realized that no one could know exactly what happened during this maneuver; whether the inner condyle was pushed up or the external lateral ligaments yielded, or the epiphysis became detached. But this is the method we were taught and practiced at that time, until the pioneer work of Ogston, of Reeves and Macewen, under the protection of antiseptic surgery, demonstrated the safety and greater certainty of osteotomy, and forcible straightening was practically abandoned, although excellent results had been obtained by its use.

Since that time, too, there has been a gradual change of opinion and practice concerning the proper age for operation. As Owen records, Ogston was of opinion that most cases of knock-knee under puberty are curable without cutting operation; that Bacher would not operate earlier than the sixth year; that Macewen would not operate on any patient under nine years of age at the very least, and would prefer them to be fifteen or more; and Barwell would not operate before the seventh year. Nowadays four years is about the dividing line, so far as it can be indicated by age, between those who should be treated for knock-knee or bow-legs with splints or braces and those who should be subjected to osteotomy, or osteoclasis. Obviously the guiding principle should be to have the bone and other tissues so far ossified and strengthened that the results of an operation will be permanent, and that these results are such as could not be obtained without operation by any reasonable amount of treatment with braces. When it is found that a child at four or at five or six years relapses after correction by either braces or osteotomy, then it is known that the child did not need an operation, for the tissues yield readily without it, and the braces are a necessity after all to maintain the correction. The question is not answered by the age of the patient, but by the condition of the tissues, and this must be left to the judgment of the surgeon. One should not allow mere impatience for results to induce him to take even a slight risk of the patient's life or limb, or even of his own reputation. On the other hand, it is useless to burden a child with braces and his parents with endless work and annoyance in the care of them, after his bones have become hardened or even eburnated and his ligaments permanently elongated or contracted in a position of deformity. Nor should he be allowed through indecision or inattention to fall between two stools, and go without either braces or operation. There are cases five or six years old which will recover perfectly with a year or two of braces, and there are cases only four years old which ought to be operated. As a rule, if the strength of the surgeon's hands gently but steadily applied is not sufficient to bend the bones noticeably, they will not

yield to braces. In case of doubt, or of indecision on the part of the parents, a padded splint may be applied for a week or two, and the effect noted. No child in a depraved state of health or recently exposed to any contagion ought to be subjected to a bone operation, nor, for that matter, to any other elective operation.

Osteoclasis is not well adapted for work very near a joint. Osteotomy is the operation of choice with many surgeons, although some prefer osteoclasis. In osteotomy Macewen's operation

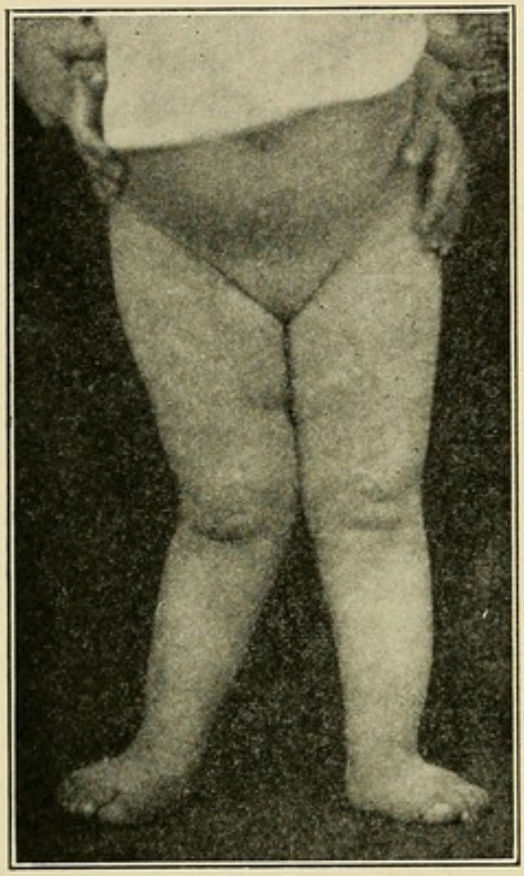


FIG. 51. KNOCK-KNEE. Aged 4 years. Case at Holy Cross Home.

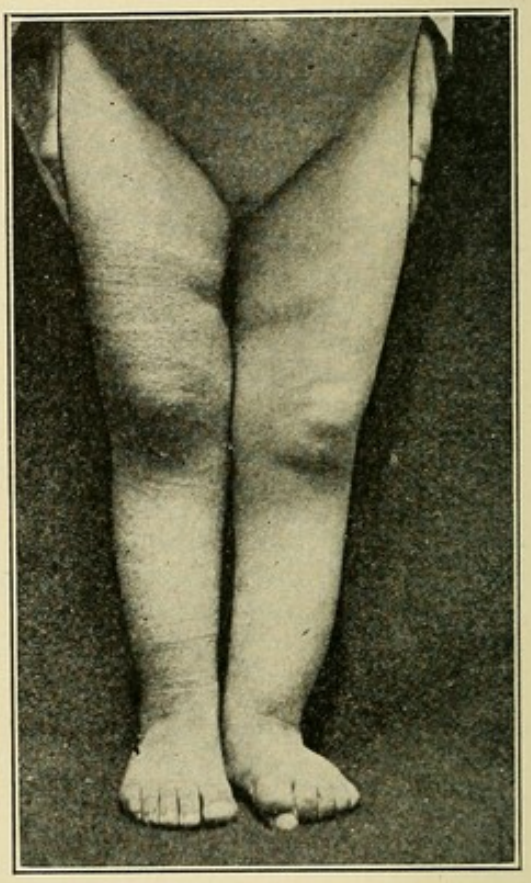


FIG. 52. Same case as Fig. 51, after osteotomy.

is the one most approved. Ogston partially divided the internal condyle with a saw, avoiding entering the joint, and then pushed up the projecting condyle by lateral traction on the leg. Reeves used a chisel instead of a saw. Macewen went above the epiphyseal line and partially divided the diaphysis with a chisel, so that it could be fractured across by straightening the limb. Macewen entered the osteotome from the inner side of the thigh. Many operators, myself included, prefer the outer side. There is really little difference (18). After careful antiseptic cleansing, the limb is Esmarched, flexed to a right angle, and the knee laid firmly on a sandbag. Some operators omit the Esmarch, and this is just as well, for there

is very little blood lost; and if by any possible accident a larger vessel is cut it will be known at once; and also, there is less oozing afterward. A longitudinal incision, about an inch long, just high enough to avoid injuring the epiphyseal line, is carried directly down upon the center of the shaft of the femur. Before removing the knife the osteotome is passed beside it till it rests upon the bone, when the knife is removed. The osteotome is then turned so that its cutting edge is across the bone. The osteotome must be firmly held while it is struck steadily with a mallet. There is no danger of doing injury unless the osteotome is held obliquely pointed backward and allowed to slip off the bone when struck. With a few strokes it can be felt to enter the medullary canal, and then enter solid bone on the farther side. The osteotome should not be driven clear through the bone. No effort should be made to try the strength of the bone by using the osteotome as a lever, but it can be loosened by lateral movements The osteotome is usually graduated with marks upon its side for measuring the depth to which it has entered; but the best guide is the sense of the hand that holds the osteotome. When it appears that the bone is sufficiently cut, the operator grasps the leg in one hand and with counter pressure near the wound breaks the bone. Iodoform and sterile gauze, cotton and bandage are quickly applied, the limb held straight and encased in plaster and the Esmarch constrictor removed. Unless something goes wrong, such as blood oozing through the dressings or the foot swelling or becoming bluish, or continued pain or high temperature, the dressing is not changed for a month. There is no necessity for passive motion after ten days, as with Ogston's operation. Usually the result is perfect union. But a splint or a plaster bandage is in order for a while longer,

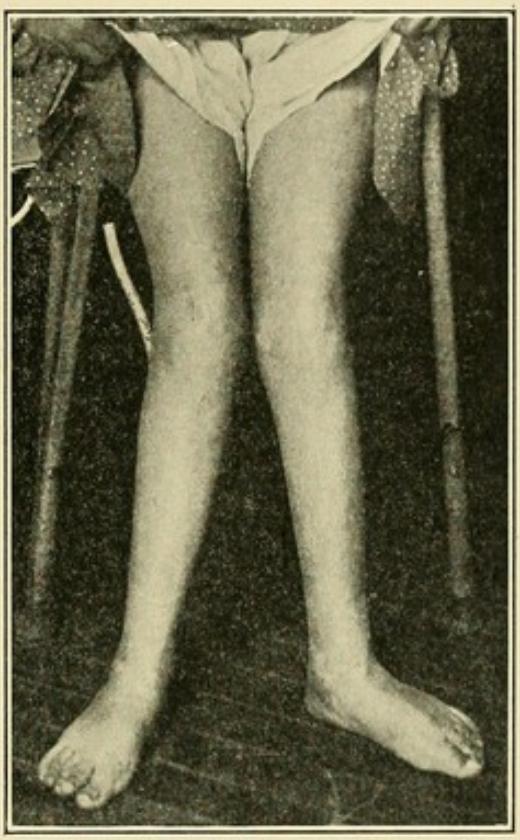


FIG. 53. GENU VALGUM. Also tuberculous. Has lost an index finger and has many scars from tuberculous lesions. Treated in New York for tuberculosis of right knee. Osteotomy of femurs at Cleveland City Hospital by the author. Result shown in Figs. 54 and 55. Girl aged 12 years.

especially if the bone cut soft, and on leaving it off the limb should be watched for a time to see that it does not bend. (See Figs. 51 to 55.)

Osteoclasis will be described in the Section on Bow-legs, and Corkscrew and Saber-legs.

GENU EXTRORSUM (GENU VARUM)

Genu Extrorsum (*Genu Varum, Bandy-leg, Out-knee*) is due to bowing outward of the femur, and sometimes also of the leg-

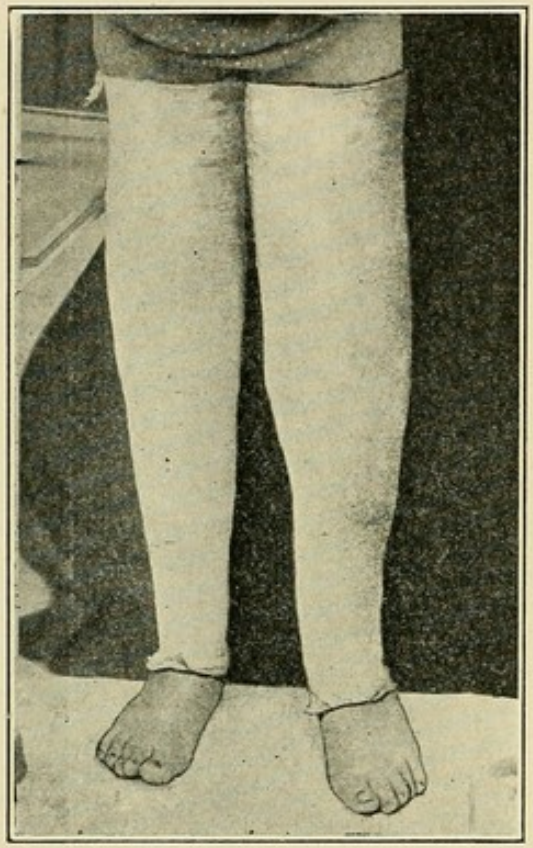


FIG. 54. Same case as Fig. 53. Wearing casts 4 weeks after operation.

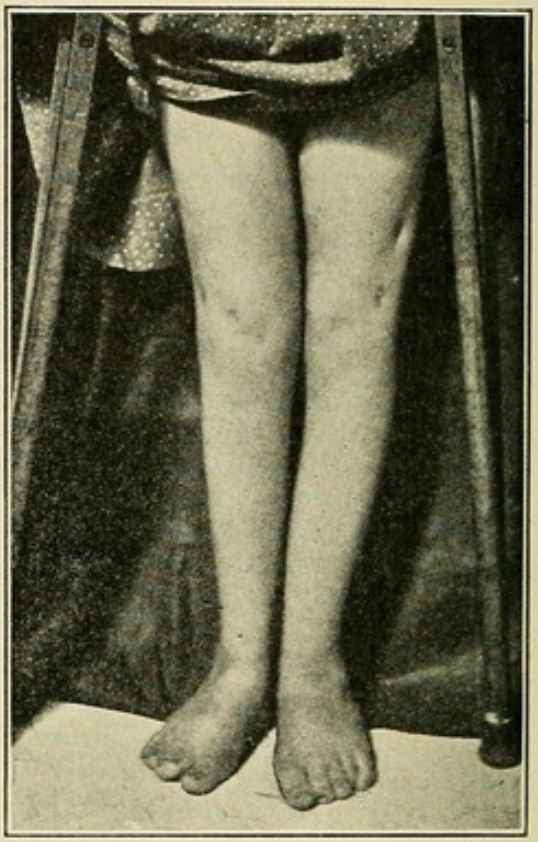


FIG. 55. Same case showing result of osteotomy of femurs for genu valgum.

bones, the knee joint not being at fault. The cause is rickets. The bones being soft, yield to muscular action and weight, while the ligaments being stronger in proportion, hold the joint in proper shape. Sometimes the femur only is bent.

Treatment.—The remarks upon knock-knee are entirely applicable to this condition as regards its curability by rest and splints and also as to the time for resorting to operation. It is true that spontaneous cure may possibly result under improved hygiene and increased general vigor; but it is equally true that such fortunate outcome is not to be depended upon, and also that when the bones have hardened in deformity there is no possibility of their improv-

ing spontaneously. Under these conditions osteoclasis or osteotomy of the femur is the only resort, and if that bone only is at fault, will give entire satisfaction. If the leg-bones also are bent, it may be necessary to operate also upon them.

BOW-LEG, CORKSCREW AND SABER-LEG

Bow-legs is the most common variety of rickety deformity that needs the services of the surgeon. It may accompany bowing of the thigh, or it may be present without other rickety deformity. It may affect one leg only or both; or one leg may be bowed and the other valgous. If the thighs be brought together in the middle line the crossing of the legs that is rendered necessary gives one an appreciation of the degree of the bowing. It can be measured by placing the internal maleoli together and noting the number of inches between the knees, and it can be graphically recorded by placing the legs flat upon a large sheet of paper and tracing their outlines. The greatest bend is often about the junction of the upper and middle thirds of the tibia, but sometimes it is near the middle and lower thirds. Sometimes the curve is convex forward, in which case it is apt to be about the middle and lower thirds or in the lower third. This bowing forward is often called saber-leg, but is not to be confused with the anterior bowing or saber-leg of late hereditary syphilis. Occasionally the tibia bends in several different directions, for instance, outward above and forward lower down, with a spiral twist in its lower third which has given rise to the name corkscrew-leg. However, these deformities are all due to the same cause, rachitis, modified by habitual position, slight differences of muscular action and the like. Other evidences of rickets can usually be found. Older children, in whom the active stage is past, usually have some memento remaining in the form of enlarged radial epiphyses, projecting lower ribs, pigeon-breast, or a large, square-cornered cranium. Flat-foot may accompany bow-leg, though it is not as constantly present as with knock-knee. Perhaps the tilting over upon the outer border of the foot saves the arch somewhat.

The diagnosis presents no difficulty.

The prognosis is unpromising if the deformity is untreated. With proper treatment the result is likely to be extremely satisfactory.

Treatment.—Young children whose rachitic bones are still pliant may be treated by rest in splints, with anti-rachitic diet, baths, massage, and manual pressure. Or the legs, held as straight as possible, may be put up in plaster, and these casts, with manual correction, renewed at intervals of ten to fifteen days for a few months. By the time the attack of rickets has subsided the bones will be

straight, and will harden in the corrected position. An alternative, though not a superior method, is by braces. (See Figs. 56 and 57.) (See remarks on Treatment of Knock-knee.) By these methods cure may be effected in a few months or a year in suitable cases. If a splint is to be used, it is simply flat and padded, with the leg strapped upon it. If both legs are bowed, either two splints may be used, or one between the legs from above the knees to below the feet, with encircling strap at the ankles, one at the knees, and one around the convexity. This makes a simple but efficient apparatus. If braces are to be used, they can be made to reach only from the feet to the middle of the thigh, but they keep their place better if extended to a pelvic band. They need not be heavy, as they are not intended to support the entire weight like a Thomas knee splint or a Taylor hip brace. The upright for the inner side of the leg should be strong enough to withstand some pressure, for from this a wide, padded band surrounds the leg at its greatest convexity and is tightened at intervals of a few days or weeks as the leg straightens. Two pads upon the inner upright of the brace, one at the internal condyle and one at the inner maleolus, make counter pressure. Braces are useless in the treatment of saber-leg, or anterior bowing of the tibia. When the bones have hardened, which is usually the case in children past four years of age, and sometimes younger, the best treatment is osteotomy or osteoclasis.

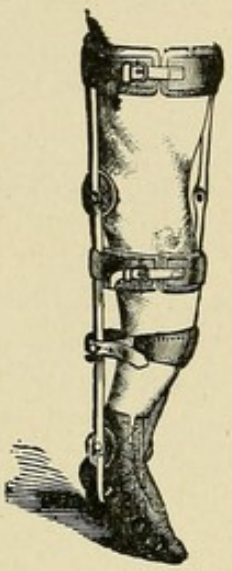


FIG. 56. LONG SINGLE BAR BOWLEG BRACE.

Osteotomy.—In osteotomy the section is made at the point of greatest convexity. The technique is that described in osteotomy for knock-knee. But with osteotomy upon the lower part of the tibia it is generally necessary first to tenotomize the tendo Achillis, as it persistently prevents straightening of the bone or pulls upon the lower fragment when it is placed in line. (See Tenotomy of Tendo Achillis.) All these operations are done under strictest antiseptic precautions. Osteotomy can be employed for ordinary bow-leg as well as for saber or corkscrew leg, and is often chosen in preference to osteoclasis by general surgeons who are not familiar with

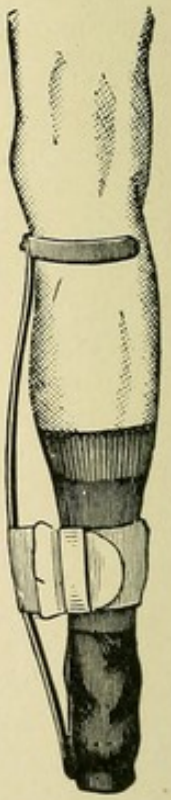


FIG. 57. BOSTON CHILDREN'S HOSPITAL BOWLEG BRACE.

the use of the osteoclast or have not one at hand. If a wedge of bone is removed from the convexity, for instance, in saber-leg, the bone is shortened. This is a distinct disadvantage, as the deformity has already shortened the bone and lowered the patient's stature. The removal of a wedge should be avoided. Osteotomy, whether for tibia or femur, is not an operation to be lightly or

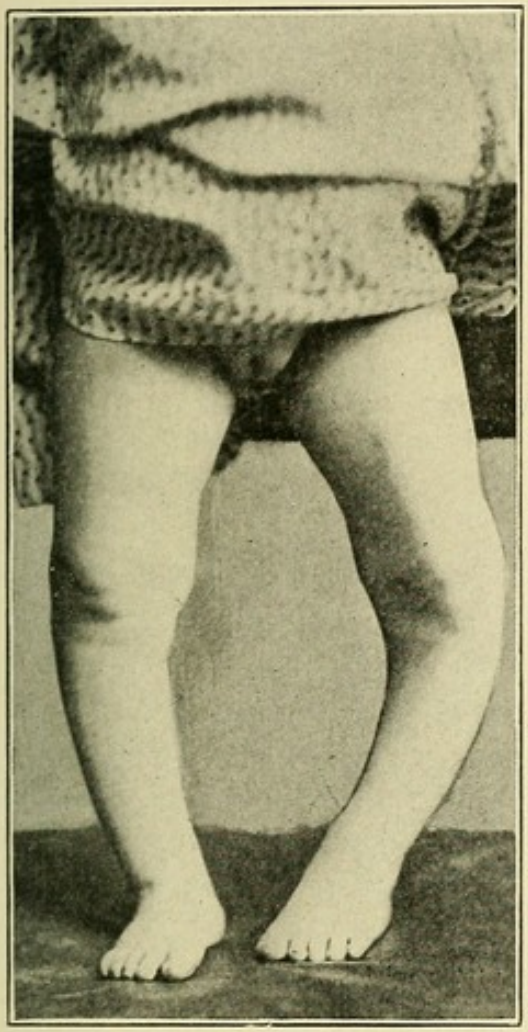


FIG. 58. BOW-LEGS. Osteotomy, both tibiæ. Wore casts 4 weeks. Aged 4 years and 3 mos.

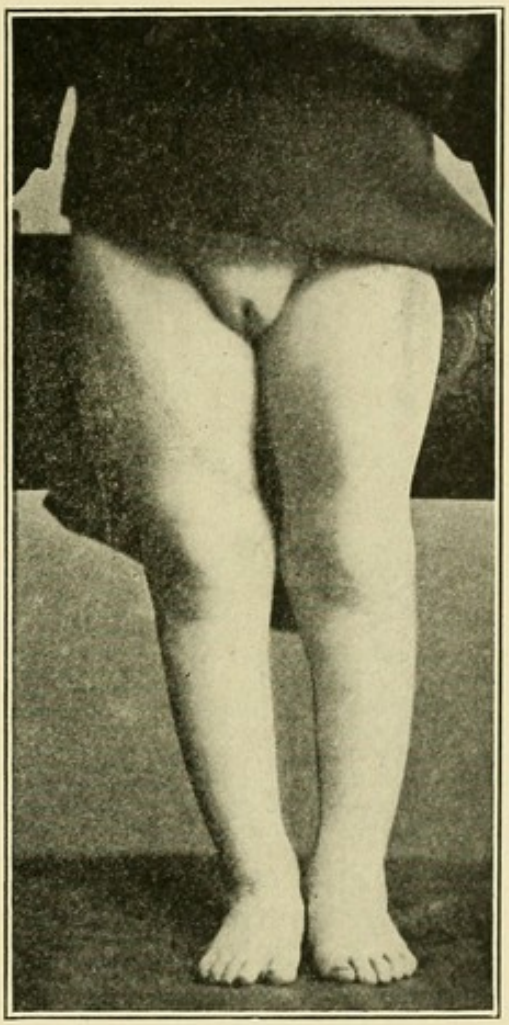


FIG. 59. Same case after osteotomy. Never wore any braces after casts were removed.

thoughtlessly undertaken. Ordinarily it is easy of execution and a safe and very satisfactory operation, and yet excellent surgeons have occasionally gotten into difficulty over it; and cases are on record of septicemia, pyemia, fat embolism, non-union, necrosis, recurrent hemorrhage and other serious and fatal effects resulting from osteotomy in the hands of competent and careful surgeons. In osteotomy an Esmarch may be used or not, as desired. The incision is longitudinal, at the point of greatest convexity, and upon that side of the bone nearest the surface, and goes down to the

periosteum. The osteotome is passed into the wound flatwise beside the blade of the knife. The knife is removed. The osteotome is given a quarter turn, so that its cutting edge is at right angles with the long axis of the bone, and is held firmly in the whole hand and driven into the bone with measured strokes by the mallet.

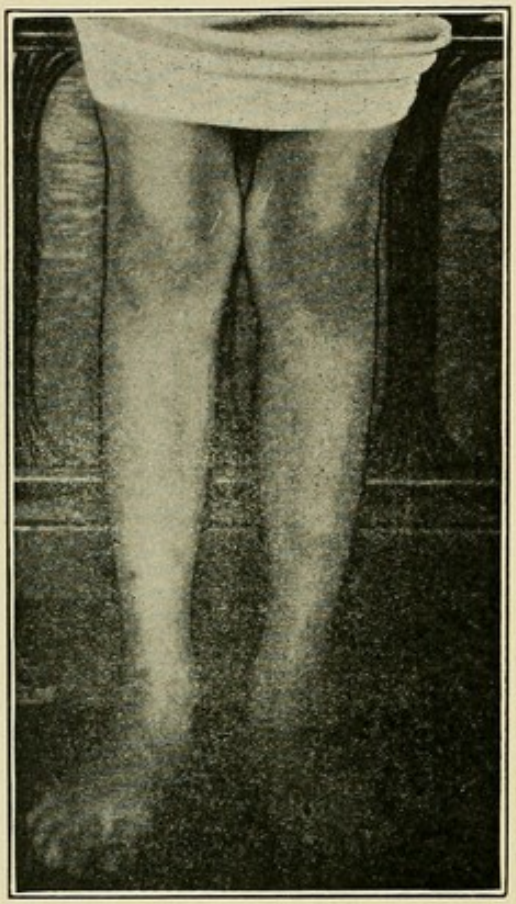


FIG. 60. Same case as Figs. 58 and 59. Six years after operation showing no relapse.

When the bone is cut about two-thirds of the way through, the osteotome is removed and the bone fractured by manual strength. It is not necessary to cut the fibula, as it can generally be broken with the hands. Neither is it often necessary to remove a wedge of bone from the convex side of the curve. The skin wound is sutured with catgut and a surgical dressing applied. The limb is placed in a corrected or slightly over-corrected position. If there are other bends in the limb in the same direction as the one corrected, sufficient over-correction should be used to neutralize them. This position blends in with the other curves, giving a generally symmetrical contour. The limb is then put up in plaster, including the foot and the knee, and if all goes well the dressing is not changed for a month. In case of discharges through the dressings, continued fever above 101 or 102 degrees F., or dusky-colored toes or pain after the first day or two, the wound must be inspected. After the first cast is removed the limb should be guarded for a time by a cast or splint, or care taken lest recurrence follow while the union is still new. (See Figs. 58, 59, and 60.)

Osteoclasis consists in producing a simple fracture by means of an instrument. This instrument, called an osteoclast, is in several varieties. In some the power is applied by a screw and in others by a lever or levers. Each has its advocates, and each is best in the hands of the man accustomed to its use. The screw applies the power accurately where it is placed, but slowly—some say too slowly. Not more than eight seconds under pressure should be required to fracture a bone (Blanchard). The lever-power osteo-

clasts act quickly, with very little bruising of tissues, but require some practice for accurate and rapid use. The Grattan osteoclast is an excellent instrument. It is one of the screw variety. (19)

Osteoclasis may be used upon any long bone that it is neces-

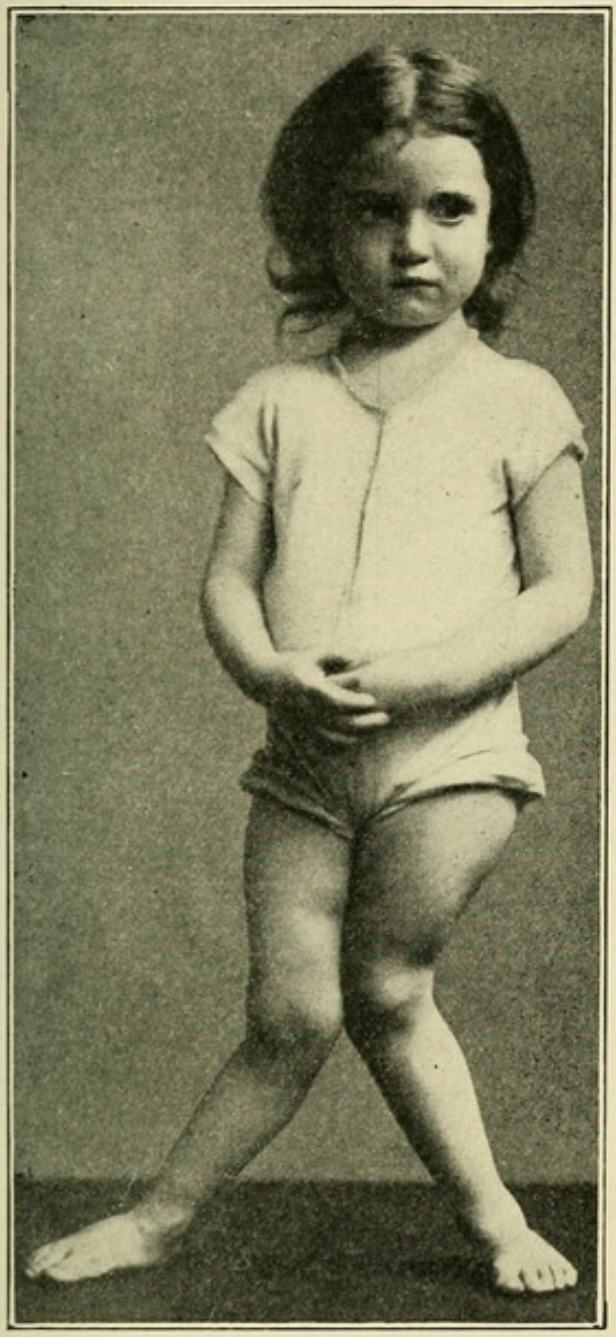


FIG. 61. KNOCK-KNEES.—Dr. Wallace Blanchard.

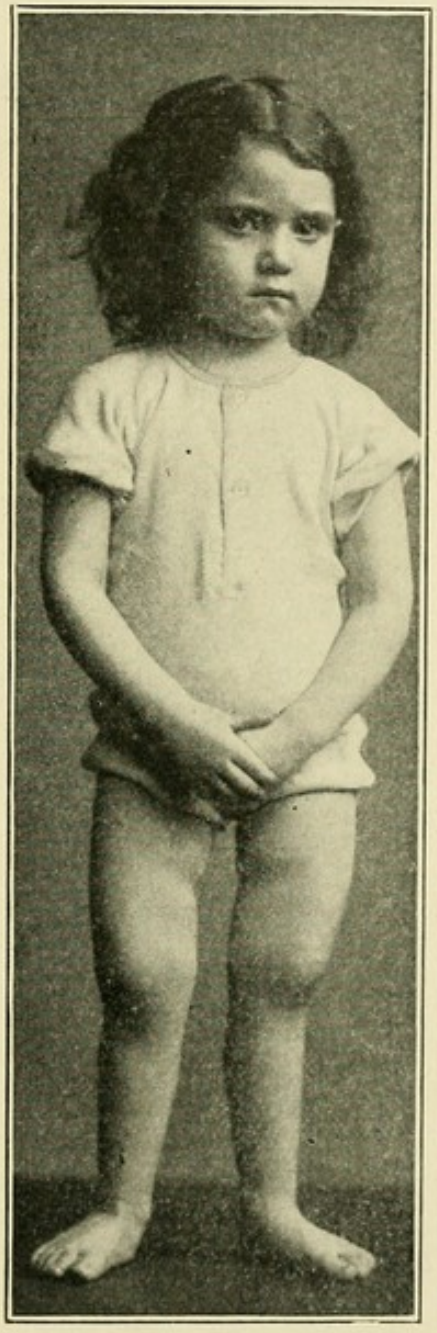


FIG. 62. Same case after correction by rapid osteoclasis above the condyles.

sary to fracture not too near a joint, if the bone is not subcutaneous where the instrument must apply its force. For instance, in saber-leg the pressure must be applied laterally and not anteriorly.

Osteoclasis has the advantage of not making an external wound,

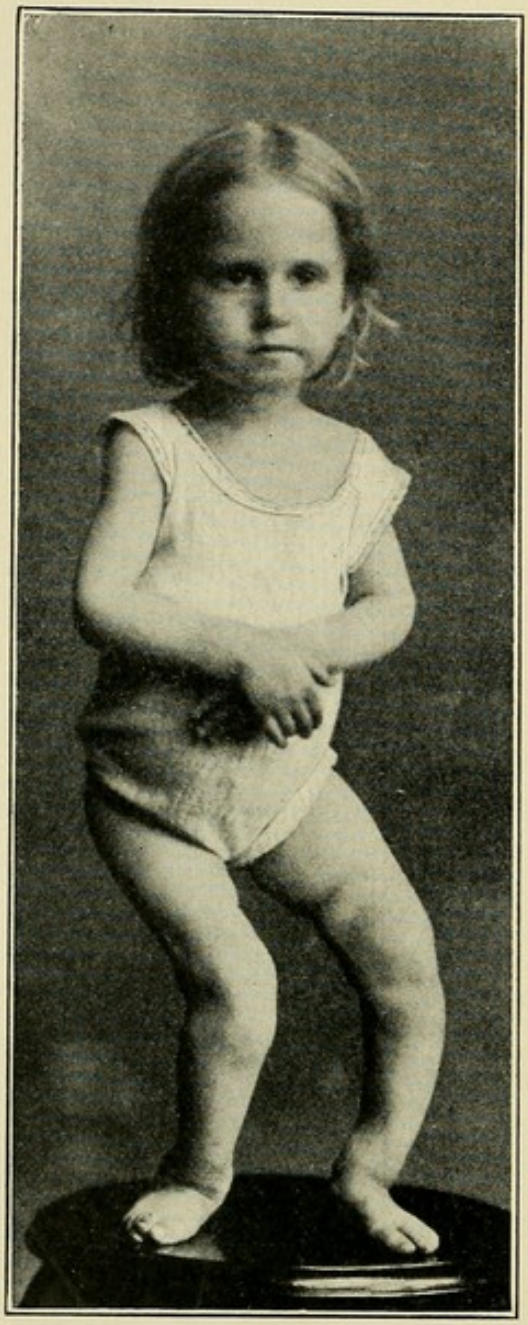


FIG. 63A. Florence W., aged 4 years. Badly deforming rachitic knock-knee of right side, and bow-leg of left side, producing difficult locomotion. For correction two supercondyloid and four tibial fractures, to which may be added four corresponding fractures of the fibulas, ten in all were necessary.

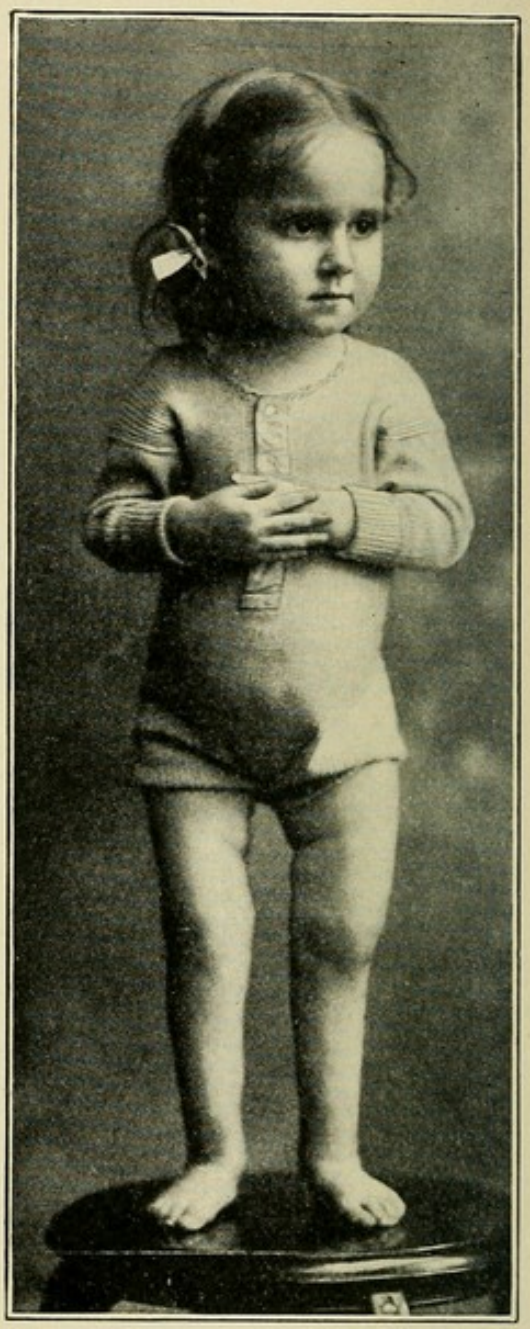


FIG. 63B. Same case after correction by rapid osteoclasis, opening up of triangular spaces, rotation and readaption of fractured ends. A skiagraph taken six months afterward showed only slight shadows to indicate the extensive fracturing and redressment of the bones.—Dr. Wallace Blanchard.

nor necessarily opening the periosteum. There may not even be a skin abrasion, yet it is well to cleanse the limb antiseptically before



FIG. 64. BOWLEGS.—Dr. Wallace Blanchard.

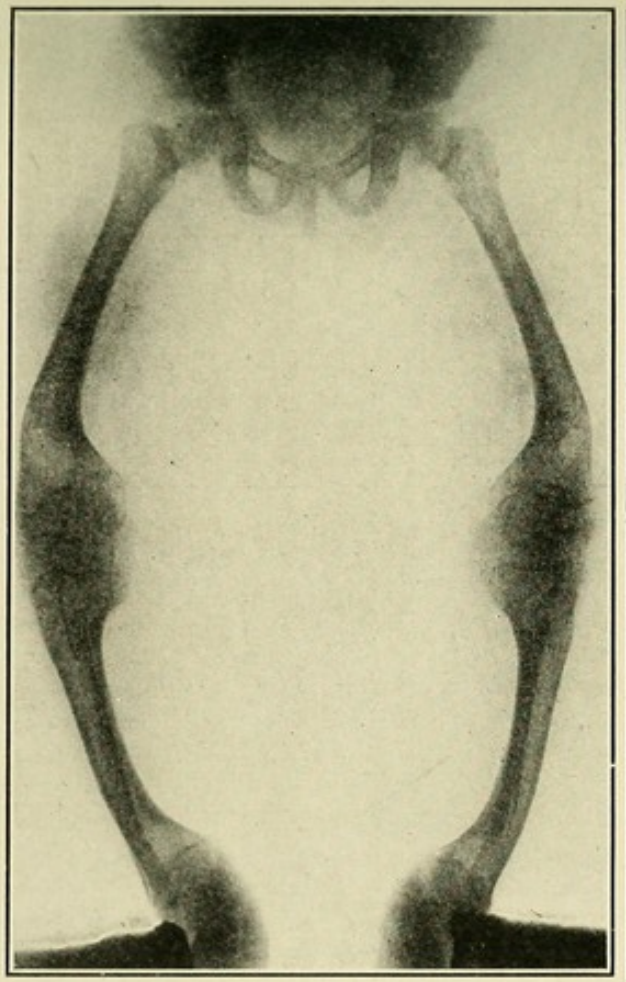


FIG. 65. Skiagraph of Bowlegs shown in Fig. 64.

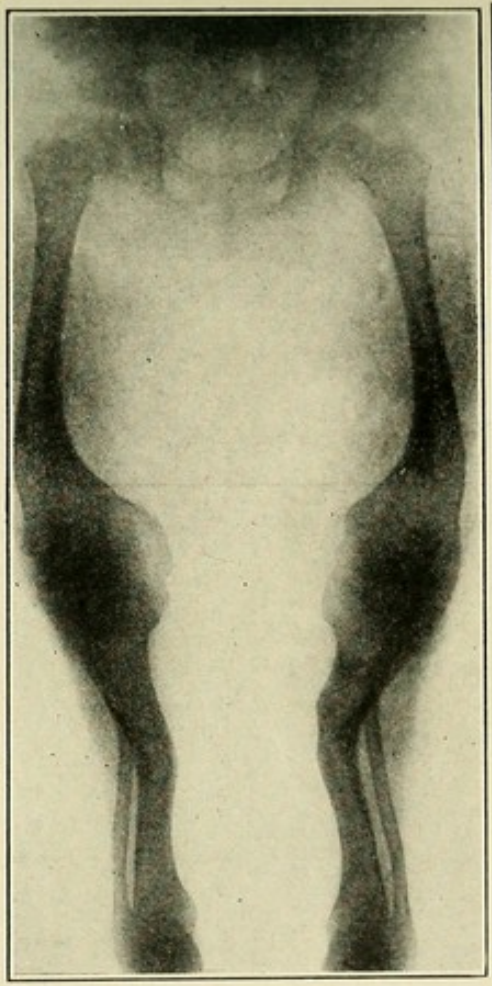


FIG. 66. Skiagraph of case shown in Figs. 64, 65 and 67 after osteoclasis.

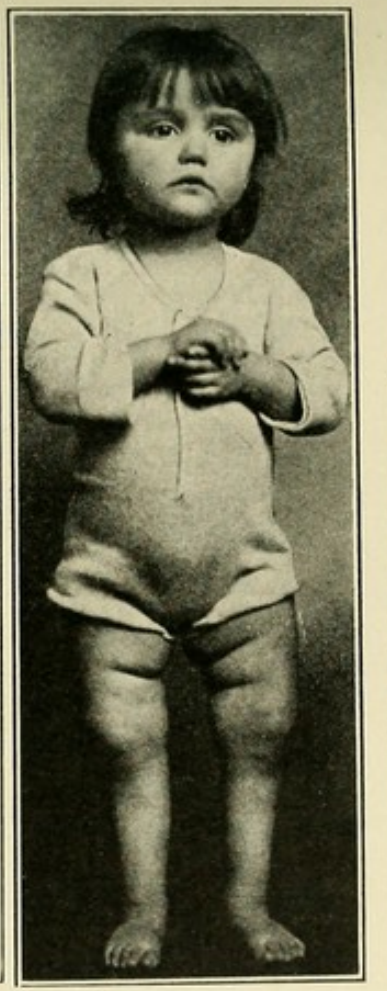


FIG. 67. Same case as Fig. 64, after osteoclasis.

operating. The principle of osteoclasis is readily understood. The screw or the fulcrum actuated by the lever or pair of levers is placed over the greatest convexity of the bow, unless the bone is subcutaneous at that point. The rings of the instrument encircle the ends of the bow and the force is applied as rapidly as may be till the bone snaps or straightens. Usually transverse fracture occurs. If it straightens without snapping (osteokampsis), it is best to carry it a little beyond the straight line. Sometimes it is a green-stick fracture, but often the bone is eburnated and almost ivory-like, and breaks sharply. In case of osteoclasis upon the lower part of the leg, the tendo Achillis is tenotomized just before the osteoclast is applied. Otherwise its traction would misplace the fragments. In saber leg or anterior bowing, after fracture by the osteoclast the lower end of the tibia is brought forward to straighten the shaft. The fracture being transverse, this position opens a triangular space posteriorly between the fragments. But this is filled in during the healing process, and nearly an inch is gained in the length of the bone. The limb is held in such position as to neutralize abnormal curves and give a symmetrical appearance. Antiseptic gauze and plaster bandage complete the work. The subsequent course after osteoclasis is that of a simple fracture without displacement. Children mind this operation but little and generally give admirable results, as seen in Figs. 61 to 67.

COXA VARA

Depressed neck of the femur is a static deformity sometimes caused by rachitis, less frequent in childhood than in adolescence, the femoral neck being short in early life. The depression may change the angle from an obtuse to a right angle or even below that. Or in a second variety, the bend is at the epiphyseal line between head and neck. The former is more common in childhood. Symptoms may not attract attention in the presence of more marked rickety deformities. There is limp, single or double, as the deformity is unilateral or bilateral, with shortening, elevation of the trochanter, limitation of abduction, inward rotation and flexion; and increase of outward rotation and extension. In the bilateral type if the femoral neck is turned backward, lumbar lordosis is diminished, if forward lordosis is increased.

Treatment is in general that of rachitis. Locally, support, transferring the weight to the perineum unless the pelvis is soft. Forcible abduction with fixation in plaster in that position may help correct the deformity, or at least stretch the adductors. In extreme cases of the first form, Whitman's operation—the removal of a wedge of bone directly opposite the trochanter minor,

leaving the cortical substance on the inner side of the bone, with abduction, bending the shaft upon the neck to normal position and fixing with plaster spica for three months.

RICKETY DEFORMITIES OF ARM AND FOREARM

Weightbearing during the sitting and creeping period of infancy, and muscular action, may bend the humerus, though seldom to a degree requiring treatment. If necessary the humerus should be straightened, by accurate, careful osteotomy through an incision, avoiding injury to nerves and vessels.

Bowing in the forearm occurs much more frequently and to greater degree than in the arm, and is usually greatest in the lower third. It tends to correct itself somewhat as the rickets is recovered from, yet surgical correction may be necessary. This is best done by osteotomy, and results are satisfactory.

Rachitic enlargement at the wrist joint often remains noticeable and unsightly but is not remediable.

RICKETY DEFORMITIES OF THE THORAX

Such deformities as pigeon-breast, funnel chest, the flattening of the sides of the thorax from atmospheric pressure and projection of its lower boundaries over the expanded abdomen producing Harrison's groove, are not amenable to any operative measures or mechanical appliances. But they are amenable in young children to general antirachitic treatment; and they are especially and markedly benefited (if treated before the process of dense ossification which follows rickets has taken place) by securing a free flow of air through the upper air passages, and by gymnastics. Adenoids and enlarged tonsils should be removed, bronchial and laryngeal catarrhs cured, and the child given breathing exercises to increase his chest expansion, and " setting up " gymnastics. An exaggeration of the curves of the clavicle may occur, but usually operation is not necessary. If one is undertaken it should be open osteotomy.*

RICKETY DEFORMITIES OF THE PELVIS

The rachitic pelvis may yield to pressure, advancing the promontory of the sacrum and approximating it and the acetabula or tuber ischii which are fixed below. Thus the pelvis is narrowed and distorted so that, in the female, later in life childbearing becomes dangerous to both mother and child. These deformities are generally not noticed in children but their possibility should be remembered and prevented by keeping the severe case of rickets horizontal for a time; and not, by the use of braces to the lower extremities transferring the pressure to a softened pelvis.

* See also chapters on Thorax, Spine, and Section on Rachitis. Osteotomy of vertebræ and ribs is not commendable.

CHAPTER VIII

DISEASES OF PERIOSTEUM, BONES, AND JOINTS NON-TUBERCULAR

Acute Periostitis—Acute Osteomyelitis—Acute Epiphysitis (Acute Arthritis of Infants)—Syphilitic Diseases of Bones, Periosteum, Joints and Cartilages—Traumatic Arthritis—Gonococcus Arthritis—Chronic Secondary Infective Osteo-Arthritis—Non-Inflammatory Arthropathies—Osteo-Arthritis—Rheumatoid Arthritis—Joint Changes in Hemophilia—Ankylosis, Arthroplasty (20).

ACUTE PERIOSTITIS

It is to be remembered that in most inflammatory diseases more than one tissue is affected. In pleurisy often that portion of the lung adjacent to the diseased visceral reflection of the pleura is involved in the inflammatory process. Similarly, in periostitis the pathological changes do not cease abruptly in the covering of the bone, but often involve the bone itself. Bone diseases often involve joints. Morbid conditions in epiphyses are extended to both joint and diaphysis. Still there is somewhat of an anatomical boundary to justify our classifications.

Acute periostitis may be non-suppurative or suppurative. The former results from slight trauma and presents the symptoms of pain, swelling, and, if the periosteum be near the surface, also redness, but no constitutional symptoms. There is no tendency for the disease to spread. If it were to do so, or to give rise to fever or chill, it would indicate infection which would rapidly merge this into the suppurative form of the disease. Rest, with the part elevated, and the application of hot compresses, usually effect a cure. But these measures should be promptly carried out, and also the employment of a brisk laxative and careful dieting; for in the beginning it is impossible to foretell whether the disease will remain non-suppurative or take the far more severe course of the suppurative variety.

Acute Suppurative Periostitis.—This disease occurs from the presence of infective organisms, generally staphylococci or

streptococci, attacking tissues whose vitality is lowered by trauma or by a pre-existent general disease. And its course depends a great deal upon the previous condition of the patient and whether he had recently suffered from scarlet fever, measles, typhoid, or any other infection.

Symptoms.—The symptoms are like those of the onset of many infections, chills or even convulsions, fever, restlessness, anorexia, accelerated pulse. Locally there are pain, tenderness, swelling, later edema, dark redness, which in superficial situations of the periosteum comes in a day, but in deeper locations not until the disease is more advanced.

The inflammatory process produces thrombotic changes in the minute blood-vessels from the periosteum which enter into and nourish the bone, and an exudation of serum and formation of pus which lifts the periosteum, denuding the bone beneath. If relief be not quickly obtained by the easing of the tension and evacuation of the pus, further stripping of the periosteum will occur, with probable death of a portion of bone, and the tedious process of casting off a sequestrum.

Diagnosis.—The similarity of the general symptoms of this disease with those of the onset of a great number of acute infectious diseases in infants and children has led to very many mistakes in early diagnosis, especially if the child is too young to draw attention to the local pain. Even when pain and tenderness are localized they are apt to be attributed to rheumatism and lead to delay of the proper treatment.

Treatment.—The only effective treatment is by incision through the inflamed periosteum. This will require anesthesia and careful antisepsis. The fact that the disease is an infection and that pus is to be encountered is no excuse for carelessness in risking the introduction of additional pathogenic organisms. The incision should be free enough to afford complete evacuation of the pus and will probably result in a prompt relief from the symptoms.

The part being dressed with a wet antiseptic compress, and elevated, the periosteum may adhere again to the granulating surface of the bone and recovery occur without necrosis. If the patient be in a depraved state of health, or if the periostitis follow one of the infectious fevers, convalescence may be slow, ultimate recovery coming only after months of waiting and a final sequestrectomy. Mild cases may assume a subacute or chronic form. (See Fig. 68.)

Osteoplastic Periostitis is a non-suppurative disease, very chronic in its course. It is due to a continued irritation of the periosteum, either locally applied or from constitutional causes, or by local irritation added to constitutional causes; not sufficiently

aggravated to produce an active inflammation, but enough to increase the vascularity of the periosteum and to excite its inherent proclivity for depositing new bone.

This newly formed bone is at first irregular in its histological formation, soft and spongy, but subsequently assumes an approach to systematic arrangement of its canals and lamellæ and and becomes ossified.

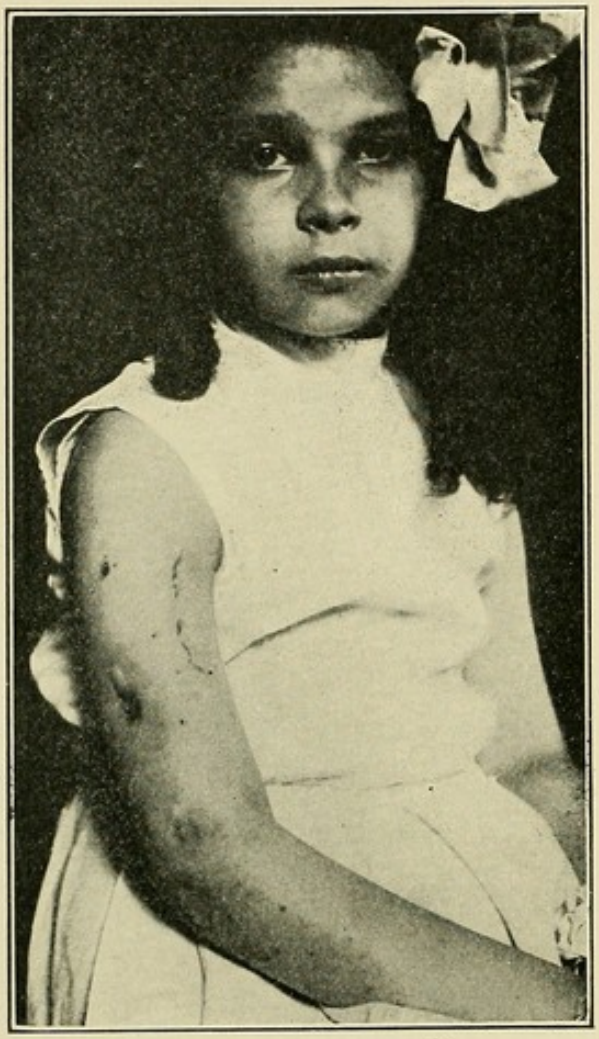


FIG. 68. PERIOSTITIS AND OSTEITIS of a mild type, in which only the pyogenes albus was found. The disease extended over months and required repeated sequestrectomies and curettings of different foci. Complete recovery. Girl aged 11 years.

The most frequent constitutional cause of osteoplastic periostitis in children is hereditary syphilis, the late manifestations of which make their appearance between the time of the second dentition and puberty, its lesions corresponding to tertiary in the adult. Bony deposits of the character described appear most frequently upon the tibiæ, the clavicles, and the bones of the forearm, although not confined to these locations. Typical instances are seen in the so-called " saber-leg," in which the anterior surface of the tibia becomes convex from the increase of bony layers beneath the inflamed periosteum.

Bone tumors and rheumatoid arthritis also present occasional examples. Osteoplastic periostitis accompanies osteitis and arthritis in some cases of tuberculosis of the lungs and empyema, and more rarely in some other diseases, and is sometimes described as a distinct complication of tuberculosis. This is called pulmonary hypertrophic osteo-arthropathy. It seems to be caused by the action of toxins produced by the disease which it accompanies. It involves most frequently the hands, especially the phalanges, feet, forearms and legs, producing hypertrophy of the bones and joints

and sometimes synovial effusions. It is particularly noticeable in the terminal phalanges, which are large and wide. The nails are greatly curved both longitudinally and transversely and are coarsely striated, or, as Fothergill puts it, "distinctly show they are only agglutinated hairs." The pathological process is one involving not only periosteum but bone, and might be classified under either heading. It also combines osteoplastic and rarefactive processes. While the deep layers of the periosteum are building new bone upon the surface the compact tissue of the bone is becoming softened and absorbed in those layers next to the medullary canal. Thus, although the bone becomes larger, the medullary canal also becomes larger. This has given it the name of expansion of bone. Although the newly formed bone is somewhat irregular in its minute formation, the general contour of an affected bone is preserved, and ossification proceeds with sufficient rapidity to maintain strength enough for use. There is no tendency to suppuration. Thus the process is quite different from the rarefactive osteitis in which not merely circulating toxins but bacilli themselves are at work in the bone.

Treatment.—Treatment is that of the constitutional disease which gives rise to the condition. In syphilis full doses of the potassium iodide will be necessary. The system should as promptly as possible be brought under the influence of the remedy, for the condition, besides being painful, especially at night, and leading to deformity, may advance to destructive instead of formative changes. In tuberculosis the local disease in the bones will show the effect if improvement takes place in the pulmonary disease and in the general condition of the patient, toward which treatment should be directed.

It is extremely seldom that incisions for the relief of tension will ever be called for, even in the syphilitic form. In the tubercular this is never required.

ACUTE OSTEOMYELITIS

The name osteomyelitis is misleading if by it we are led to understand that only the medulla of bone is engaged in the inflammatory process. Ostitis and periostitis also are combined with it; the compact lamellar structure being secondarily and the periosteum finally involved. Osteomyelitis may be acute or chronic and the acute may be of two varieties.

Acute Simple Osteomyelitis (*Non-suppurative Myelitis*) is traumatic in its etiology, resulting from contusions or fractures. Unless there be pyogenic organisms introduced from without or they be already present in the system at the time of the injury, contusions and simple or even comminuted fractures ordinarily do not

give rise to suppuration. They occasion non-suppurative inflammation with its changes in the blood-vessels, exudation of blood plasma, emigration of leucocytes, and reparative processes carried on by the cells of every tissue involved, each producing and organizing new tissue after its own kind. In the young this process goes forward more rapidly than later in life, owing in part to the great vascularity of the periosteum and the unexpended vitality of the cells. Non-suppurative osteomyelitis may almost be regarded as a physiological process of repair.

Acute Infective Osteomyelitis.—This disease is what the older writers, and some not so old, called acute necrosis and attributed to an infective inflammation of the periosteum—a sub-periosteal diffuse phlegmonous inflammation. That which has here been described as periostitis was thought to have been located just outside of the periosteum, a parosteal inflammation. They knew, too, that a "sub-periosteal" periostitis might extend to the medulla. That an inflammation of the medulla might extend to the periosteum. That an inflammation might begin in the cancellous portion of the epiphysis or in the epiphyseal line and extend to the medulla of the diaphysis. That an inflammation might begin in any one of these situations and extend to all the others. Wright refers to McNamara and some continental surgeons as believing that what he (Wright, likewise many other English surgeons) describes as "acute periostitis" is really acute osteomyelitis. He continues: "This, however, is, we believe, not the case as a rule, since if it were so, complete recovery in these cases without extensive necrosis would not be nearly so common as it is. Moreover, in cases of acute periostitis dying of pyemia, sections of the bone have shown an entire absence of osteomyelitis in some instances."

However, most recent writers describe this grave form of disease under the name "acute infective osteomyelitis" or "suppurative osteomyelitis," and all are agreed as to its pyogenic origin, symptoms, and course; and, for the most part, as to its treatment. It is the most serious acute bone disease occuring at any time of life and is particularly prevalent in the young subject up to the seventeenth year; which is as much as to say before ossific union of epiphysis and diaphysis in the long bones has taken place. It is the long bones of the extremities which are most frequently attacked. This illustrates again the law that where there is great developmental activity there is likely to be great pathological activity. This is the period of the most active growth in length, which takes place at the epiphyseal line in the long bones. As is so often the case in diseases in which exposure to weather and to injuries plays a part in the etiology, males furnish more cases of osteomyelitis than females, especially during youth and adoles-

cence. Slight injury is more frequently a determining cause than severe injury. It is most apt to occur in those who have recently suffered from one of the infectious diseases, or whose general vitality is lowered by inheritance or by an unsanitary manner of living, or by excessively rapid growth.

The infective organisms found in connection with this disease are staphylococci, streptococci, and bacilli in several varieties, but all capable of producing pus; and all, as we know from study not only of this but of other diseases, capable of assuming more or less virulent types in different cultures of the same organism and in different patients with the same disease. The staphylococci are represented by pyogenes aureus, albus or citreus. The staphylococcus pyogenes aureus heads the list in frequency. The pneumococcus, the bacillus coli communis and the bacillus typhosus are not rare. The germ of influenza or la grippe contributes a share. The most virulent cases are mixed infections and particularly those in which a streptococcus is present.

Pathology.—The inflammation begins in the newly formed bone in close proximity to the periosteal line. When the focus is immediately beneath the periosteum it pushes that structure loose from its attachment to the bone. When the inflammatory seat is in the red marrow of the cancellous bone, where pus formation produces great tension, numerous infected emboli are forced into veins and lymphatics and set up endocarditis or pleuritis, or meningitis or metastatic abscesses in lungs, brain, kidneys, spleen. The arteries also in the inflammatory area become thrombotic and their blood supply is lost, and this, with the stripping away of the swollen and loosened periosteum, leads to necrosis in mass of adjacent bone. The thick and vascular periosteum of the child is very readily peeled from the bone, being only firmly attached to the epiphyseal cartilages and somewhat firmly at tendinous insertions. The extent of the destruction is only limited by the violence of the inflammation and the length of time it is allowed to go on without interference, or the pus finds exit by bursting through the soft parts. Ere this occurs the whole shaft may be denuded and necrotic, and, loosening also from the epiphyses, may lie like a foreign body in the pus sac composed of the periosteum. In one of my cases the entire radius was thus cast loose and subsequently removed. In many cases the destructive changes are mainly at the end of the diaphysis, the periosteum having yielded and allowed the escape of the abscess contents into the soft parts. This, however, does not allow of its escape externally. Confined still by fasciæ, muscles and skin, it will burrow and extend. Again, with escape of pus and relief of tension, the periosteum may finally become reattached at least in part to the bone beneath. But the infection focus may have been originally

nearer to the medulla of the shaft or may quickly extend to it from the cancellous marrow, setting up suppuration there. The inflammation in the marrow itself with the pressure produced within its closely confined space is thought to account for the fatty emboli which have been forced into the circulation, and are so often found in the lungs and elsewhere.[1] If the inflammation has been more central and has not caused loosening of the periosteum, the necrosis also may be confined to the central portion of the bone.

If the patient survives the toxemia and escapes the fatal complications and the pus has found exit by natural or surgical means, there begins a process for the removal of the necrosed bone or sequestrum. Granulation tissue has circumscribed the area of inflammatory activity and afforded a degree of protection to the rest of the system. A process of softening and liquefaction of a portion of bone overlying the sequestrum takes place. The periosteum, if its inner layers were not destroyed, has produced new bone; and after the lapse of months the sequestrum may be entirely separated from its involucrum which presents one or more openings or sinuses from which detritus is continually discharged.

Symptoms.—The symptoms are those common to an acute infection of virulent type. Often the most alarming symptom is a chill or convulsion. In older children lassitude may have been complained of previously, and severe pain. With the chill comes high fever and by this time excruciating pain, worse on movement. There may be morning remission of the fever and evening rise, and this with delirium, diarrhea and exhaustion give a picture much resembling typhoid, with the addition of pain and tenderness in the bone or bones involved. The child cannot permit a movement or touch of the parts without agony, and holds them, involuntarily as well as voluntarily, fixed by reflex spasm of the muscles. The soft parts over the diseased bone become reddened and swollen, then intensely reddened and edematous. This whole series of phenomena advances with frightful rapidity. In some, the so-called fulminant cases, the septic intoxication is so overwhelming that death may occur within thirty-six hours from the onset. It is not uncommon to find edema of a limb in forty-eight hours and fluctuation soon after. If the disease breaks through into a joint the symptoms of acute purulent synovitis are superadded. If the patient survives longer, evidences of infection metastases may appear; septic pneumonia, pericarditis, pleurisy, meningitis, nephritis, in fact, there may be disseminated foci in muscles including heart muscles, in almost any of the viscera, and not uncommonly pyemia. Enlargement of the spleen and albuminuria are usual and do not necessarily imply splenic or nephritic inflammation. Eruptions or

[1] See Peters' very clear account in the American Practice of Surgery.

rashes like those of many septic intoxications may appear upon the skin.

Diagnosis.—So many errors and disastrous delays in diagnosis of this disease would not be made if only patients were invariably carefully examined. The general symptoms of the onset of this disease so resemble those of many other acute infections that the practitioner, after noting the temperature, pulse, and respiration, and perhaps looking at the throat, is apt to say "It may be scarlet fever, or typhoid, or perhaps only a spoiled stomach. We can tell more certainly in a day or two." And so precious time is lost. The young child does not locate pain accurately, and his cries and dread of handling is perhaps attributed to peevishness or fear of the doctor. If attention is drawn to pain or tenderness about a limb, too often they are attributed to rheumatism. If, as is not infrequently the case, there is a history of exposure to cold or wet, the diagnosis of rheumatism is considered proven. As the scapegoats of medical pediatrics are teething and worms, the scapegoat of joint and bone surgery in childhood is rheumatism. Mr. Owen has very graphically described [1] the evils of this ready diagnosis of rheumatism in acute infectious osteomyelitis, and points out, what many a practitioner would discover if he only took pains to examine, that the swelling is in the shaft of the bone (albeit near the epiphysis), whereas in rheumatism it would be in the joint. Moreover, the joint inflammations of rheumatism are multiple—scarcely ever confined to one joint or limb. With infectious osteomyelitis the trouble is usually in one part, frequently, but not always, one extremity. Yet it should be borne in mind, as Peters has emphasized, that the occurrence of multiple foci in osteomyelitis should receive attention. And he cites a case which presented points of infection in both tibiæ, both astragali, sixth and seventh ribs, two points on spine of right scapula, infra-spinous fossa of left scapula, and the left pubic ramus. While some of these points were, as he remarks, probably pyemic, the advice to examine all palpable epiphyses on admission of a suspected case, and to watch for new foci during the development of a case, is nevertheless good. It seems hardly credible that the skin eruption of osteomyelitis should lead a practitioner to deceive himself as to the nature of the disease, but it may resemble scarlet fever or other exanthem, and this mistake has occurred.

Prognosis.—There is hardly a disease of childhood in which, for the saving of limb or life, so much depends upon prompt recognition of the disease and the employment of proper treatment. With the exception of the fulminant cases, which, regardless of treatment, inevitably go on to the fatal end, it may be said that nearly

[1] Surgical Diseases of Children, p. 365, et seq.

all cases could be saved if treated early. But that even the ordinary cases not treated will probably prove fatal and are certain to result in serious loss of bone, and many of them in spontaneous dislocations, contractures, sub-luxations, ankyloses, chronic sinuses, et cetera.

Treatment.—The treatment is surgical. This does not mean leeches, fomentations, icebags, poultices. It means the use of the knife in making prompt incision or incisions down upon the diseased bone. Yet the parts should not be inconsiderately laid open from end to end of the bone, as is sometimes advised. That makes an extensive wound in a young child; and the incisions should be made with due respect for the vessels and nerves. Even muscles should not be incised if a safe and suitable intermuscular space can be followed to the bone, or if the muscle fibers can be separated longitudinally by dry dissection down to the periosteum, which must be incised. The objects of the opening are free drainage and relief from tension, and if these are secured the incision is sufficient. If there is evidence that the disease has extended beyond the reach of the incision another incision can be made lower or higher to find the extreme extent of the suppurative process. The area between can be washed out from one opening to the other. It is necessary, also, to explore with drill or gouge into the bone itself. Especially is this true if the case is of the virulent type with evidence of great toxemia and yet not enough pus is encountered on going beneath the periosteum to account for the general condition. Then the bone, even the medullary cavity, must be explored; and if pus be found which extends beyond reach, a counter opening must be made, the same as the counter opening in the soft parts, and the canal cleaned between. I do not think it is advisable early in a case to attempt to open the entire shaft, or even the entire periosteum, and undertake to remove every particle of diseased tissue. For one reason, I do not believe it is possible to remove every minute thrombotic blood-vessel or lurking microbe; certainly not without a sacrifice of much sound tissue and the risk of opening to infection parts not otherwise infected. For one cannot tell, early in a case, just how far an infection has extended.

It is well worth while, as Nichols has pointed out, to endeavor to preserve the endosteum as well as the periosteum. Experience with this as with analogous conditions proves that when tension is relieved and free drainage afforded there is comparatively little danger of further absorption of toxines or of metastases and pyemia. The attack of the enemy is drawn off by friends from without, and nature relieved can erect her own barriers. The wounds should usually be dressed moist, at least at first, with ample absorbent dressings while it is draining. Sandbags, splints or sup-

porting apparatus should be used. Splint or other support is necessary even if epiphysis and shaft have not separated. If they have separated no one would deny their necessity of support; but under other conditions one sometimes sees the principle of rest neglected. Besides promoting rest, the splint aids to prevent contractures. It should be so applied that it need not be removed while the dressing is made. In the meantime the general condition should receive attention in the way of anodynes sufficient to relieve the pain, stimulants without stint, as much easily assimilable food as the patient can make use of, and baths, the ice-cap and hypnotics as required.

There are some cases of acute osteomyelitis in which the question of amputation will rise, and this may occur at two different stages of the disease. First in a very virulent type of medullary disease with thrombosis of the large vessels of the limb and perhaps implication of a joint. In such a case the danger of amputation is very great, and there is no certainty that other foci of disease have not already been started. It is certainly inadvisable to consider amputation unless thrombotic vessels can be ligated above any thrombosis.

The second stage or condition is when exhaustion is threatening from long-continued suppuration, especially if joints are suppurating or a whole shaft has become destroyed. This condition is rather more promising of a safe operation; but it is also usually more amenable to other measures of relief, such as excision, curettage, more thorough irrigation.

After the acute stage of the disease has passed there comes a long period of waiting which is very tedious for the patient and his friends, while nature is endeavoring to separate the sequestrum from the bone which survived. This process will require from six weeks to three or four months, according to the bone involved, the size of the sequestrum and the age of the patient. This time should be used to improve the general condition of the patient with well-studied diet, baths, massage, and, if possible (and it generally is possible), by life in the open air and sunshine. A bed-ridden patient can be carried out of doors upon a cot or Bradford frame; many can use crutches or a wheel chair; if the trouble is in the upper extremity they can walk out. Wounds or sinuses should of course be carefully dressed and splints or braces worn when necessary. On account of the slowness of nature's methods of separating the dead from the living bone, many surgeons have tried to improve upon it. Some have advocated cutting down upon the dead bone and chiseling or gouging it away, even going over the line into living bone, and then closing the wound. This procedure has been applied at different lengths of time after the onset of the disease, even as soon as the cessation of the active illness, or as long as would

almost suffice for a natural separation of the necrosed bone. But it is impossible to precisely define beforehand where the line of separation is going to take place. Consequently the operation is sure to result in a waste of living bone, and no one has been able to show a result obtained by surgical interference before separation of the sequestrum any more satisfactory than that produced by nature. It should be understood, too, that natural processes, if given time enough, are capable of taking care of the entire process, not only of separating the dead bone from the living, but extruding it from the body. This would come about, as before remarked, by a process of osteoporosis, a softening and liquefaction and removal of a portion of the living bone which encircles the dead, thus creating an opening through which the disintegrated and gradually dissolved dead bone would be carried by the discharges or crowded out by the granulations. The encircling involucrum would then close in and the construction of a new bone very much resembling the original in shape and of size natural to the part would be built up. But these changes would occupy months and years; and there is a stage at which surgery can be of great assistance, by removing the sequestrum when it has been separated, or almost separated, from the involucrum. That the proper stage for interference has been reached may be judged by the length of time elapsed, by the evidence of the formation of the involucrum as shown by thickening in the shaft, or as shown by the X-ray, and by the use of the probe introduced through a sinus into a cloaca of the involucrum. It is sometimes possible, if the sequestrum is entirely loose, to move it with the probe perceptibly to the sense of touch. To delay removal of the sequestrum after it has separated only allows time for the hardening of the involucrum into more dense or eburnated bone, and loses the advantage of the first vascularity and activity of the periosteum present at three or four months after the necrosis.

Sequestrectomy should be performed with all precautions against sepsis. The Esmarch tourniquet not only facilitates the work by securing a bloodless field, but it saves blood, and often there would be, without it, a good deal of blood lost. In opening down to the bone, sinuses and cloacæ should be utilized as much as possible, and the soft parts, especially nerves, which are not easily reunited, should be duly respected. The periosteum should be raised over the necessary area with as little injury as possible to the osteogenetic layers of its under surface. The edges of a cloaca are then gouged or chiseled or snipped away with gouge forceps, until a sufficient opening is made to loosen and extricate at least a piece at a time of the sequestrum. It may be that more than one opening into the involucrum will be needed, or a long slit cut in it, and the sequestrum divided before all the dead bone can be removed. All

openings should be as narrow as possible, and if very long, a bridge remaining in the middle strengthens the trough of bone that is left. In short, the surgeon should exert his mechanical skill to accomplish his purpose with as little sacrifice as may be of sound bone or tissue that might produce bone. The sequestrum removed, suspicious pockets or exuberant granulations should be curetted or touched with pure carbolic acid or hydrogen peroxide, all pus, blood, scrapings or spiculæ carefully wiped out with gauze. The cavity, if not a large one, is then rather firmly packed with iodoform gauze; if the cavity is large, cyanide or plain sterile gauze is used. An ample dressing is applied and bandaged in place and the Esmarch rapidly removed. The limb is placed upon a splint, elevated, and next dressed in not less than two days nor later than the third day. By this time there will be no bleeding; and the wound should be but lightly packed and dressed as before. In the course of a few months one may expect to have not only the wound entirely closed but the bone reproduced.

On account of the time consumed in this process and the necessity of repeated dressing of this gradually filling and closing cavity, many surgeons have applied their learning and skill to devise a method for prompt repair and closure after sequestrectomy. Methods attempted have included plastic and osteoplastic plans, and also the introduction of various foreign substances into the bone to occupy the vacant space or to become the framework for the building of new bone. Before any young surgeon undertakes to advance the art along this line, he may save time by studying the history of the subject. Memorable events were Schede's work with blood-clot and the use of decalcified bone chips as employed by the late lamented Senn. The great difficulty is in rendering such a cavity absolutely sterile. The substance for filling the bone cavity must be innocuous, and various metals, plasters, cements, transplanted living bone, catgut, and other materials have been tried. Von Mosetig-Moorhof uses a mixture of iodoform 60 parts, spermaceti and oil of sesame, each 40 parts. These are heated in a water bath up to 100 degrees C. and constantly agitated while cooling to prevent the iodoform from settling. The preparation of the bone cavity is a very important matter. It is prepared by curetting, mopping with a solution of formalin 1 per cent., or of bichloride solution 1 to 500, or of chloride of zinc 12 per cent., or of carbolic acid 95 per cent., followed by alcohol, mopping with dry gauze, and drying with a current of hot air. The cavity must be absolutely dry and sterile or the result will be a failure. The mixture, heated to 50 C., is poured into the cavity and the periosteum sutured over it with catgut. Temporary drainage by a few strands of catgut is supplied, or no drainage. The outer wound is closed separately with

fine silk. A generous surgical dressing is applied and the part immobilized. The first dressing is left on from ten days to two weeks. This substance and method have certain advantages not pertaining to any others yet tried. One is that if it fails the condition is not worse than before, as occurs when some of the osteoplastic plans are tried. Again, the substance is not only innocuous, but antiseptic, and yet it is claimed that iodoform poisoning has never been caused by it. Another advantage is that it is gradually absorbed away and its place taken by bone tissue. Excellent results have been obtained by this method in a large percentage of cases.

ACUTE EPIPHYSITIS (ACUTE ARTHRITIS OF INFANTS)

In 1884 Thomas Smith published in the St. Bartholomew's Hospital reports a series of cases which have often been cited, of what he called acute arthritis of infants. It is now considered that this disease is identical with what is called "acute epiphysitis," "acute purulent synovitis," "pyemia of bone," and even in a very confusing way, "acute osteomyelitis."

A study of cases and of case reports would lead one to suspect that a number of different diseases are here grouped as one, albeit a number of different names have been used to designate what is supposed to be the same disease. An acute epiphysitis begins in the epiphysis and may sometimes by timely interference be arrested there. But it tends quickly to invade the joint. And in cases in which the joint is involved the inflammation may be severe enough to extend through the epiphyseal line and separate the epiphysis. The joint cavity may burst open or be evacuated by the surgeon and recovery take place without separation of the epiphysis, and with very little impairment of function; or with separation of the epiphysis and so much damage to the epiphyseal line that the bone never afterward grows in length; or the patient may die of toxemia and exhaustion, or pyemia. Even then the disease does not tend to strip up the periosteum nor extend into the medulla and cause necrosis of the shaft like acute infective osteomyelitis.

The cases of acute arthritis described by Holt and others in which the gonococcus is found are cases of purulent synovitis. The disease begins in the joint, not in the epiphysis, and it does not tend to attack bone. Small joints rather than large are affected, often a number of joints in the same case, and the general symptoms distinctly precede the local ones. In cases of acute epiphysitis, as has just been said, the point of origin and the destructive course are different. The disease prefers the largest joints and the number of the cases diminishes with the size of the joints. There is far less frequently more than one point attacked, either simultaneously or in succession, than in the gonococcus infection; and the local and general symptoms begin almost together.

Acute epiphysitis is a disease of infancy, and is more frequent and usually more severe in early infancy. Some writers enumerate all the predisposing causes of infectious osteomyelitis and add to them syphilis and tuberculosis, as the predisposing causes of acute epiphysitis. But while these two diseases may be predisposing causes, acute epiphysitis should not be confounded with the epiphysitis of hereditary spyhilis. That disease may show great tenderness, and even loss of function, but no such swelling or constitutional disturbance as the disease in question.

Symptoms.—The bacteriology is the same as that of infectious osteomyelitis; and the symptoms are so similar that differentiation is sometimes difficult. They are severe pain and tenderness, fixation of the joint in a semiflexed position by muscular spasm, swelling. The surface may be reddened and effusion may be detected in the joint; but these may not be perceptible until much damage has been done and the abscess is about to make its way to the surface. Other symptoms are fever, sleeplessness, or stupor and prostration. But it may be detected that with epiphysitis the tenderness and swelling are distinctly in the situation of the epiphysis or extend into the joint, while with osteomyelitis the tendency is for the swelling and tenderness to extend down the shaft. The habit before referred to of pronouncing all joint diseases rheumatism leads to errors in the detection of acute epiphysitis. But rheumatism is very rare at the age when this disease is most common.

Treatment.—The treatment is precisely similar to that laid down for infective osteomyelitis, namely, early incision and drainage, and support of the patient. If one could be sure the case was one of synovitis from the gonococcus and that suppuration would not occur, he might be content to wait a little, at least until aspiration and examination of the fluid. But in cases of true acute epiphysitis early diagnosis and early relief of tension afford the only hope of saving the joint or the usefulness of the limb, or perhaps the life.

The gonococcus cases may recover completely. In other infections there is apt to be serious impairment. Those in which the epiphysis has been separated may become flail joints; and if the epiphyseal cartilage is seriously damaged growth in length of the bone is stunted. Two incisions are usually necessary to properly drain a joint; although many a joint has been saved by one. The incisions should be made at the most accessible part of the joint and away from any nerve trunk or great vessel.

SYPHILITIC DISEASES OF BONES, PERIOSTEUM, JOINTS AND CARTILAGES

Pseudo-paralytic Syphilitic Perichondrosis sometimes manifests itself quite suddenly by the inability of an infant to use a limb. Upon examination a ring-like swelling encircles one of the

long bones at the situation of the epiphyseal cartilage. In some cases other epiphyseal cartilages will present similar enlargments. The annular swellings are tender on pressure or motion, and the infant refrains from moving the affected limb. Wasting of the muscles makes its appearance. Confirmatory evidence of syphilis may be found in snuffles, rashes or a history of them, cranio-tabes or bosses. In rare cases the syphilitic disease may suddenly separate the epiphysis from the shaft, and even produce suppuration.

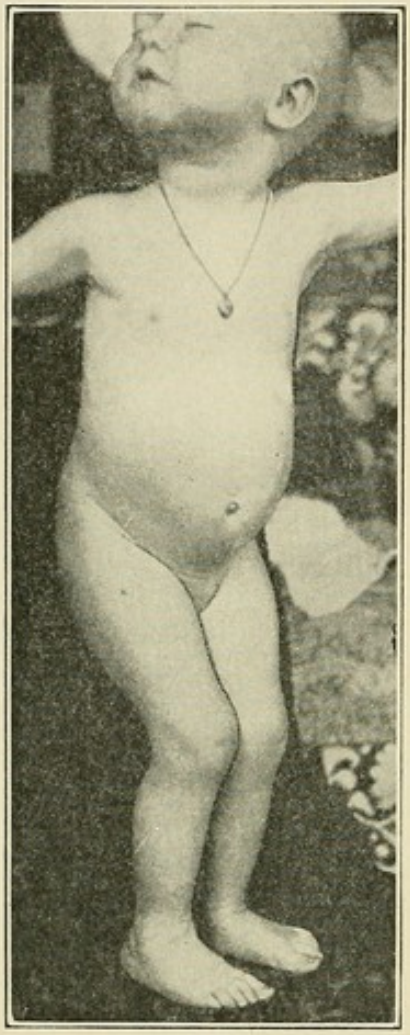


FIG. 69. PLASTIC OSTEO-CHONDROSIS. Hereditary syphilis. The knee could not be fully extended. Patient 22 months old.

There should be no real difficulty in distinguishing this disease from infantile paralysis, rickets, and scurvy, which each have their own characteristics. The use of gray powder or mercury in any form effects a certain removal of the symptoms in the syphilitic case.

Instead of epiphysitis, or following it, osteomyelitis or periostitis may appear and produce a thickening of the shafts as well as the epiphyses, which later ossify. One has seen what appeared to be a plastic osteo-chondrosis result in such a change in size and shape of the articular ends of the bones at the knee joint that the limbs could not be fully extended. (See Fig. 69.) After months of anti-syphilitic treatment the chronic enlargement subsided to the normal. This condition later was followed by partial paralysis of one upper and lower extremity and pupillary paralysis in the eye of the opposite side and loss of the hair. Iodide of potassium in large doses and mercury in small doses cleared up these symptoms, excepting the eye paralysis, which diminished but remains slightly noticeable at this writing.

CRANIAL BOSSES are rounded elevations upon the frontal and parietal bones. They are supposed to be produced by an overactivity of the pericranium excited by the syphilitic virus when the disease is inherited. A similar condition is present in some cases of rickets and it has been argued that the bosses are due to rickets in-

stead of syphilis. M. Parrot, who first described the cranial bosses and attributed them to hereditary syphilis, considered rickets only a manifestation of inherited syphilis. That theory cannot be maintained. One evidence against it is that in rickets the younger children in a family are those increasingly affected, while in syphilis the older children are more severely diseased and the virulence decreases with the later ones.

Cranio-tabes—thin, parchment-like spots in the occipital and parietal bones in the region of the lambdoidal suture elsewhere described—also appears in both syphilis and rickets, and is more generally believed to be evidence of luetic taint; although tabes is found also in infants not presenting any other evidence of either syphilis or rickets, but only malnutrition. Syphilis is said to sometimes produce premature ossification of the cranial sutures.

Nose and Palate.—Disease of the bones of the nose is an early manifestation and that of the palate and face with extensive destruction are among the late manifestations of hereditary syphilis. (See Section on Syphilis in Chapter IV.)

Ostitis and Periostitis.—A form of ostitis and periostitis of the long bones is very characteristic, although seen but rarely by comparison. It is typically presented in the tibiæ, which swell, become somewhat tender, and undergo a slow chronic osteoplastic periostitis, especially upon their anterior aspects. This is often accompanied by a diffuse ostitis; and it is not impossible for periostitis, the formation of gumma and its degeneration resulting in caries or necrosis, and for overgrowth of new bone both in thickness and length, to be in progress in the same bone at the same time or to alternate in their activity. Arrest of growth may result from syphilitic epiphysitis. Syphilitic disease is apt to give rise to a deformity called saber-leg, from the bowing forward of the tibia due to formation of layers of bone beneath the periosteum. Sinuses leading to carious cavities or to necrotic areas may also be present in the same case. (See also Osteoplastic Periostitis.)

Syphilitic Synovitis may accompany periostitis or ostitis when it approaches the joint, or it may appear independently of any other lesion. It is apt to affect several joints and to disappear under the influence of iodide and mercury.

Diagnosis.—There is not a great deal of likelihood in average cases, of mistaking between tuberculosis and syphilis if one look farther than the lesions themselves for the diagnosis. The family and personal history should always be inquired into, and often will uncover evidence of value. Physical examination will often discover otitis, keratitis, Hutchinson's teeth or nodes in the syphilitic case; or scars of cold abscesses, strumous glands or enlarged phalanges, with signs of visceral complications in the tubercular

patient. Both are chronic diseases of bone, but with tuberculosis there is less tendency to formation of new bone or of necrosis, and more tendency to suppuration and to caries than in syphilis. Pain more severe at night or constant pain in the absence of abscess is more characteristic of syphilis.

The enlargement of a new growth is more definite in its outline and is more apt to be about the end of a long bone than spread along a shaft.

With periostitis the swelling comes more promptly after the pain than with osteomyelitis.

Chronic periostitis non-syphilitic is not apt to be symmetrical.

One has seen a swelling of three weeks' duration of the lower ends and a portion of the shafts of both femurs in an infant of nine months, which was very puzzling. There was tenderness, little fever, and some redness upon one thigh. A history of continued artificial feeding and the age of the infant, led to the use of anti-scorbutic diet, under which the thighs promptly improved. This seemed to confirm a diagnosis of scurvy, although the gums were not spongy, and although the frontal bones presented the appearance of moderate-sized bosses.

Prognosis.—In the conditions which arise during infancy the prognosis is extremely good if treatment is instituted early. Even the separated epiphyses will reunite and the local swellings and tenderness subside. The later lesions are more stubborn to overcome, yet they yield to energetic medication. When bone has been destroyed before the nature of the disease is discovered or the treatment pushed, it can never be reproduced.

Treatment.—Early symptoms of lues hereditaria yield in a remarkable way to mercurial treatment in any form. (See Section on Hereditary Syphilis.) The most available preparations are gray powder and oleate, or blue ointment; though baths are particularly useful when there are also skin lesions, and sublimation, or hypodermic injection can be used in a very urgent case. The hypodermic method seems unnecessary, and being of no especial advantage and painful, I never employ it.

In the older children, that is, in the later manifestations, potassium iodide, or this with mercury are very efficacious. One looks with confidence for improvement in nearly every case as soon as enough of the medicine has been used. Large doses of the iodide are sometimes necessary, and, unless the effect is obtained, the dose is gradually increased, up to the point of tolerance. When given with large quantities of water there is little danger of gastric derangement from the remedy, and no fear of iodism appearing before the desired alteration in the lesions.

TRAUMATIC ARTHRITIS

Traumatic Arthritis occurs in children the same as in adults with little that is peculiar to mark either symptoms, course, or termination. It may vary all the way from simple synovitis, with or without effusion, as a result of contusion, to an acute suppurative arthritis following a crush, or a compound dislocation, or a penetrating wound of the joint with infection. The symptoms are pain and tenderness, swelling, altered position, redness and heat of the joint and muscular tension. The pain is in the joint itself excepting in the case of the hip. Pain is worse on motion. There is tenderness at certain points. Swelling is sometimes very prompt and large, especially if there is an effusion. Altered position almost always places the limb about midway between flexion and extension, this evidently equalizing pressure in all parts of the joint and making it the least uncomfortable. Redness is not present in a simple synovitis, but makes its appearance if acute suppuration takes place. Redness appearing early indicates injury of peri-articular structures. Local heat amounting to one or two degrees is present in proportion to the violence of the inflammation.

Muscular tension is always marked in a purulent joint inflammation. The fluid effused in acute synovitis may be very small in amount; or it may be altogether absent, in cases called "dry synovitis." The small amount of fluid is apt to be fibrinous and to lead to adhesions between the articulating surfaces, thus causing fibrous ankylosis. Fever is not a necessary accompaniment of simple synovitis; but if suppuration ensue fever of three or five or more degrees will be present. Moderate fever may be present from absorption of effused blood in or about a joint, but this will subside in two or three days.

Diagnosis.—The diagnosis is not difficult when the history is known and the symptoms are at all definite. There may be difficulty in deciding whether an enlargement in the situation of a deep joint is an inflammatory exudate or fluid within the joint. In superficial joints a fluid would fluctuate. Then there may be a question as to whether simple effusion or suppuration is present. The amount of fever and constitutional disturbance is an index; also the amount of muscular tension. If necessary, tapping with antiseptic precautions may be resorted to for diagnosis.

Prognosis.—Prognosis is somewhat better in children than in adults. One has several times been able to verify the statement of Volkmann and Krause that even purulent synovitis does not invariably impair the joint permanently if the pus finds a quick exit or is promptly removed.

Treatment.—The treatment of acute simple inflammation is

the same as in the adult, namely, elevated position, rest, the ice-bag or cooling and astringent lotions in the acute stage; counter irritants, blisters, cautery, massage, sometimes aspiration or hyperemia in the later stages and for removing the products of inflammation. If pus is present in the joint it must be promptly and freely opened and drained. An acute traumatic arthritis may merge into a chronic condition.

One important point in the treatment of traumatic arthritis is the prevention of deformity. An injured joint should always, if possible, be put up in the position in which it will be most useful if ankylosis takes place. The hip, knee, and ankle should be in the position for walking, the elbow at a right angle and with the wrist half way between pronation and supination. But, if possible, ankylosis should be prevented and function restored by passive movements begun as soon as the inflammation has subsided enough to allow it. There is nothing to be gained by attempting motion in an injured joint so early that it is irritated to an exacerbation of the inflammation. But a degree of pain and temporary soreness is to be expected during and after the passive motion, and should not prevent its repetition a day or two later. Massage and hot douches are very useful in restoring function to the joint.

Arthritis of Infective Origin, Non-Tubercular,—Non-Syphilitic.—There is a class of cases of arthritis occuring in the course of or following the infectious diseases, for instance, typhoid fever, scarlet fever, variola, measles, mumps, dysentery, diphtheria, gonorrhœa. It will not be necessary to devote much space to any or all of these, yet they have a definite place in the surgery of childhood. For example, of thirty-five cases collected by Keen, of dislocations of the hip-joint in arthritis following typhoid fever, thirty-two were under twenty years, and twenty-two were under fifteen years of age; and a large majority of the cases occurring in connection with the exanthemata are in children. Keen[1] analyses the collected cases of typhoid arthritis under rheumatic typhoid arthritis, septic typhoid arthritis, and typhoid arthritis proper.

The ordinary joint inflammation occurring in the course of scarlet fever is often called scarlatinal rheumatism. It is unfortunate that the name rheumatism cannot be substituted by a more distinctive title when an arthritis occurs in connection with a specific infection. Such conditions might well be called toxic or irritative in these secondary cases designated as rheumatic, which present pain, tenderness and sometimes synovial effusion. The causative factor appears to be the toxines developed by the primary disease without the presence in the joint of any discoverable organism. The second

[1] "Surgical Complications and Sequellæ of Typhoid Fever."

class of cases which occur in typhoid, scarlet fever, and the other primary infections, are well called septic or suppurative, for, even if they begin sometimes apparently as serous inflammations, they

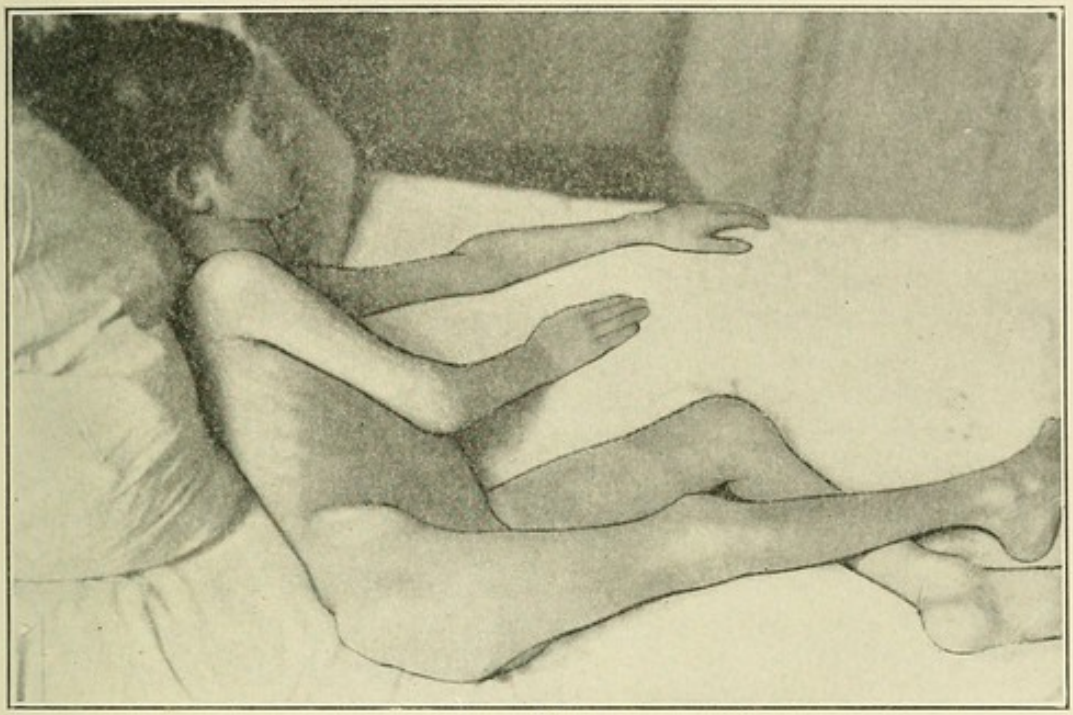


FIG. 70.

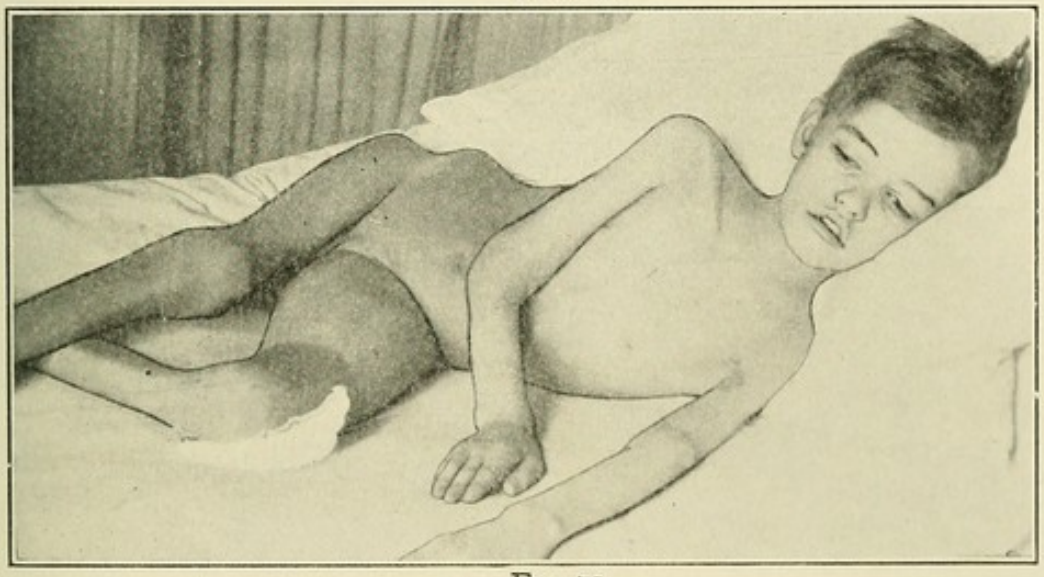


FIG. 71.

FIGS. 70 and 71. POST-SCARLATINAL POLY-ARTICULAR ARTHRITIS affecting the right elbow, both hips and the right knee. The right hip had been dislocated during the height of the effusion, and had never been reduced.

cause suppuration in the joint or joints affected, and pyogenic bacteria are found in the joint.

There may be a distinct third class, such, for example, as Keen considered in connection with typhoid as "typhoid arthritis proper," in which the joint affection is caused by the organism of the primary disease alone, unmixed with the strepto- or staphylococcus, and producing a slow but large distension of the joint, without tendency to suppuration or ankylosis, but with a considerable danger of dislocation of the joint.

Whatever the minute pathology of these cases, clinical experience records their occurrence not only after typhoid but after the exanthemata. Figs. 70 and 71 are from photographs of a boy of eight years who was brought to the City Hospital, Cleveland, with a post-scarlatinal poly-articular arthritis affecting the right elbow, both hips, and the left knee. The right hip had been dislocated during the height of the effusion, and had never been reduced. The joints were so tender as to preclude any examination without anesthesia, and the boy was as helpless and pitiable as could be imagined. He was also developing tuberculosis. The joint conditions of these unfortunate cases are apt to be overlooked during the height of the primary illness, the general state of the patient being so serious that local conditions are less regarded than they should be, or the joint regions are so exquisitely painful as to forbid a careful examination, or they are considered to be "rheumatic" and requiring only rheumatic medicine. Keen draws attention to the fact that in nearly one-half of the cases of dislocation of the hip in typhoid the actual dislocation was the first fact observed in connection with the joint, so insidiously had this complication approached.

The inflammatory joint complications need special attention wherever located, but it is in the hip-joint that they are particularly apt to be overlooked, and also to result in dislocation by decubitus alone or by slight accident in turning or handling the patient. Analogous dislocations occasionally occur in rheumatism with large effusion, and in adults in locomotor ataxia and hemiplegia where the ligaments and muscles are completely relaxed. In the cases occurring with infectious fevers the joint capsule is gradually completely distended and relaxed so that the slightest force will cause displacement. In the case of the hip-joint, even adduction with rotation inward, or with the shoulder or knee-joint, gravity with muscular action, will dislocate the joint. The distended condition of the joint should be discovered if it occurs, and the limb placed in position and supported in such manner as will prevent dislocation.

If dislocation occurs it should be reduced. This is usually effected without difficulty if attempted early, the head of the bone slipping into place without impact, for there is absence of muscular tension or capsular suction. When easily reduced the luxation

may easily recur; and means should be used to guard against such an accident. Inflamed joints should be supported at rest by splints or bandages, slings or sandbags, and the inflammation allayed by cold or hot applications. Aspiration should be done if the joint is over-distended. If suppuration occurs it should be incised and drained. If ankylosed in dislocation, osteotomy and perhaps tenotomy may be necessary to bring the limb into position to be used.

GONOCOCCUS ARTHRITIS

This corresponds to the usually mono-articular gonorrheal arthritis of the larger joints in adults; but is quite different from the pyemic cases alluded to in the section on epiphysitis. If merely irritative as a result of toxines, it should be treated by rest and sedatives to the joint; and the local primary infection in vagina, urethra or eyes cured as soon as possible. But if there is suppuration (which probably is caused by the presence in the joint of the gonococcus itself) prompt incision and drainage should be resorted to. Vaccines should be tried.

CHRONIC SECONDARY INFECTIVE OSTEO-ARTHRITIS

A secondary infective arthritis following scarlet fever or other infection may assume the character of an osteo-arthritis, and become chronic. It should be treated upon general principles.

NON-INFLAMMATORY ARTHROPATHIES

A number of diseases could be grouped under this heading. Some are caused by primary disease of the nervous system, such as syringomyelia, luetic disease of the posterior columns, tumors, or injuries of the spinal cord, myelitis, hemiplegia, locomotor ataxia. They are known as Charcot's joint-disease and are uncommon in childhood. They usually present synovitis, with degeneration of cartilage, ligament and bone and may have villous growths and osteophytes. Dislocations are not uncommon. Other diseases of this group are of metabolic or of unknown origin. We have space for but two, osteo-arthritis and the joint-changes of hemophilia. *

OSTEO-ARTHRITIS (RHEUMATOID ARTHRITIS)

Marsh writes: "The old writers styled the affection rheumatic gout; Haygarth (1805) nodosity of the joints; Robert Adams, chronic rheumatic arthritis; Garrod, rheumatoid arthritis. The French term it arthrite sèche, or, after Cruveilhier, *usure des cartilages articulaires;* the Germans, arthritis deformans. Many recent authorities speak of it as osteo-arthritis, or monarticular rheumatism, or, when it is seated in the hip, morbus coxæ senilis.

* Treatment is by rest, support, braces and gypsum bandages. Operative reparative surgery is apt to be disappointing. Aspiration may be required. Amputation is a last resort.

So profuse an assortment of titles suggests that much doubt has existed as to the real nature of the affection": Which is very true; and doubt still exists and the number of titles augments. One of the most recent writers (Painter, in "American Practice of Surgery") describes it under the name atrophic arthritis. Thus the termination "itis" is retained and the disease is classified under the non-tubercular inflammations of joints, although the article states that "it is in no sense an inflammatory disease" and that "the inflammatory causation theory receives no positive support from pathology, for all the lesions which, through any stretch of the imagination, could be called inflammatory, are of such a chronic nature that they might be caused by any local irritation, be it inflammatory or otherwise." So we are not yet at an end of confusion in our nomenclature and classification. If one were to venture yet another name it would be chondro-atrophic arthropathy. It is not peculiar to childhood and is rarer in youth than in adult life, yet it does occur before puberty. While occasionally associated with or following the acute infectious diseases or rheumatism, it is not thought to be a direct result of either, nor yet of any central nervous lesion, but of some as yet unknown disorder of metabolism accompanied by an unaccountable loss of lime salts from the body, infiltration of the synovial tissues and atrophy and erosion of cartilages. There is also degeneration of bone, but no caries nor necrosis. Its course is extremely chronic. It is usually poly-articular, beginning often in the phalangeal joints, with spindle-shaped swelling from thickening of the synovial villi. There is not much pain, slight tenderness, and no local heat. The adjacent muscles atrophy. Motion becomes more and more restricted, and deformity occurs, usually by traction of the flexors upon the joints whose cartilages are atrophied. (See Fig. 72.) With treatment the disease can at least be arrested and the use of the joints often considerably improved.

Treatment.—Nutrition should be kept up by a mixed diet to the full capacity of the digestion. Medicine should comprise such reconstructives and tonics as hypophosphites, iron and strychnine, rhubarb or columba and sodium or potassium bicarbonate. Baths, douches, packs are useful in all stages. Exercise, passive or active, should be begun after the acute condition is over, and systematically persevered in. Massage is useful, especially after the first stage. Rest and protection of the joints should be afforded by means of splints, which can be removed for the administration of the water treatment, the exercise and the massage, and then replaced. Braces can often be used to support the joints and protect them, to prevent deformity and to a certain extent to correct it, while not interfering with such motion as they are capable of. When the treatment

mentioned does not succeed in preventing deformity that seriously impairs function, it may be necessary to improve the position and degree of motion by operative means. When the joint is full of hypertrophied villi, arthrotomy or a modified erasion may be resorted to, in a manner similar to that described for fungous tuberculosis, but less extensive. No gouging is necessary, but a thorough

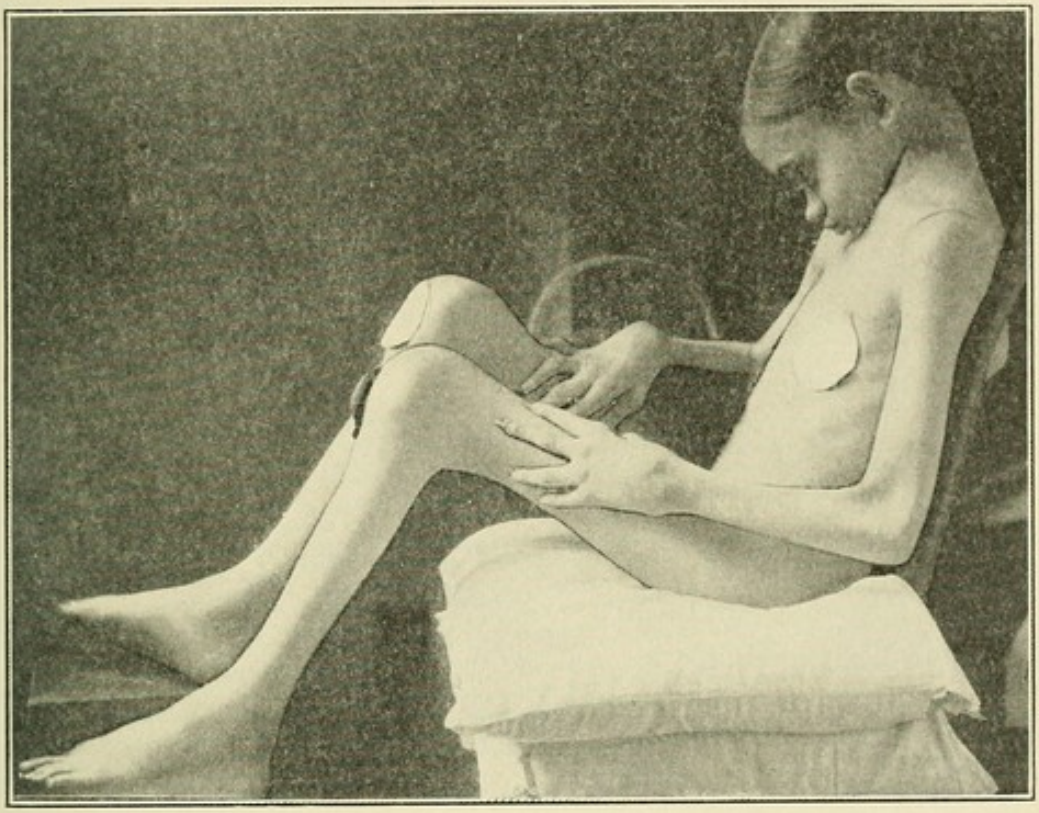


FIG. 72. RHEUMATOID ARTHRITIS. Boy 17 years. Disease began in 12th year. Joints have slight motion only. Patches of plaster put on by a quack.

trimming of the synovial membrance to free it of the villous growths, and careful closure of the synovial capsule and of the skin; all done under strict antiseptic precautions. Adhesions between the freshly cut synovial surfaces do not necessarily follow these operations. With the increased room between the articulating surfaces it may be possible to correct the deformity. If this cannot be effected with a safe degree of force, tenotomy of the flexor tendons may enable the surgeon to accomplish a reduction. In long-standing cases in which the removal of joint fringes is unnecessary, forcible correction is performed by manual strength or by the genuclast, without or with tenotomy. As a class, these cases are much more favorable for forcible correction than cases of ankylosis in displacement after tubercular or other inflammation, for the reason that there are fewer adhesions, less danger of lighting up an old

inflammation or spreading an infection, and less danger of injuring vessels which may have become embedded in scar tissue in the neighborhood of the joint.

JOINT CHANGES IN HEMOPHILIA

Concerning the peculiar morbid state known as hemophilia, or the bleeding disease, see section on that subject in an earlier chapter. The joint changes result from capillary hemorrhages of the synovial membrane, with swelling and a low grade of inflammation. The inflammation produces adhesions which limit motion in the joint. Degenerative changes also take place in the cartilages with fibrillation and atrophy. The articular ends of the bones are lipped. The changes in the cartilage and bone are quite similar to those of rheumatoid arthritis. The latter has no hemorrhages. Neither of them suppurate. The swelling may come suddenly and may be associated with hemorrhage appearing elsewhere, or by slight traumatism, though these associated conditions are often absent. The skin may appear stretched and shining over the joint, or ecchymotic. There is some tenderness about the joint, pain on movement, and local heat. The swelling and soreness may slowly subside, but often there remains some permanent impairment, and recurrent attacks.

Diagnosis.—Any obscure, subacute, relapsing swelling of joints in a male patient should be viewed with suspicion until the possibility of hemophilia has been excluded A family history of bleeders, or a concurrent or previous obstinate hemorrhage in the patient, or the presence of numerous and persistent " bruises " from trifling injuries would set one right on the diagnosis. The absence of such warning indices or a failure to inquire for them may lead to disastrous consequences. Serious and fatal hemorrhage has occurred from incising, or tapping, cauterizing, and even blistering hemophiliac joints.

Treatment.—The joints should be placed upon splints, with moderate pressure from a bandage, and an ice bag applied. Later, massage and stimulating liniments may assist in reducing the swelling and restoring function. The affected joint should be very carefully used and protected from even slight injury. The internal treatment will be found in the Section on Hemophilia.

CHAPTER IX

TUBERCULOSIS OF BONES AND JOINTS

Bone Tuberculosis — Joint Tuberculosis — Tubercular Arthritis of the Hip (Hip-Joint Disease; Morbus Coxarius; Articular Ostitis of the Hip)—Tuberculosis of the Knee Joint—Tuberculosis of the Ankle—Tarsal Tuberculosis —Tuberculosis of the Elbow — Tuberculosis of the Shoulder—Wrist-Joint Tuberculosis—Sacro-Iliac Disease—Tubercular Dactylitis (Spina Ventosa)—Tuberculosis of the Sterno-Clavicular Joint—Tuberculosis of the Ribs and their Cartilages—Tuberculosis of Other Bones.

These are the commonest bone and joint diseases of childhood. Considering the chronic course which they run, as well as the number of cases, they claim a great majority of all the hours a surgeon devotes to bone and joint surgery, far outnumbering the cases of osteomyelitis, acute epiphysitis, gonococcus pyemia and syphilitic bone and joint disease, all combined. These manifestations of tuberculosis belong to childhood and youth rather than to infancy, for they seldom appear before the second year. The questions of heredity and of the predisposing causes have been dealt with in a previous section. There is a possibility of an inherited tuberculosis which will show itself in bone. But there is a centainty that an inherited vulnerability to tuberculosis, that a lowered state of vitality from unsanitary living, overcrowding, lack of suitable food and of fresh air and sunlight, and the effects of diseases, especially of the infectious diseases, and notably of measles and whooping-cough, predispose the child to an attack of tubercular disease of bone or joint just the same as they do to an invasion of the viscera or any other tissue. However, tuberculosis of bone or joint may make its appearance unaccountably, where there is no known predisposing cause. Neither is the atrium of infection nor any primary tubercular disease always traceable. There may previously have been lymphadenitis, but quite frequently the disease of bone or joint is the first evidence that a tubercular infection has taken place.

Traumatism, particularly slight traumatism, is frequently an exciting cause; and it often determines the location of the disease, as had long been observed clinically before it was beautifully demon-

strated experimentally by Schueller and by Krause. While severe traumatism, even in the presence of tuberculosis in the system or introduced at the time of the traumatism, does not increase the liability to the disease. This has been explained as being due to the greater effort made locally by nature in case of a severe injury than is made in case of a trifling injury.

The conditions being favorable for the disease, the only essential causative factor is the tubercle bacillus.

BONE TUBERCULOSIS

Tuberculosis may attack bone of every class, cartilaginous or membranous; and bony tissue of any type, cancellous or compact; or of any shape or location. It prefers cancellous tissue; and its choice of location is the newly-formed immature ossifying tissue in the ends of the long bones, near the epiphyseal line. In the short bones it locates centrally.

The tuberculous process in bone is the same as in soft parts, if we make allowance for the different physical qualities of bone. In general miliary tuberculosis we may find, as a matter of pathological interest, miliary tubercles in the bone marrow. But the form of bone tuberculosis which is present in surgical disease is an ostitis which results in caries. The lesion first presents a grayish center, surrounded by a red zone of congestion. With the congestion there is swelling and infiltration, followed by a cheesy degeneration. Encapsulation may arrest the disease. Cicatrization may take place by the conversion of embryonal cells into connective tissue, or even into bone, the bone around the cicatrized granulating focus becoming sclerosed and forming a capsule. Even if caseous degeneration has taken place, the wall of the cavity containing it may become cicatrized, and so temporarily sealed in. Or there may be softening of the area of inflammation, new foci being established in the surrounding bone, and these, in turn, degenerating. Or there may be a proliferation of granulation tissue, which undergoes fatty degeneration and produces tuberculous abscess, an irregular carious cavity in the bone containing semi-fluid material resembling pus in appearance and often containing particles of disintegrated bone or calcareous matter. Occasionally a mass of diseased bone will become separated as a sequestrum from the surrounding bone, but as a rule the process is one of caries. Its cavity is lined with a "pyogenic membrane." If the process of softening, which always progresses in the direction of the least resistance, leads to escape of the abscess contents from the bone into the surrounding soft parts, we have a para-articular abscess. It is extremely rare for a tuberculous abscess to form in close proximity to a joint without a primary implication of either joint or bone.

If the breaking down of bony tissue extends in the direction of the articular cartilage, and that, in turn, with its covering of synovial membrane, gives way to it and allows the invasion of the joint, this joint abscess may, in turn, break through its walls and become a para-articular abscess. At this stage, if conditions are favorable, the opening between bone cavity or joint cavity and peri-articular abscess cavity may become obliterated by processes of repair, and cure may follow.

The abscess outside the joint may find its way by a comparatively short route to the surface. But it follows the line of least resistance, which often carries it between ligaments or muscles, along fascial planes, or in the direction followed by vessels or nerves until it reaches the skin. (See also Abscess in Section on Spinal Caries.) After producing necrosis of a portion of skin the abscess escapes, leaving a long sinus, which continues to discharge. Its lining is covered with spongy granulations, and if the opening in the skin temporarily heals over, it soon bursts out again and discharges its accumulation. Only in case of great improvement in the condition of the patient do these sinuses heal spontaneously. Usually they show no tendency to heal.

JOINT TUBERCULOSIS (21)

Tubercular disease of a joint generally begins in one of the bones composing the joint, although it may begin in the synovial membrane. If beginning in the head of a long bone it may, as before stated, find its way through into the joint by destroying a part of the articular cartilage; or it may emerge at the margin of the epiphyseal line, and in those articulations whose epiphyseal line is within the capsule the disease is readily communicated to the joint. This nearness of synovial membrane to epiphysis is clearly depicted in Figs. 73 to 77 after Power.

When tuberculosis occurs in synovial membrane, König found it sometimes in the form of miliary tubercles located in the subsynovial tissue, and without alteration of the surface of the membranes, and without symptoms in the joint. Or there may be a primary diffuse miliary tuberculosis, with or without osseous focus connecting with the joint. They may be small gray tubercles, located somewhat deeply and occasioning no symptoms; while in other cases, without granulations, the only indication of the existence of a tubercular joint disease is a slight hydrops of the joint.

Tubercular hydrops is produced by a tuberculous infection of the synovial membrane, which gives rise to a copious effusion into the joint. The joint becomes distended with fluid, but the pain, if present at all, is so slight that the patient is able to use the limb. If the joint is aspirated and the fluid drawn off it resembles normal

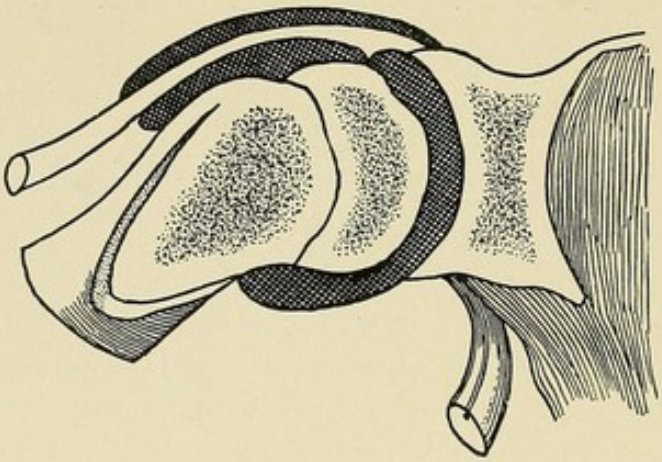


FIG. 73. SEMI-DIAGRAMMATIC SECTION THROUGH THE RIGHT SHOULDER JOINT, to show the relation of the synovial membrane to the upper epiphysis of the humerus. The synovial membrane on the inner side comes below the epiphyseal line, but on the outer side it stops at the anatomical neck, and is separated from the synovial sheath of the biceps.—Power's Surgical Diseases of Children.

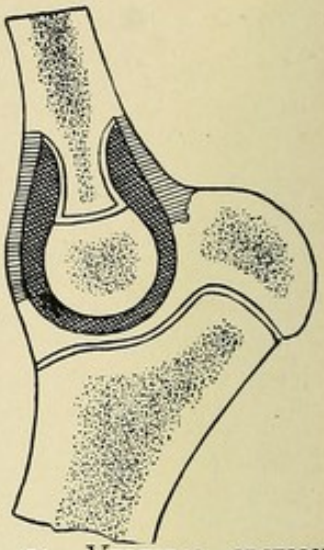


FIG. 74. VERTICAL SECTION THROUGH THE ELBOW JOINT, showing the relation of the synovial membrane to the lower epiphysis of the humerus, and the upper epiphysis of the ulna. Semi-diagrammatic after a drawing made by Mr. John Hutchinson, Jr. —Power's Surg. Dis. Children.

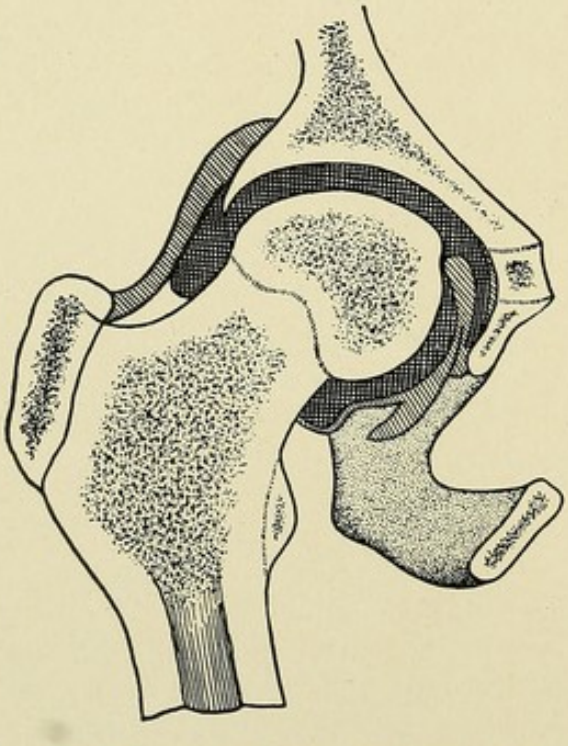


FIG. 75. SEMI-DIAGRAMMATIC DRAWING REPRESENTING A SECTION THROUGH THE LEFT HIP-JOINT to show the relation of the synovial membrane and capsular ligament to the epiphyses, and to the articulating surfaces.—Power's Surgical Diseases of Children.

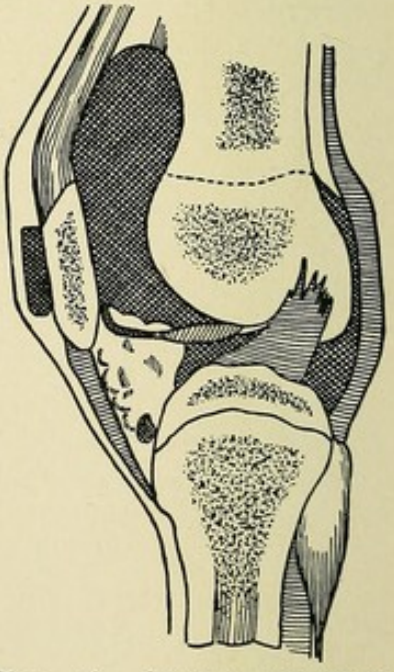


FIG. 76. SECTION THROUGH THE LEFT KNEE-JOINT, to show the relation of the synovial membrane to the epiphyses of the femur and tibia and to the articular surfaces. Semi-diagrammatic drawing from Power's Surgical Dis. of Children.

synovial fluid, though it may be less viscid and contain small shreds of lymph. Reaccumulation of the fluid rapidly takes place in the course of a few days. Or there may be fibrinous deposits in the synovia. In these cases of hydrops the synovial membrane presents but little alteration. There are a few tuberculous nodules imbedded in it. The condition is analogous pathologically to tubercular ascites. Later the synovial membrane becomes thickened and the joints assume the more usual condition presented in tubercular synovitis. (Senn.)

Hueter describes a form of synovial tuberculosis in which a thin vascular layer of granulations from the border of the cartilage approaches the center of the surface of the joint in the manner a pannus invades the cornea; with also a thickening of the synovial membrane which encroaches upon the joint space, resembling the physiological pannus of the embryo.

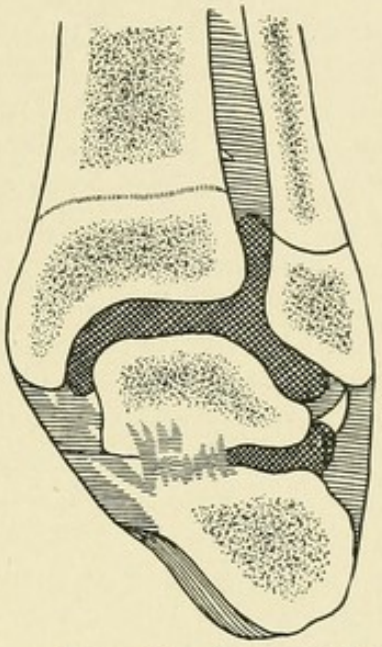


FIG. 77. SEMI-DIAGRAMMATIC DRAWING OF SECTION THROUGH THE ANKLE JOINT to show the relation of the synovial membranes to the epiphyses and to the artragalus. — Power's Surg. Dis. of Children.

A common and characteristic form of joint tuberculosis is that described by Bilroth as fungous synovitis, and by Hueter as synovitis hyperplastica granulosa. It is probably an advanced stage of the pannous form. It affects the synovial membrane generally, which becomes hyperemic, thickened, and covered with velvety granulations. The granulation tissue is abundant, springing from the intima of the synovial membrane, and while resembling the granulations of an open wound, have no tendency to undergo cicatrization. The tubercle bacilli are imbedded in the granulations, where they retard the growth of the young blood-vessels and thus determine early degeneration of the inflammatory product.

It is this form of joint tuberculosis, in which the ligaments and para-articular structures are early involved, that the thick mass of tissue, somewhat gelatinous in appearance, but more firm, and containing foci of cheesy degeneration, are produced, and called clinically, "white swelling of the joint." Three types of this diffuse synovial tuberculosis are described, varying with the location in the layers of the synovial membrane of the tuberculous foci.

Effusion does not occur in the pannous nor in the hyperplastic (fungous) forms of joint tuberculosis. The tuberous form of joint tuberculosis described by Riedel and König is very rare.

The rice-bodies so frequently found in dropsical joints, and also in synovial sheaths, and named from their resemblance in appearance to grains of boiled rice, may be taken as an indication of the tubercular nature of the inflammation in the joint. They were at first thought to be detached papillomatous growths. Their fibrinous composition seemed to tally with the well-known tendency of tubercular inflammation of joint surface and tendon sheaths. Yet it appears that they may not be composed of ordinary fibrin, nor dependent upon the presence of villous outgrowths in the joint. They may be developed upon the surface of the synovial sheath, and thence launched into the synovial fluid. While not in every instance tubercular in their origin, they are usually so. The microscope may not be able to find the evidence, but inoculation experiments will demonstrate the difference.

The articular cartilage takes no active part in a tubercular inflammation of bone or joint, at least not early in the process. But it may be completely destroyed by the action of granulation tissue upon it from the bone or from the synovial side, the destructive process extending from the periphery toward the center.

The course of events in a tubercular inflammation of bone or joint may at any time be greatly altered if pyogenic organisms gain access to the diseased area. This is especially evident in case of the reinfection of a tuberculous abscess. In this event there is great danger from septic absorption, and of exhaustion from profuse suppuration. The pyogenic inflammation destroys the barrier of granulation tissue enclosing the abscess and allows extension of the tuberculosis locally, or a general tubercular infection with the profuse and prolonged suppuration, amyloid degeneration of the liver, spleen, kidneys, and intestinal villi.

Symptoms and Diagnosis of Tubercular Bone and Joint Disease.—The classical signs of inflammation are considerably modified when the inflammatory process is of a tubercular nature, and especially if it be located in bone or joint.

Heat.—Local heat upon the surface is not perceptibly increased.

Pain and Tenderness.—Although an inflammation, tubercular ostitis is so slow in its course that neither tension nor its consequence, pain, are very marked symptoms. By the time tension would increase the bone has become softened and yields to the pressure. External pressure, as in standing erect with spinal caries, increases the pain. The pain is dull and aching and worse at night. The night cries of children, moaning and restlessness and grinding of the teeth in sleep, while not pathognomonic, always call for a thorough examination for tubercular bone disease. Pain is not always felt at the point of the disease. Its localization will be referred to later.

Tenderness is closely allied to pain. It is a more constant and

reliable symptom than pain. A tubercular process in bone, if it approaches anywhere near the periosteum, produces a localized sensitive or tender spot, which can be found if searched for, and may be the only point of differentiation between a tubercular synovitis and an osteitis.

Pain in a tuberculous joint may not be severe in daytime, but when the child falls asleep and the relaxed muscles allow the ulcerated synovial surfaces to come together, sudden pain causes him to scream out, the so-called "night cries" or "night terrors." Yet in some tuberculous joints, Senn thinks in those with most exuberant granulations, there is very little pain or tenderness so long as the joint surfaces are thus protected. But when the inflammatory process has proceeded so far as to threaten abscess, the pain and tenderness are very considerable by day, as well as by night, and will be greatly increased by pressure or attempts at movement.

Swelling.—Excepting in spina ventosa and diffuse osteomyelitis, tubercular osteomyelitis does not produce enlargement of bone. These are forms of rarefying osteitis or osteoporosis, usually accompanied by plastic osteomyelitis or periostitis, which increase the bulk of the bone externally. Swelling is a symptom in the majority of cases of joint tuberculosis. It is caused by thickening of the synovial membrane and fungous growths from its surface, or by an effusion into the joint in diffuse synovitis, or by inflammatory exudate outside of the joint. Hydrops is the most common and readily detected symptom. If it is painless and recurs after tapping, it is characteristic. The penetration of the capsule by a tuberculous abscess within it causes a diminution of the swelling, with an increase of swelling at some point outside the joint. There is one form of joint tuberculosis in which the joint is diminished instead of swollen; namely, the atrophic synovitis of Volkmann. (Senn.)

Friction or crackling sounds in the swollen joint are signs of the tuberous or dry fungous synovitis. The para-articular swelling at the junction of long bones and at the ankle produces a fusiform swelling that is quite characteristic.

Redness.—The deeply seated and slowly advancing inflammation does not have the same effect upon the skin as an acute pyogenic inflammation. If there is swelling the skin is somewhat stretched and whiter than normal, with a few large blue veins across its surface. If the inflammatory process in either bone or joint advances until the skin itself is implicated, it turns a dark red or bluish-red color, and even after abscess evacuates, the margins of the opening retain this hue.

Fluctuation is present in hydrops and in intra-articular abscess, and pseudo-fluctuation is present when the joint is filled with fungous growths. The aspirating needle will differentiate.

Atrophy of Muscle and Bone is a symptom common to tuberculosis of both bones and joints. Duplay and Cazin reviewed the whole subject in an endeavor to discover which of the numerous theories—functional inactivity, mechanical stretching, propagation of inflammation to the muscles, and vaso-motor changes—would best account for the atrophy, and considered them all insufficient. In common with most authors they agreed with Vulpian that the cause is tropho-neurotic; the irritation of the ends of the articular nerves reflect to the spinal centers, and from there upon the centers of the muscular nerves. (Senn.) This explains the rapid development of the atrophy, the absence of the reaction of degeneration, and the simple atrophy found in the muscles.

Flexion with Tonic Spasm of the Muscles is present and usually an early symptom in all cases of active tubercular joint disease. It is not present in tubercular hydrops articuli. It is due to reflex irritation of the nerves of the articular surfaces. It is pretty generally accepted that this reflex neurosis has a great deal to do with the structural changes, the atrophy of all the tissues of and about the joint, partial fibrosis of muscle, and fixation in malposition, which occur later.

Shortening and Displacements are among the symptoms of joint tuberculosis in its later stages. Shortening, and sometimes displacement, were formerly attributed to destruction of some part of the articulation; and this may be the cause in some cases. But, as before remarked, tropho-neurotic changes may be responsible for atrophy of the bones of an affected limb, as well as of its other structures, and shortening can result without destruction of bone.

Subluxations and malpositions are due to muscular contractions while the joint is in partial flexion, rotation or lateral deviation.

Differential Diagnosis.—Tuberculosis of bones and joints must be differentiated from rheumatism, from syphilis and sarcoma. The acute inflammations of periosteum, bones or joints are not so apt to be mistaken, as the onset is more sudden and severe. Rheumatism is poly-articular and is apt to be accompanied by endo- or pericarditis. With syphilis there is apt to be enlargement of the lymphatics and other evidences of luetic taint, and the trouble yields under the therapeutic test.

Prognosis.—The destructive processes of tuberculosis in bones and joints and the reparative processes which may follow are chronic in their course, extending over months or years, or sometimes alternating through a lifetime. It is pretty safe to assume that a child with bone or joint tuberculosis has other foci of the disease somewhere in its anatomy. There is more probability of the disease becoming general in a child, or becoming active in the

meninges or elsewhere. But if it does not prove fatal through secondary lesions, there is more hope of repair of bone or joint than there would be in an adult.

A cured case of bone or joint tuberculosis may have a recurrence, or one of the other foci may become active months or years after. Eradication by operation of a local lesion in bone or joint may not permanently cure the patient of tuberculosis, but it may prevent further absorption from that lesion. There is great danger of general infection resulting from operations upon tuberculous tissues. Septic infection of the tuberculous area adds greatly to the danger. Amyloid degeneration of the liver, spleen, kidneys, or intestinal villi are of very grave import. Individual cases differ so widely it is impossible to predict in the beginning what will be the final outcome of any given case. Relief from pain, reflex spasm, tenderness and swelling, with improved appetite and increasing weight, are all favorable indices.

Treatment of tubercular bone and joint diseases is general and local. The general treatment is considered in the general Section on Tuberculosis in a preceding chapter. Rest is the most important of the agencies for local treatment, especially of diseases of joints. In bone diseases it does not give such evident good results, excepting in spinal caries. Unrest is produced by three factors—weight-bearing, motion, and muscular tension, both that which is normal and the spasmodic tension excited by reflex irritation.

Rest may be secured by lying in bed, by extension and counter extension, sometimes spoken of together as traction, and by splints, which are means of fixation. Splints are of many materials and in many varieties. They are applied for fixation; that is, to prevent motion, and in some varieties also to produce traction. In one sense a bed is a form of splint. It limits motion and prevents weight-bearing and relieves muscular tension. A carious spine, or even the whole skeleton, may be splinted by a Bradford frame, or a wire gauze cuirass, or by plaster of Paris, or poro-plastic felt, or a steel brace; and the limbs by plaster, or starch, or silicate of soda, or wood, or steel, et cetera. Traction is thought by some to be beneficial by pulling apart the inflamed joint surfaces and so relieving the irritation. Others think it acts as a means of fixation. Both are doubtless right. Traction also relieves muscular tension and reflex spasm by tiring out the irritated muscles at the same time it does the work they were attempting to do—it prevents motion in the joint. Traction has a further use in correcting the faulty position of an extremity. It may be applied by a weight or by the weight of the limb itself, or by the tension of a spring or other mechanical device. Fixation by splint has some effect to relieve these, but more slowly. Splints and traction in one or

other form can either or both of them be used with the patient in bed or out of bed, as the case requires. Weight-bearing upon the lower extremity can be removed by raising the sound limb and using crutches, or by using a splint which takes its bearing at the pelvis. When bone or joint is secured at rest it should be in its most natural position for its usual function. The hip, knee, and ankle should be in the position of walking. The spine should have as near as may be its natural curves. The elbow should make nearly a right angle, so that the fingers could reach the mouth. These positions will usually be found the easiest to maintain. If the limb is held by muscular or false ankylosis in some other position it should at first be put at rest in that position, but with subsequent adjustments should be gradually brought to one that would be more useful if ankylosis were to take place. Counter-irritation by blisters, setons and the like is no longer recommended. Scott's dressing of compound mercurial ointment is still used, and often appears beneficial. I believe its effect is due rather to the pressure than to the mercury. The only counter-irritant of marked power in joint tuberculosis is the actual cautery usually applied with the Paquelin apparatus. This, I think, is really useful, especially if the joint is painful. Anesthesia is generally necessary with children, though one has had boys of eight or ten who preferred not to take the anesthetic and bore the rapid application of the cautery bravely. The skin is rendered aseptic and then touched with the button at white heat over a goodly part of the swelling. The burn is then dressed with iodoform gauze, cotton, and the part put up in a plaster bandage or other fixation splint.

Injections of antiseptic or chemical substances have long been in use in tuberculosis of joints. A great many drugs and chemicals have been employed with the idea of destroying the bacteria or checking their development or of limiting their action upon the tissues or promoting repair of their ravages. Tincture of iodine, or the compound tincture of iodine, carbolic acid two to three per cent., balsam of Peru in emulsion with oil of sweet almonds, 1 to 4, and a .07 per cent. solution sodium chloride, arsenious acid in the form of Fowler's solution, corrosive sublimate, phosphate of lime, camphorated napthol, formalin and glycerine, and others have been used. The injections are made either in the cavity of the joint or deeply in the tissues near the boundaries of the synovial membrane. The use of all these, excepting formalin, has been almost abandoned, although some still use injections of iodoform into joint cavities and abscess cavities, and a few use the chloride of zinc around the joint. The chloride of zinc was recommended by Lannelongue, who injected it into the periphery of the lesions, for instance, in four or five points around the joint, or in tuberculosis of

the lymph nodes. A ten per cent. solution is used, under antiseptic precautions, using half a drachm or more at a sitting. The injection, never made superficially, is to be made deeply, avoiding vessels and nerve trunks and not entering the joint.

After the operation the part is bandaged, splinted and elevated. A considerable reaction follows, with swelling. This subsides in a few days and a plaster bandage puts the joint at rest. The iodoform emulsion is injected into the cavity of the joint or tuberculous abscess, the pus having first been evacuated with a trocar and canula, and the cavity washed out with a 3 to 5 per cent. solution of boric acid, all under the strictest antiseptic precautions. The puncture should be made so as to reach the joint or other cavity by the shortest route possible through healthy skin. Ether solutions with iodoform are not recommended. A 10 per cent. emulsion of iodoform in glycerine or olive oil is the best preparation. One has usually employed the glycerine mixture as follows: The iodoform 10 per cent. is washed in solution of bichloride of mercury, 1 to 2000, the watery solution decanted and the iodoform rubbed with enough alcohol to make a paste. Seventy per cent. of glycerine, and water to make 100 are then added. The glycerine should be boiled previous to mixing. Or the iodoform in the proportion of 10 per cent. may be purified by mixing with five per cent. solution of carbolic acid, standing forty-eight hours, with occasional shaking. The carbolic solution is strained off, and the iodoform mixed with the glycerine. Sometimes mercuric bichloride 1 to 2000 is added. (Cheyne.) Of this form a drachm or two to an ounce may be injected after evacuation and irrigation, at intervals of one to two weeks. The injection is followed by swelling, which subsides in a few days. Two or three injections will generally show whether there is to be improvement. Improvement will be shown by "diminution of the contents of the joint or abscess at each tapping, lessening of the solid contents of the fluid and increase of its viscidity." "Parenchymatous and intra-articular medication with antibacillary remedies has yielded the best results in tubercular spondylitis, attended by abscess formation, and tuberculosis of the knee and wrist joints." (Senn.)

In my own experience the injection of iodoform emulsion has appeared more useful in cold abscess cavities than in joint tuberculosis, and is no longer used in joints.

At present formalin is in favor for injection in hydrops articuli; a two to four per cent. solution in glycerine. It should never produce tension.

Of late local hyperemia has come into some prominence as a therapeutic agent for tuberculosis of bones and joints. It is sometimes called the Bier treatment or the Bier-Klapp method, after

Prof. Bier of Bonn and his assistant Klapp. (See Sections on Septicemia and on Tuberculosis, et cetera.) In the limbs the hyperemia is induced by constriction. An elastic woven rubber bandage is applied around the limb above the seat of the disease. It need not be immediately above but farther up if convenient. The band is not applied in a limited zone, but rather widely, and drawn tightly enough to check the venous return somewhat, without interfering with the arterial supply. The limb below the constriction gradually swells and becomes reddened and slightly bluish, but not blue. The bandage is left on for about an hour and then removed. This is repeated daily. At no time should the application or its result be painful. At no time should it cause coldness or numbness, though there may be slight prickling just before it is removed. If pain results, the technique should be corrected. If with correct technique there is pain, the case is not suitable for the method. Extra warmth may result from the proper degree of hyperemia, and if it does it augurs well for the result. Cases of tubercular bone and joint disease usually require the treatment to be continued for months, and it may be necessary for a year or even more. Occasional intermissions of a week in the treatment are found beneficial. Joints are not kept at rest during the treatment unless use causes pain. If there is no pain, patients are encouraged to use the limb moderately. If tuberculous ulcers, sinuses, or abscesses are present exercise is not permitted. Tuberculous abscess must be opened, and the treatment should not follow the opening for a few days. Ulcers and sinuses do not contra-indicate the treatment. They are benefited by it. If loose sequestra are present they should be removed; but if not loose they should not be disturbed. If a joint is markedly hydropic or purulent, or so disorganized as to require resection, treatment by hypermia is useless, until after operative interference. The results obtained in favorable cases are relief of pain; and following the relief of pain there is cessation of the reflex muscular spasm, and as a consequence, the avoidance of deformity and the restoration of mobility. There is also, it is claimed, regeneration of both soft and bony tissues. In cases which show improvement the treatment is continued until these results are obtained.

If rest has been tried without avail, and injection and local hyperemia treatment have failed to check the disease, and in some cases which advance too rapidly to wait for these methods, there is no choice but to cut down upon the bone or joint and attempt an eradication of the disease. This is especially true if to the tubercular infection a pyogenic infection be added, or if a tubercular infection has attacked the epiphyseal line. In the latter case, after applying the Esmarch constrictor, the focus should be cut down upon and the diseased bone gouged out. After thoroughly irrigating the

cavity it should be swabbed with solution of zinc chloride 1 to 15, irrigated again with sterile water, the bone cavity packed with iodoform gauze, and the wound in the soft part with sterile gauze. Dressing is changed once in 48 or 60 hours, and allowed to heal by granulation.

If the joint abscess affect only the synovial membrane it may be sufficient to incise freely, irrigate and drain. If there be superficial disease of the cartilages or bones upon the articulating surfaces, erasion or arthrectomy will be necessary. If the destruction be greater, resection may be the only resort. Resection should be reserved for cases in which the disease has invaded both joint and bone or which cannot be eradicated without going into the joint, and in which less radical methods, such as erasion, are insufficient or have been tried and failed; also in which the general condition demands relief from the local disease, and is yet sufficiently good to endure a severe operation. These are matters of judgment upon each case individually.

The whole tendency of practice of late years, in dealing with tubercular bone and joint disease is more conservative than formerly. The complete removal of all the diseased parts about the joint, including suppurating old sinuses and cavities, will sometimes avoid amyloid degeneration, prevent further dissemination of toxines and even of the tubercular disease itself. On the other hand, it is often very difficult to remove every particle of diseased tissue; and surgical trauma sometimes leads to a general dissemination of tuberculosis.

Resection should always be avoided if possible in children, or some form of atypical rather than typical resection be employed. It is often impossible to tell before the joint is opened whether the operation is going to be an arthrectomy or an atypical or typical resection.

When after any method of treatment the inflammation in a joint has subsided, considerable judgment is necessary in putting it to work again. Simple inflammatory disease may be dealt with more promptly and the child given liberty in a week or two after the trouble has subsided. But with tubercular inflammation months rather than weeks must elapse before one can feel sure that the trouble will not return with use. There is much less danger of ankylosis in children's joints than in those of adults. And when, after operation, ankylosis is desired the bones should be held in position for months and sometimes for years on account of this tendency to form a joint.

Different Joints Affected, Different Ages.—The relative frequency with which tuberculosis affects various joints and the frequency at various ages are shown in the following tables. The

first table is from Cheyne. The second table is from Holt, giving the number of cases of each form of joint tuberculosis applying for treatment at the Hospital for Ruptured and Crippled, New York, during ten years.

	First Decade	Second Decade	Third Decade	Fourth Decade	Fifth Decade
Hip	30.2	20.3	4.8	...	12.5
Knee	29.5	22.8	18.2	36.6	6.2
Ankle	5.4	5.9	3.6	3.3	12.5
Tarsus	4.6	5.9	8.4	3.3	18.7
Shoulder	...	1.6	4.8	...	...
Elbow	6.7	9.2	6.	13.3	18.7
Wrist	.6	8.4	15.8	13.3	6.2
Fingers	1.5	4.2	2.4	...	...
Ribs	...	...	1.2	10.	12.5
Os calcis	2.6	2.4	2.4	3.3	...
Odd bones	6.7	3.2	3.6	...	...
Spine	12.	15.2	28.	20.	12.5

Head of the femur	146
The acetabulum	187
The femoral neck	28
The trochanter	5
The femoral shaft	5
The pelvis above the joint	10
	381

Of the 146 cases in the femoral head it was found that—

The disease was primary in the head in .....44 cases
The disease was secondary in the head in .....48 cases
The question was undetermined in.....54 cases

Of the 187 cases in the acetabulum—

The disease was primary in .....98 cases
The disease was secondary in .....49 cases
The question was undetermined in.....40 cases

Spine	2,145	cases, or	37.5 per cent.
Hip	1,937	cases, or	34.0 per cent.
Knee	1,222	cases, or	21.5 per cent.
Ankle or tarsus	255	cases, or	4.5 per cent.
Elbow	71	cases, or	1.2 per cent.
Wrist	50	cases, or	0.9 per cent.
Shoulder	24	cases, or	0.4 per cent.
Total	5,704		100.0

TUBERCULAR SPONDYLITIS, or spinal disease, will be found described in the Chapter on Diseases of the Spine.

TUBERCULAR ARTHRITIS OF THE HIP (HIP-JOINT DISEASE; MORBUS COXARIUS; ARTICULAR OSTITIS OF THE HIP)

Etiology and Pathology.—The general etiological factors have already been discussed. Quite frequently there is a history of trauma, but this is by no means always the case.

Location of the primary lesion is in the head of the femur near the epiphyseal line, or in the acetabulum, or in the synovial membrane; when the latter, it is apt to be in that portion of the membrane near the ligamentum teres. When in the bone it is not invariably near the epiphyseal line. It may be in the neck of the femur. When in the acetabulum it is more often in the iliac portion. The majority of writers agree that the disease most often begins in the acetabulum, and these conclusions, arrived at largely by post-mortems of cases which went on to resection before the discovery of the Roentgen ray, have since been to a great degree confirmed by the study of radiographs. König's statistics are probably as reliable as any statistics; they show the relative frequency of the point of origin as well as it could be judged in three hundred and eighty-one cases which were severe enough to go on to excision.

The typical disease is well divided into three stages. In the first the disease is in the bone only, the joint not being affected. In the second stage the disease has penetrated into the joint and involved its structures in the tubercular process and usually produced abscess. Abscess may form in extra-articular ostitis and remain in proximity to but outside of the joint cavity. In the third stage the head of the femur and the ligamentum teres and sometimes the femoral neck are absorbed or disintegrated, together with other ligaments about the joint, a portion of the acetabulum, and often with the escape of the abscess contents into the peri-articular tissues.

Abscesses follow the line of least resistance. When forming outside of the joint the abscess may press its way forward and appear at the anterior margin of the tensor vaginæ femoris, a very frequent situation, or in Scarpa's triangle, or may track down the thigh. Abscess may form within the joint, and, bursting the capsule, escape through the cotyloid notch and so to Scarpa's triangle; or may escape posteriorly and burrow beneath the glutei; or penetrate beneath Poupart's ligament into the pelvis; or burrow beneath the sheath of the psoas, and, reversing the usual course of psoas abscess, extend into the pelvis. When the disease is located in the acetabulum it may extend through and invade the interior of the pelvis and form abscess in the iliac fossa, or escaping through the sacro-

sciatic foramen it may burrow in the ischiorectal fossa. With disease in the acetabulum abscess formed within the joint may perforate the acetabulum and pursue the same course as an abscess originally pelvic.

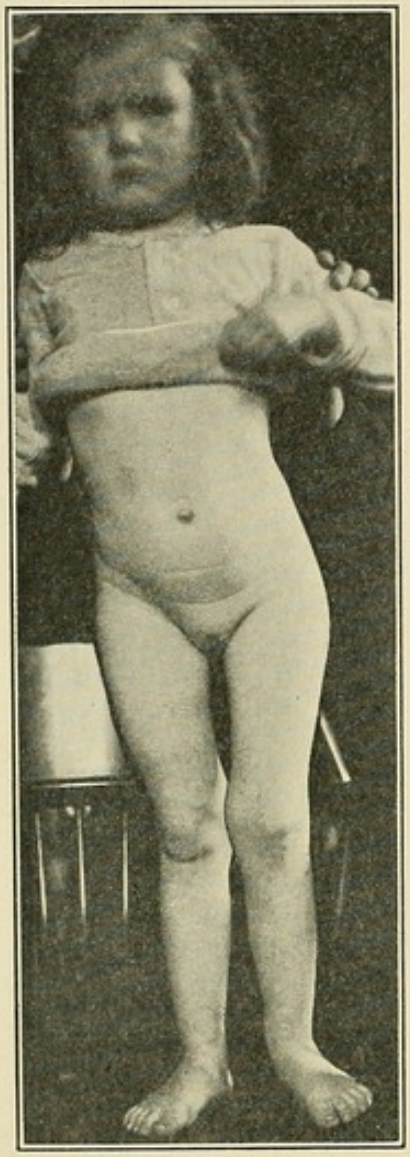


FIG. 78. FIRST STAGES OF MORBUS COXAE, left side. A limp is usually the first symptom. The patient keeps the limb slightly flexed and steps lightly upon it, unconsciously avoiding movement and jarring of the joint. In standing the greater part of the weight is upon the sound limb. Girl aged 5 years.

Intra-pelvic abscesses from hip-joint disease have been known to discharge into rectum or bladder, feces and urine then penetrating the joint and discharging through sinuses upon the surface. (Marsh.)

The tonic spasmodic contraction of the muscles about the joint pressing the head of the femur against the upper part of the acetabulum may produce absorption of that portion of the acetabulum pressed upon, allowing the femoral head to assume a position higher and farther back upon the ilium. A ridge of new bone forms a new upper margin to this "wandering acetabulum," as it is called. The head of the femur, or, the head being absorbed, what remains of the neck, may become dislodged from the acetabulum onto the dorsum ilii or anteriorly; or by an osteoplastic reparative process the acetabulum may become obliterated by new bone.

Symptoms and Course.—A limp is usually the first symptom. This may be so inconstant that it excites no alarm for a long time. The limp is apt to be worse in the morning and pass off with exercise. Sometimes it shows more with fatigue. The patient keeps the limb slightly flexed and steps lightly upon it, unconsciously avoiding movement and jarring of the joint. (See Fig. 78.) Late in the case the limp is due to resultant deformity.

Pain may be an early symptom. It is not severe in the beginning in the ordinary case. But there are acute cases in which it is very severe early. In others the severe pain comes in the second stage. The pain may be referred to the hip region. But it is very

common and characteristic to have the pain located in or about the knee. Pain is aggravated by movement and also has unaccountable exacerbations. Pain may be so slight that it is scarcely noticed by the child and difficult to locate, or so severe that it destroys rest day or night if not relieved. Sometimes it can be elicited by pressure upon the joint from in front. Pain produces the so-called "night cries" or "night terrors." This phenomenon when present usually occurs as soon as the child falls into a sound sleep. He cries out suddenly either with or without waking up. After being pacified he becomes quiet for a time and again cries out, and sometimes repeats this at intervals throughout the night. In other cases after once or twice screaming he sleeps quietly. This symptom is caused by a sudden re-contraction of muscles which during waking hours have been reflexly contracted, but had relaxed their tonicity on the approach of sleep. This sudden re-contraction presses the hypersensitive surfaces of the inflamed joint together and causes pain.

Attitude.—Early in the disease the limb is abducted, slightly flexed and rotated outward. This position is instinctively assumed because it affords the greatest ease. Flexion relaxes the iliofemoral ligament, abduction relaxes the ligamentum teres and the upper portion of the iliofemoral ligament, while the rotation outward relaxes the inner portion of the ligament and the posterior portion of the capsule. Later in the disease, and especially if there has been some destruction of the head of the femur or the acetabulum, or at least of the capsule, the position of the limb is changed, being adducted, flexed and rotated inward.

These attitudes of the diseased limb occasion, as Howard Marsh so well described, certain compensatory positions. (See Figs. 79, 80, 81, 82.) With the limb held stiffly abducted, flexed and rotated, in order to bring legs parallel for walking, the patient is obliged to move the sound limb toward the abducted diseased one, and then to stand erect he must tilt his pelvis laterally. To bring the flexed thigh to the perpendicular he arches his lumbar spine into lordosis. This change incidentally produces an apparent lengthening of the diseased limb, which is discovered to be only apparent and not real on observing the position of the pelvis.

If the limb is held stiffly in adduction the compensatory movement is reversed. The affected side is raised, the lumbar spine is concave on the diseased side and there is apparent shortening. Actual lengthening is practically unknown and actual shortening occurs only later in the disease when there has been bony loss of head of femur or of a portion of the acetabulum. Whether there is true or only apparent shortening, may be proven by the application of Nelaton's or of Bryant's test lines. Nelaton's line is drawn from the anterior superior spine of the ilium to the most prominent part of the tuber

ischii. The normal trochanter will touch but not go above this line. Bryant's line is drawn horizontally outward from the iliac spines, and the distance between the projection of this line vertically to the trochanter is compared on the two sides.

Rigidity.—Muscular rigidity is the most reliable symptom of

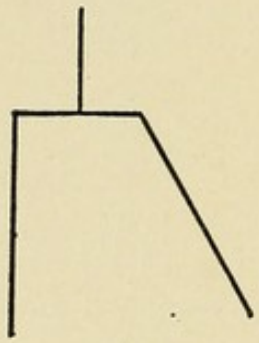


FIG. 79. DIAGRAM REPRESENTING THE LOWER EXTREMITY FIXED IN ABDUCTION. The limb cannot be brought parallel with its fellow without tilting the pelvis. After Marsh.

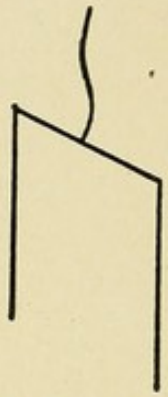


FIG. 80. DIAGRAM ILLUSTRATING TILTING OF THE PELVIS WHEN ABDUCTED LIMB IS BROUGHT DOWN; with apparent lengthening of the diseased limb, and curvature of the spine. After Marsh.

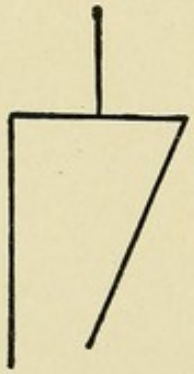


FIG. 81. DIAGRAM ILLUSTRATING LOWER EXTREMITY FIXED IN ADDUCTION. To bring the limbs parallel the diseased side of the pelvis must be tilted up. After Marsh.

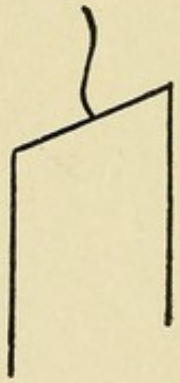


FIG. 82. DIAGRAM ILLUSTRATING THE TILTING OF THE PELVIS NECESSARY FOR WALKING if a limb is fixed in adduction. The result is apparent shortening of the diseased side and corresponding curvature of the spine. After Marsh.

hip-joint disease. The reflex muscular spasm so often referred to in discussing joint diseases is almost invariably present in morbus coxæ under all circumstances excepting during anesthesia, or after it has been subdued by treatment by enforced rest of the joint. In examining a case brought in a stage so early that only slight limp or pain or possibly both are present, a degree of rigidity can be

detected. The patient should be stripped and laid horizontally on the back upon a table. All manipulations of the joint should be very gentle, lest the muscles become irritated and the patient also excited, and nothing can be made of the examination. The patient's confidence should be gained by gentle handling, rotation, flexion and extension of the sound side first. Then rotation of the suspected limb should be tried before the other motions, by rolling it slightly back and forth under the outstretched hand upon the table. If there is no inflammation the limb rolls freely. The leg is then grasped just below the knee and fully flexed and extended. If when the limb is fully extended with the knee flat upon the table the lumbar spine is found to be arched up from the surface of the table it is demonstrated that the pelvis has moved with the thigh. If now the limb be raised until the lumbar spine lies straight upon the table the position of the limb shows the degree of the flexion of the thigh upon the pelvis. The patient is now laid straight with heels together and it is observed whether the pelvis is tilted laterally or is at right angles with the spine. If the pelvis is oblique and the crest of ilium on the suspected side is too high, it shows the limb is in adduction; and the degree of the adduction can be found by moving the limb inward until the iliac crests are at right angles with the spine. It is at this stage that one frequently finds the patient instinctively making extension upon the diseased limb by placing the sound foot upon the other and pushing down; or by hooking the foot of the affected limb around the bedstead; or fixing the thigh by holding it in the hands. If, however, the pelvic crest is too low on the suspected side it proves the limb is fixed in abduction, and by moving it from its fellow the degree of the abduction will be seen when the pelvis comes to right angles with the axis of the spine. Rotation can also be tested by gently grasping the leg below the knee, half flexing it and rotating the thigh to the limit of its natural range, the other hand being placed up the iliac crest. With a healthy joint the femoral head rolls freely in the acetabulum. The method of testing rotation by rolling the limb on the table is more delicate and should be used first. The degree of fixed flexion can also be tested by flexing the sound thigh firmly upon the abdomen, and by this means holding the lumbar spine down upon the table, while the suspected limb is extended. In testing for rigidity each movement should be carried to its extreme range, for oftentimes it is only as the limit is approached that any restriction is evident.

Swelling.—Swelling should be examined for by palpation and may be detected in front of the joint or behind the trochanter. There may be very slight thickening or decided brawny swelling all about the joint. Usually swelling that can be detected is evidence of advanced disease.

Tenderness may sometimes be elicited by pressure, but should not be tested for early in the examination lest fear be excited. Jarring the joint by striking on the heel is of no practical value.

Atrophy.—Muscular atrophy is a very constant symptom, and, after rigidity, the most unmistakable. It is most easily seen in the flattening of the gluteal and upper thigh muscles, with consequent partial effacement of the gluteal fold, or the fold may appear single instead of double. It can also be detected by grasping the thighs and observing the flabbiness of the wasted one; and by spanning its circumference with the fingers and thumb; or by comparative measurements with a tape-measure of the circumference of the two thighs at corresponding points.

Shortening.—An advanced case coming for examination may show marked adduction, with actual shortening, the acetabulum having traveled upward upon the ilium, or more perceptibly the head and neck of the femur having been disintegrated or absorbed. In such a case abscesses may be found about the joint, or sinuses which have discharged abscesses, or the scars resulting from such sinuses if they have healed.

Abscess.—Abscess may be found in a case only a few weeks advanced; but usually abscess does not develop for several months after the onset. Abscess is much more apt to occur in cases which have not been treated or have been unskillfully treated; and yet they will occur in some cases in spite of the most prompt and skillful treatment. If an abscess is small and deeply seated it may be difficult to find, or to distinguish from brawny swelling; but an abscess of any size or not in the depths about the joint may be readily detected on palpation as a circumscribed swelling which fluctuates. Tuberculous abscess is generally a " cold abscess " coming with very little warning of its approach. There may be tenderness on pressure as well as swelling and fluctuation at a definite point. But occasionally abscess of hip disease comes acutely, or is heralded by increase of the pain on movement, by elevated temperature, and by night terrors which subside as soon as the abscess has pointed and discharged. In examining for abscess and for acetabulum disease digital exploration per rectum should never be omitted.

Amyloid Disease.—In examining any case in which suppuration is or has been present, enlargement of the liver or spleen and albuminuria should always be looked for. While rare without long and exhausting suppuration, it may occur sooner than expected; while in other cases when the history would lead one to anticipate it no such degeneration takes place.

The typical symptoms are a pale, waxy skin, emaciation, with enlarged liver and spleen, and albuminous urine having normal or low specific gravity. Later there is general anasarca beginning in

the eyelids in the morning. Sometimes diarrhea, which it is often impossible and indeed dangerous to stop, and sometimes nausea, dizziness and other evidences of uremic poisoning.

Diagnosis is usually made readily enough if one has a clear idea of the symptomatology and of the methods of examination. Yet there are conditions under which it is difficult to demonstrate and a few other diseases which may simulate this disease or present some of its symptoms. In incipient cases the symptoms may be very slight or inconstant. The pain may be present only occasionally; the lameness evanescent; the muscular spasm may be confused with voluntary movements; the thickening over the joint so slight as to be scarcely distinguishable in a fat child. Pain referred to the knee while no tenderness or impairment of the knee can be discovered is always mentioned as a symptom of hip disease, and yet similar pain may be produced by sacro-iliac disease, caries of the lumbar spine, or pelvic abscess independent of any joint disease. It has been stated that muscular rigidity is the most constant and reliable symptom of hip-joint disease, and this is true. Yet flexion and extension may be interfered with in disease about the upper end of the femur which does not approach the joint; or extension may be limited in psoas or pelvic abscess from spinal caries, or appendicitis; flexion may be checked by gluteal abscess, or inflammation from causes independent of the joint.

There should be no difficulty in excluding congenital dislocation of the hip notwithstanding the deformity.

Acute inflammations are excluded by their acuteness although otherwise the symptoms are similar. All the acute infections of bone or joint should be borne in mind and excluded before the diagnosis of tubercular coxitis is decided upon.

Sacro-iliac disease has no symptom in common but the limp unless abscess occur. The location of the disease can be found if sought for.

Simple inflammation from slight injury of or about the joint may subside and merge into a tubercular inflammation.

Hysterical joint disease is very uncommon; but when it does occur the pain complained of is quite severe, can be elicited by slight touches as well as firmer pressure, and the muscular rigidity is lacking when the patient's attention is diverted.

A difficult class of cases to form an opinion upon are those which first present themselves after having had some treatment resulting in a disappearance of the symptoms—whether only temporarily or permanently it is impossible to say.

It is only in very exceptional cases that anesthesia is of any advantage in examination. For instance, an advanced case was sent to me with a diagnosis of bony ankylosis. I considered the fixation

due to tonic muscular contraction; and anesthesia readily made the demonstration. One should be extremely careful of manipulations under anesthesia. The guardian muscles being relaxed, damage may be done.

If there is a suspicious history of occasional lameness or pain, or if there is slight restriction of freedom of one of the movements of the joint, but not enough to make a positive diagnosis, it is still not safe to say the case is not incipient hip-joint disease. Such a case should be kept under observation.

Prognosis.—The mortality from hip-joint disease directly is about five per cent. The mortality from all causes directly or indirectly traceable to the disease or to the tuberculosis which produced the disease is twenty-five per cent. The causes of death are exhaustion from prolonged suppuration with or without amyloid disease, tubercular meningitis, general tuberculosis or phthisis. Ultimate recovery of the limb cannot be certainly promised in any case. The course of treatment will surely require one year and may take two to four years or more. Complete recovery of the limb is possible if proper treatment is instituted early and thoroughly carried out. In other cases the recovery is practically complete, as only slight lameness results from a little shortening or a trifling stiffness of the joint which is partly compensated by increased mobility of the pelvis and spine. Motion in the joint without lameness may possibly occur even after suppuration in the joint. But this is not to be expected, for it is usual to have shortening and limitation of motion after suppuration, and the shortening may amount to a fraction of an inch or several inches. Ankylosis may vary from a slight limitation of some of the motions to complete ankylosis. On the other hand, lameness from shortening may result without suppuration, from damage to the epiphyseal line of growth, and shortening from this cause may increase the lameness with growth of the other limb. Muscular atrophy does not entirely disappear.

Treatment.—The treatment of hip-joint disease is constitutional and local. The constitutional treatment is that of tuberculosis and has been discussed elsewhere. Local treatment is mechanical or operative. As was stated in the general discussion, the first great principle in the treatment of joint diseases is rest. It remains to choose the best means for securing rest to this joint. As to the choice between traction and fixation, there are many differing opinions. I am well aware that cases have done well with traction applied by other methods and also with fixation alone; but after trying different means and methods in my own cases and observing the results in other men's cases my preference is for traction at the beginning of the treatment. In the typical case, with pain and muscular spasm, the patient will be made comfortable, the tonic

contraction of the muscles subdued, the inflammation controlled more promptly and efficiently by traction than by any other method of treatment. And the traction at this stage is best applied with the patient horizontally in bed, by means of the weight and pulley, usually described as Buck's extension.

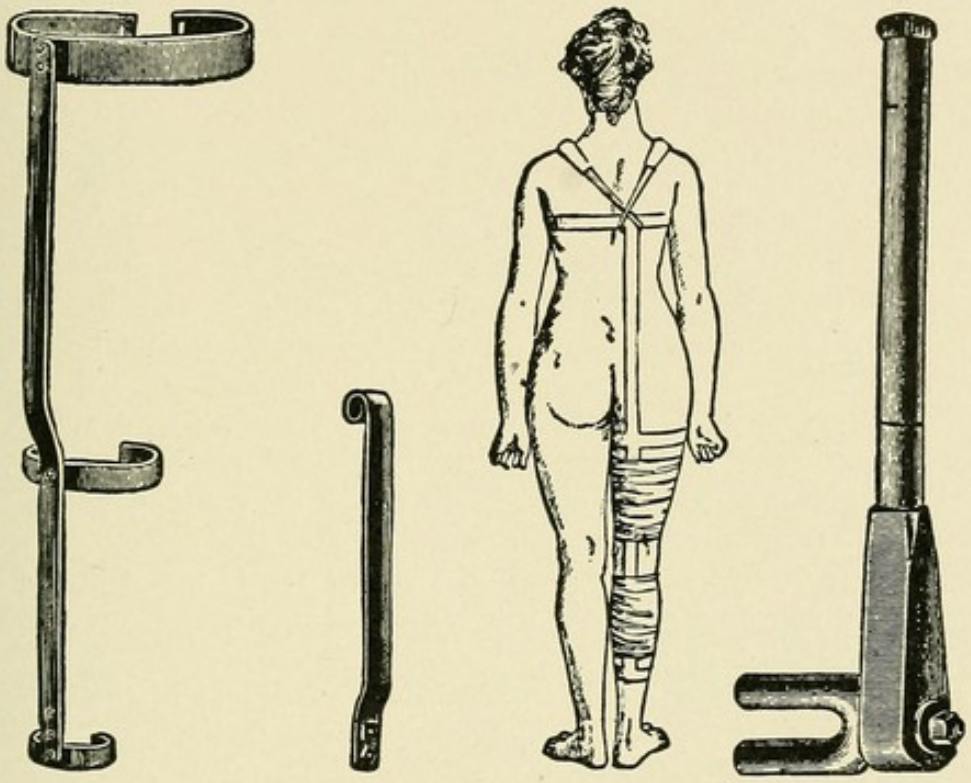
Traction applied in this manner, besides securing rest, and relieving pain and muscular tension, at the same time and by the same means overcomes deformity. I believe, too, the rest in bed is of advantage at this stage just as it is to any tubercular patient who is carrying an elevated temperature and losing weight. This is a point not always considered in this light, yet it does present an additional advantage, not merely in traction, but in traction applied in this manner. The room the patient is to occupy should be the brightest and airiest in the house. The bed should be, if possible, one that can be moved into the sunshine by the window or carried out of doors in warm weather. The mattress should be firm and level and the springs sufficiently strong to remain level with the patient in bed, or should be stiffened with a board or slats to prevent sagging. The pillow, if any is used, should be small. Every surgeon is familiar with Buck's extension applied with a strip of adhesive plaster two or three inches wide at each side of the thigh, meeting at a spreader a few inches beneath the foot, and connected with a cord running over a pulley to a weight that hangs down at the foot of the bed. Before applying the adhesive plaster the skin should be carefully washed with soap, followed by antiseptic solution as if preparing for operation, and the plaster passed over an alcohol flame. If the plaster is thus carefully applied it can be kept on several months without irritating the skin. The adhesive strap should begin well up on the thigh, but the strapping below the knee should be lined with a strap equally wide with its non-adhesive side next to the surface of the leg, so that traction is made only on the thigh and not on the ligaments of the knee joint. The spreader below the foot should be wide enough to prevent the straps from pressing on the maleoli. A roller bandage should be applied over the adhesive straps from the ankle to the perineum, and it is well to have the turns of the roller basted together or to run a few strips of adhesive lengthwise of the limb, or a coating of soluble glass, to prevent slipping of the spiral turns. The pulley fastened to the foot of the bed should be at such a height and at such an angle that the traction is applied, for the time being, in the direction of the long axis of the limb in the attitude which it has assumed as a result of the disease. If this position raises the limb from the mattress it must be comfortably blocked up with an inclined plane.

The weight should not be hung upon the cord for some hours after the plaster straps are applied, so that they have become

firmly adherent. The rule often given for approximating the correct weight is one pound for each year of the child's age, but this ratio of weight increases too rapidly. It is scarcely ever necessary to use a weight above three or four pounds for a child under ten years of age. Too heavy a weight will actually increase pain and muscular irritation and do harm by stretching ligamentous structures. Also, if the traction is exercised in a direction other than the proper one, intra-capsular tension and irritation are increased. It is often advised that if the weight tend to draw the patient to the foot of the bed the foot of the bed should be raised a few inches from the floor so that the weight of the patient's body acts as a counter-extension. This is seldom necessary when the weight is not excessive. The amount of weight should be carefully graduated to the muscular strength and tension. It is not intended by the weight to at once overpower the resistance of the spasmodically contracted muscles. The continued tension of a light weight will ultimately overcome their contraction; while the relief afforded the inflamed joint by rest and relief from irritation removes the reflex stimulation which caused the spasmodic muscular action and they relax. As they do so the inflamed surfaces are more and more separated and the relief increases. It is often surprising how soon the effect begins to be noticeable. Sometimes in a few hours some relief is experienced, and in a few days the patient, who before was fretful through the day and restless, screaming at intervals at night, is comfortable and happy all day and sleeping quietly at night. Appetite begins to improve and fever to subside. In a few days the surgeon will test the improvement by releasing the weight from the limb for a few minutes while he takes the cord in his hand and attempts to bring the limb nearer to the axis of the spine. It may be that the position can be corrected a few inches both as regards the flexion and the adduction or abduction as the case may be. But while he lowers the limb as soon as the lumbar spine begins to arch up from the bed the limit is reached for the correction of flexion; and while moving the limb laterally, as soon as the pelvis begins to tilt, the movement should be carried no farther, but the pulley moved as necessary to exert traction in the long axis of the limb in this improved position. Thus a new adjustment is required once in a few days, and in a week or two the limb may be quite horizontal upon the bed and parallel with the spine.

It is necessary with many children on putting them to bed for traction to use means to keep them quiet in the horizontal position. Some are so unruly that it is necessary to apply a long splint on the sound side from axilla to ankle. And often it is necessary to pin them down to the mattress. By rubber sheet and draw-sheet underneath them and proper attention, even young and unruly children can

be kept quiet upon the back, and no fear of bed-sores. Bed-sores in a child under any ordinary conditions are a disgrace to the nurse. After a few days of enforced quiet the child becomes accustomed to lying still and will quietly maintain the horizontal position, until he improves, when he becomes playful and the restraining jacket or chest-band is again required if the recumbent treatment is to be pursued. About this time, in a case which is doing well, the question



FIGS. 83 and 84. THOMAS' HIP SPLINT.

must be decided whether the patient is to continue in bed or be furnished with apparatus for ambulant treatment so that he can go out of doors. Pain has been relieved, the muscular tension is gone, the deformity has been overcome, and he has gained weight. It is entirely feasible to keep him in bed for a year or more without detriment to his general health, without bed-sores or any local mischief as a consequence, and with the best possible result to the joint. But there are means by which treatment can be continued and the patient allowed to go about. These means aim to employ traction or fixation or both. One of the best as well as simplest of applications and cheapest is the plaster of Paris splint. Some surgeons apply it as a spica of the thigh and pelvis. Some would have us include the leg and thorax. Usually it is sufficient to begin just above the knee and extend the bandage an equal distance above the hip joint.

This will control motion in the hip. Some children are so short in the pelvis that a splint which aims to go no higher than the pelvic crest and is not too tight does not control motion in the hip joint. The plaster is applied over either a seamless knitted garment or a layer of bandage, and is strengthened with small strips of wood or a flat strip of steel placed vertically in front of the groin. A similar piece bent to the proper curve strengthens the splint behind, but can be dispensed with by taking care to close the opening apt to be left at the meeting of the turns of the bandage on the buttock. The sound foot is elevated by a shoe with sole and heel from 2½ to 3½ inches thick, and the patient walks with crutches, carrying the foot on the affected side entirely free from the floor. Patients under four years of age cannot be trusted with crutches. Boys take to crutches a little more readily than girls. Splints of leather or poroplastic felt of the same size and shape as the plaster splint can be used with satisfaction. The best way to model such a splint is to cut off a light plaster splint, make a cast by filling it with plaster, and apply the softened leather or felt to the plaster model, bandaging it on until dry. Or leather may be cut to shape from a paper pattern, soaked in cold water, applied to the patient and allowed to dry in position. Felt must be softened in hot water and is sticky and disagreeable when wet. When made over a plaster model a felt splint is very satisfactory. Leather and felt splints are made to buckle or preferably to lace on. The Thomas hip splint is very popular in England and also much used in this country. (See Figs. 83 and 84.)

It consists of a bar of iron or steel shaped to fit the back and posterior surface of the limb, from just below the scapula to the lower third of the leg, with a cross-bar at the top having strap and buckle in front around the thorax, one at the lower end around the leg, and one at the upper part of the thigh. Also supporting straps over the shoulders. I cannot agree with those who consider the Thomas splint clumsy and inefficient, having often used it with great satisfaction. It should be shaped to fit the patient. A pattern is made by placing a strip of lead or copper upon the patient's back and limb, bending the metal to fit the surface, laying the metal strip upon a paper and tracing the outline with the measurements for total lengths, and the circumference and position of the bands. This makes a diagram for the instrument maker which should insure a perfect fit. A bandage over the splint at waist and thigh are usually applied. I have sometimes had the splint made with a pelvic belt of metal and leather to go just below the iliac crests, and an extra thigh band. Ridlon's modification is another form. (See Fig. 85.) With a high-soled shoe upon the sound side and crutches the patient goes about.

The plaster, leather, felt and similar hip splints, and the Thomas

splint secure fixation without any attempt at traction. In some cases as soon as traction is removed the sensitiveness about the joint and the muscular spasm begin to return and the patient must at once be returned to bed with the weight and pulley or be provided with an ambulant brace that applies traction. Of this type of splint there are several varieties and each has modifications; but a generally acceptable kind is Taylor's long hip splint. It consists of a steel pelvic band to which is attached a long bar which extends down the outer side of the limb to a point some inches below the foot, where it bends inward at right angles and has a rubber-covered plate which rests on the floor. To the pelvic band are attached two perineal straps which support the patient when he steps upon the splint, his foot not reaching the ground. To the foot-piece are attached two straps, one for each side of the leg. These are to be fastened into buckles which are to be attached by long strips of adhesive plaster to the limb as would be done with Buck's extension. The side-bar is made with a ratchet and key by which the bar can be lengthened or shortened. A cheaper splint upon the same principle is shown in Fig. 86. To put on the splint or brace, the patient should lie upon his back while the adhesive straps are applied, one at each side of the limb, a buckle being strongly attached to each strap at its lower end just above the maleolus, and held in place by a spiral roller, the bandage being held from slipping down by strips of adhesive plaster. A shoe and stocking are worn, the stocking having openings through which the buckles project. The pelvic band of the splint is buckled in position, the perineal bands are drawn just tight enough to keep the pelvic band below the iliac crests and above the trochanters. The foot straps are buckled into the side

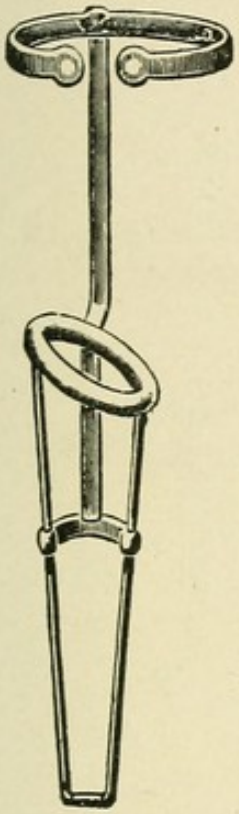


Fig. 85. Ridlon's modification of Thomas' hip splint. Combines the Thomas knee and hip splints.

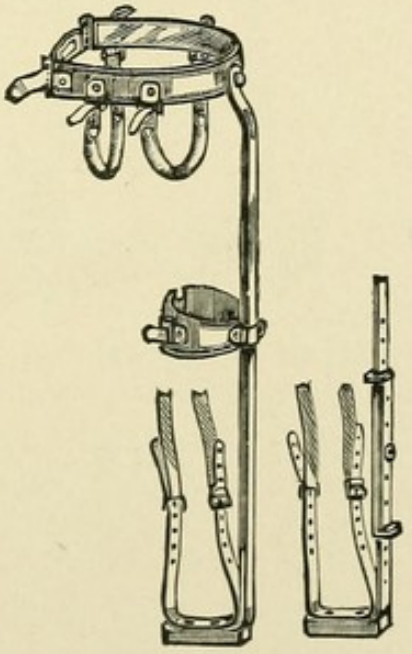


Fig. 86. Hospital long splint. Practically the same as Taylor's, but cheaper.

straps of adhesive which draw upon the limb, and the brace is lengthened until the side straps making extension and the perineal bands counter-extension are just sufficiently taut to secure proper traction. When this is done the foot-piece should be several inches below the sole of the shoe, far enough to make it impossible for

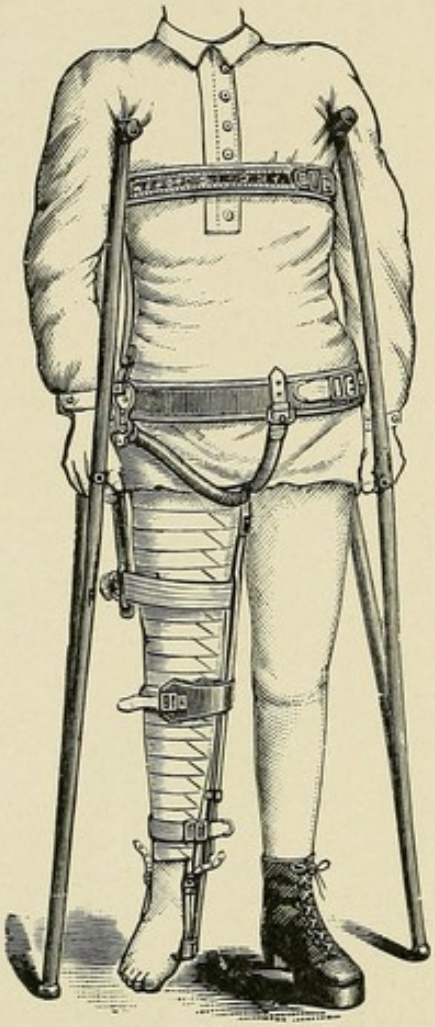


FIG. 87. PHELPS' HIP CRUTCH AND FIXATION SPLINT.

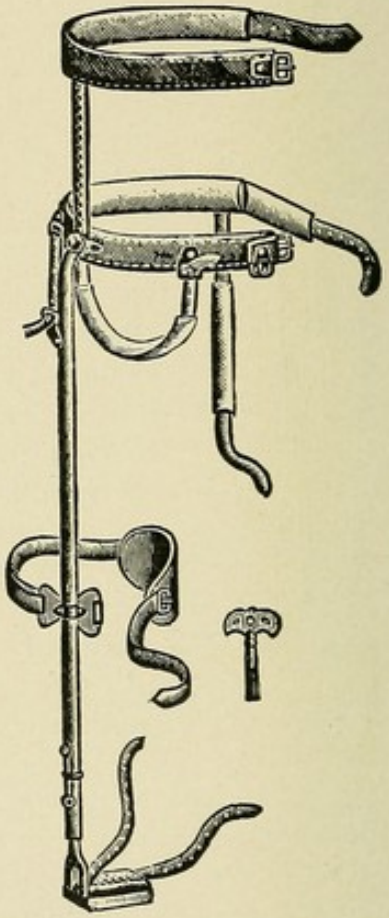


FIG. 88. RIDLON'S TRACTION HIP SPLINT.

the foot to bear any weight. It may be said of this method of traction, as of the weight and pulley, that it is not so much the amount of the traction as it is its constancy that overcomes the muscular spasm and secures rest for the joint. With a raised sole on the sound foot and a pair of crutches the patient goes about comfortably and safely.

The Phelps hip splint is an ingenious and excellent apparatus; but is more expensive, harder to fit, and requires greater nicety of adjustment during treatment. It consists of a pelvic metal band from the outer side of which, sloping inward and downward, a band

encircles the affected thigh. From the inner side of the latter band, at the perineum, a side-bar descends to the foot-piece which extends below the foot and is attached to the limb, as with the Taylor brace. But the Phelps brace has two additional features, an upright, which rests upon the pelvic band and extends upward to a band encircling the chest like a Thomas splint, and an arm, which extends downward from the pelvic band on the same side to a thigh band. This arm is so jointed to the pelvic band that the thigh band encircling the upper portion of the thigh can be drawn away from the median line, by this lateral traction pulling the head of the femur away from the acetabulum. (See Fig. 87.) There are other splints designed to accomplish the same thing either by pulling or pushing laterally upon the femur. But while they are correct in principle they have been found not only difficult of application but unnecessary in practice. Ridlon's traction hip splint secures efficient fixation and traction. (See Fig. 88.)

These methods and means of traction with ambulant splints constitute what is sometimes called "the American plan," having been devised and perfected and advocated by such American surgeons as Davis, Sayre, Taylor, Gibney, Bradford, and Shaffer. When a patient first begins to wear a brace some difficulty may be experienced in preventing chafing of the skin. But by cleanliness and care, free use of astringent washes and drying powders and frequent changing of the temporary coverings of the perineal straps, the skin will become tolerant and easily managed.

The question will arise as to when the treatment may be discontinued. No promise should be made by the surgeon as to a definite time. As before stated, treatment will probably require one year and maybe two or more. Quite frequently a year and a half has completed the cure. Occasionally a patient is apparently well in nine months. Owing to the persistent nature of the disease and the liability of recurrence, the apparatus should not be laid aside until from three to six months after all pain, tenderness and muscular spasm have disappeared from the limb. Then its use should only gradually be discontinued by leaving it off a part of the day, then all day, then also at night; the high sole on the sound side and the crutches being still retained. At any sign of a return of symptoms treatment must be resumed. If all goes well the limb may very cautiously and gradually be put to use.

Treatment of Abscesses.—Abscesses and their situation have been described in the general discussion, and their treatment alluded to under the heading of iodoform injections and the Bier treatment. Great discrepancy of opinion and practice as to the treatment of abscesses in hip-joint disease has prevailed, some advocating an entirely expectant plan, hoping for the absorption and disap-

pearance, or the quiet and harmless evacuation which sometimes take place. Others are for opening the abscess cavity, scraping out the lining and either closing immediately or packing the cavity with iodoform gauze. There is no good rule that will apply to all these cases. Some abscesses are small and cold, and make little disturbance locally and none in a general way. While others are large or more active, and may burrow and destroy far and wide, or produce fever, pain and emaciation. The first class may well be let alone. The second class should be dealt with. As to the method of opening and scraping, it would be very good if one could be sure before operating that every part of the abscess cavity and its sinus, and accessory sinuses and their cavities could be reached and their tuberculous infection thoroughly eradicated. But how often is this the case? While any wound-making, without eradication, invites general tuberculous infection; and any opening risks the addition of pyogenic infection. When an abscess is large or increasing or causing marked local or general disturbance it is much better that it should be evacuated, with strict antiseptic precautions. In order that there be as little risk as possible of admission of pyogenic germs and escape afterwards of the substance injected, this evacuation should take place through a canula or a very small opening. An aspirating needle is generally too small; there are often curds and flakes of "pus" and débris. The cavity should be washed out with 3 to 5 per cent. boracic acid or 1 to 2000 bichloride solution, the latter to be followed with sterile water. Then the iodoform emulsion should be injected—a few drachms to an ounce, prepared and used as before described, and sealed in with collodion or a gauze pad. This procedure may have to be repeated two or three times at intervals of ten days to three weeks before the cavity will cease to refill, and remain quiescent.

Operative Treatment.—Comparatively few of the cases of hip-joint disease coming early and receiving proper treatment will ever require operative interference. Those which have been neglected in the beginning and a few in which the system seems particularly vulnerable to the tubercular process and irresponsive to treatment may go on until such a stage is reached that an operation is imperative. No hard and fast rule can be laid down. Each case must be judged upon its own merits. This will require a consideration of both the local and general condition, and the history of the case as to what manner of treatment had been used and for how long; whether the principle of rest had been obeyed and had had a fair trial, together with the other local and general measures that often produce remarkable changes in apparently hopeless cases which have not been placed under favorable conditions. If there is extensive destruction about the joint, as evidenced by deformity, by

sinuses leading down to necrosed bone, abscess cavities still suppurating, the local condition preventing any general improvement or rendering it worse in spite of proper treatment, there is no choice but to operate.

Arthrectomy is not very well adapted to the hip-joint.

Excision is the operation usually demanded by the condition and the structure of the joint. If excision were done before the peri-articular structures were implicated, the results would be far better. It is usually not resorted to until it is evident that milder means are a failure, and by this time the parts all about the joint are involved even if they were not at first.

The patient is placed upon the sound side and the operation is done with careful antiseptic preparation, including the opening, draining and scraping of all sinuses and abscesses in the neighborhood of the joint or connected with it.

A number of different incisions are recommended for giving access to the joint. The old crucial incision is no longer used. The curved incision of Ollier and the still more convex-posterior incision of Sayre give access to the joint but are longer than is always necessary. The straight incision of Langenbeck is made with the thigh flexed to an angle of 45 degrees. It begins above, in line with the posterior end of the inferior curved line of the ilium and goes directly down upon the joint, its lower end being just below the apex of the great trochanter. It need not be more than two or three inches long and opens the joint from its upper and back part to the trochanter. It generally gives as much room as is necessary. Perhaps it will only be necessary to remove the separated epiphysis. But all the diseased part of the femur should be removed. Healthy periosteum should be spared and no sound bone sacrificed. The trochanter should be spared if possible. If it is necessary to remove the whole femoral neck and trochanter, all muscular attachments must be separated. Then, if convenient, the thigh may be adducted and the bone thrust out through the incision to be sawn; or a chain saw or osteotome can be used in the depth of the wound. Loose fragments or sequestra from the acetabulum may be removed, but it is not advisable to attempt to scoop or gouge away all the soft bone within reach. If the acetabulum be perforated and an abscess within, the opening should be enlarged to afford free exit. Free irrigation with hot bichloride solution is followed by a suture or two at the angles of the wound. The cavity is packed with iodoform gauze and dressed with sterile or cyanized gauze, cotton and adhesive straps. Buck's extension is applied with the weight very carefully graduated, and sandbags to steady the limb; or a long splint interrupted at the hip may be used. The wound may be dressed on the third or fourth day, merely by removing the gauze packing and introducing fresh. A

few years ago Barker and other English surgeons attempted immediate closure after excision of the hip, and they did succeed in some cases. But it is so difficult to remove every particle of the disease and leave the tissues sufficiently sound for immediate union that the practice cannot be advised for general use. Usually there will be some suppuration, and irrigation at each dressing with sterile salt solution may be necessary before repacking. The wound closes by granulation. The femur should not be held by the extension at too great distance from the acetabulum. Fibrous ankylosis is the rule. The patient may be allowed up and around with a Taylor or Thomas splint or a fenestrated plaster splint, before the wound is closed. Several months should elapse, however, after complete healing before he should be allowed to use the limb. It will not be strong for a year or more.

Amputation.—Amputation for incurable hip-joint disease in children is comparatively rarely resorted to in this country at the present day. It is very unusual to have a case so neglected or so intractable as to require it. The indications for amputation as formulated by Marsh can hardly be improved upon: "When hip disease is complicated with extensive disease of the shaft of the femur, attended with copious and persistent suppuration, and especially if amyloid degeneraion is making its appearance, when excision has been performed but has failed to arrest suppuration, and the general health has given way. When the patient, as the result of extensive disease of the joint, is steadily losing ground, and when it is believed that his general health would not enable him to carry out repair after excision. In some instances of free suppuration associated with disease of the pelvis, amputation may be advantageous either by securing free drainage, or by enabling the operator to remove diseased bone that cannot otherwise be reached. The presence, however, of disease of the pelvis which is either extensive or of long standing must generally be regarded as a strong reason against the operation." And yet the disease may be only in the neighborhood of the acetabulum, or, as Wright remarks, it may be necrosis and not caries, and the disease in the limb may be preventing repair in the pelvis. Under these conditions pelvic disease does not contra-indicate amputation.

The operation is better borne than might be expected. If once the effects of shock and hemorrhage are past, recuperation is rapid. The best method of amputation is that of Furneux Jordan. While this is a good method of amputation under any condition not requiring removal of the soft parts at the inner side of the thigh, it has special advantages in children, in whom one must be very saving of blood; and in cases that have previously been resected. Inasmuch as this operation has frequently been described differently from the way Mr. Jordan first performed and described it, I shall give here

a correct description of the original method almost in Mr. Jordan's own words. The limb is exsanguinated as completely as possible by the Esmarch bandage and by position, and a tourniquet put over the external iliac artery. A straight incision is made on the outer side and the trochanters and upper part of the shaft freed from their muscular attachments. The capsule is opened, the femur freed, enucleated for quite a distance down the thigh, the skin drawn upward and the soft parts cut straight through. No bone being left, the muscles retract and are easily covered by the skin. Larger vessels are tied with catgut, the wound between acetabulum and gluteal region packed to stop oozing. Adjustment made by deep silver sutures. The advantages are that the wound is less severe, the cut surfaces less extensive, and further removed from the trunk; ordinarily less shock, less hemorrhage, less opportunity for septic infection; vessels more easily dealt with. The soft parts may, if the surgeon prefer, be divided circularly, after retracting the skin, but before the bone is enucleated, through an incision on its outer side. The main principles of the operation are " enucleate the bone where it is most thinly covered; cut across the soft parts where they are smallest; do not touch the bulky soft parts at the inner and upper parts of the thigh." Wright advises ligaturing the femoral or external iliac as a preliminary; although he thinks " elevating the limb before operation and digital pressure with the help of an elastic tourniquet in the early stages of the operation are as efficient means of controlling the hemorrhage as any."

Double Hip-joint Disease may occur. The onset is not usually quite simultaneous on the two sides. Treatment can be carried out for both joints at the same time.

TUBERCULOSIS OF THE KNEE-JOINT

Tuberculosis of the Knee-joint—(Tumor Albus; White Swelling of the Knee-joint)—is one of the common and important affections of the joints. Nearly one-third of all the joint diseases of children are tuberculosis of the knee. According to Willemer, as quoted by Senn, in patients under ten years of age the starting point of the disease is in the synovial membrane in 39 per cent. of the cases, and in one or both of the articular extremities of the bones in 61 per cent. With patients between 10 and 20 years of age 49 per cent. are synovial and 51 per cent. osseous; above 20 years of age 33 per cent. are primarily synovial and 65 per cent. primarily osseous. The knee shows a larger percentage of cases of synovial origin than in hip disease. The tubercular synovitis of the knee is generally one of two varieties—tubercular hydrops or fungous synovitis. Of these the latter is far more common, the knee-joint often presenting the typical specimens of pulpy degeneration. It generally begins at the folding

of the synovial membrane, but finally involves the whole joint. The para-articular structures, including the ligaments, are affected early, causing the large, dense, gelantinous mass which appears at the joint. This mass contains cheesy foci which break down and form local abscesses. (See Tubercular Arthritis.)

Suppuration often takes place also within the joint. When the disease begins in one or both of the bones of the articulation there is great alteration and destruction. Deformity due to muscular contraction is one of the pathological changes resulting from tumor albus. (See Fig. 89.) The approach of the disease is usually insidious. It may be attributed to some injury.

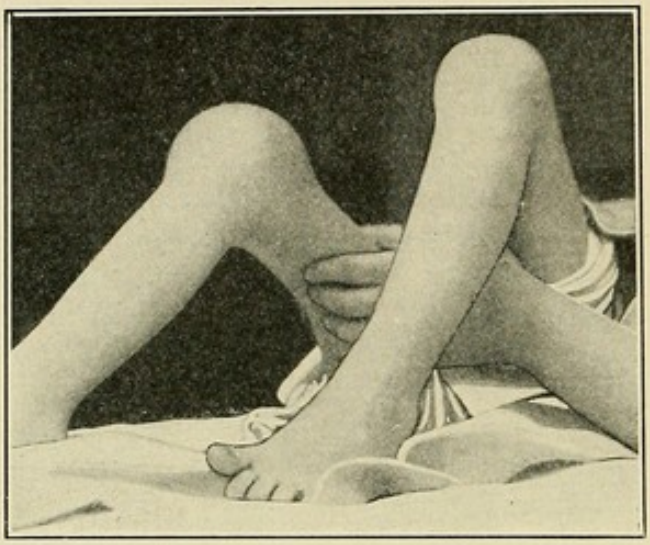


FIG. 89. TUBERCULOSIS OF KNEE-JOINT. "White swelling," muscular contraction, and subluxation. Treated by fixation and gradual extension. Boy aged 5 years.

Symptoms. — Lameness is an early symptom and may appear before pain and swelling, but these follow. Limp is due to muscular contraction which causes slight flexion and stiffness, rather than tenderness. These symptoms come on slowly but increase persistently until all are well marked. Pain is generally not very severe. Muscular atrophy appears, which makes the increasing swelling of the joint more conspicuous. The swelling is rounded, smooth and white, and feels quite firm. When there is abscess, or effusion in the joint, fluctuation may be detected. Muscular contraction increases, the joint being flexed. The continuous traction of the flexors upon the joint produces subluxation of the tibia backward upon the femur. The swelling in front exaggerates the appearance of this condition. The leg is also rotated outward. This flexion, subluxation backward, and outward rotation are sometimes grouped as "the triple displacement." The knee becomes ankylosed in this position. The temperature of the joint is perceptibly elevated.

Diagnosis.—In the early stage of lameness, pain and tenderness with some swelling, the trouble may, as usual, be mistaken for rheumatism. Osteo-myelitis and syphilitic arthritis and sarcoma must be excluded. Gonorrheal arthritis is not impossible in children and should be excluded. It has, though rarely, occurred when purulent discharge was not perceptible from any mucous surface. Referred

pain from hip or sacro-iliac, or spinal disease should be borne in mind. The slow advancement and muscular atrophy are characteristic. Muscular rigidity is the most common and reliable symptom; with limitation of motion, most noticeable at the extremes of the normal range. Gentle passive motion will usually elicit the spasmodic muscular contraction even before rigidity is marked.

Prognosis.—This disease is very chronic in its course and will continue from a year to two or three or more years. Treatment will shorten the course of the disease and greatly modify the outcome, but will never abort it.

If the disease is not treated it will go on to destruction of the joint, and, at the best, result in ankylosis in a position of deformity, if the patient is not carried off too soon by general tuberculosis or pulmonary tubercular meningitis or amyloid disease. With treatment the result will depend largely on when the treatment is begun, as well as upon its location and the general condition of the patient. Under somewhat favorable conditions and treated from the beginning, recovery may result with very little impairment. At least abscesses and ankylosis may be prevented. If treatment is not begun until there is great swelling, flexion and formation of abscess, the best that will probably be accomplished will be a control of the inflammation without farther involvement, and a result with ankylosis in a useful position. An advanced case, with destruction in articular bones requiring resection, can at the best result in nothing better than bony ankylosis with shortening.

Treatment.—The constitutional treatment has been discussed under Tuberculosis and Tubercular Arthritis. The local treatment consists in rest, counter-irritation and compression, the evacuation and injection of abscesses, tapping and injection or incision and drainage of the joint, peri-articular injections, correction of deformity, erasion and resection.

The most important therapeutic factor is rest. This may be secured by various methods, and that method should be chosen adapted to the stage of the disease and condition of the case. If seen early and there is no acute pain or tenderness, fixation by a plaster bandage from the ankle to the perineum, with a high sole (three inches) on the sound foot, and a pair of crutches, meet the indications. If there is quite severe pain and some tenderness about the joint, a good-sized patch should be touched with the Paquelin cautery before the plaster is applied. If the knee is very painful, tender, considerably swollen, and there is marked spasm of the muscles with flexion, nothing will relieve all the symptoms so promptly as bed, and traction with weight and pulley. The traction should, of course, be made in the long axis of the leg, which will gradually approach the long axis of the thigh as improvement occurs. In the

course of a few weeks this treatment will usually prepare the limb for some form of ambulant apparatus, such as the plaster bandage or the Thomas knee-splint. This splint consists of two steel uprights connected at the top with a ring which encircles the thigh at the perineum, and at the bottom with a crossbar a few inches below the foot. The thigh and leg have each a trough-like case in which the back of the limb rests, being held in its place by straps or bandages

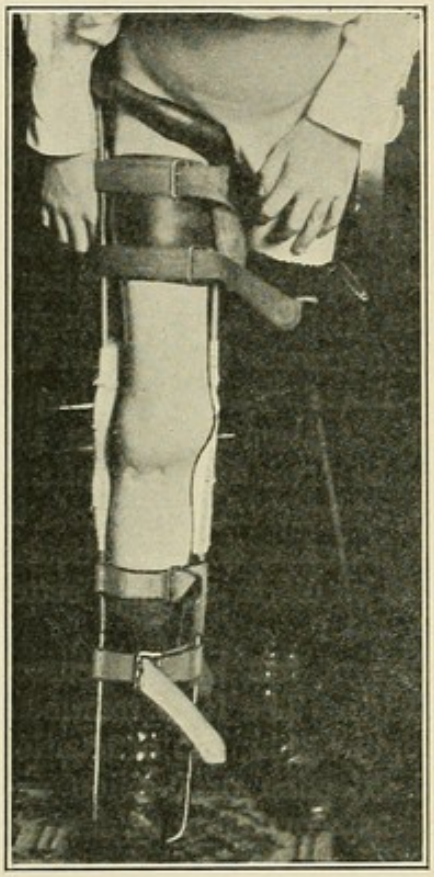


FIG. 90. Same case as Fig. 89 after reduction of the deformity by extension, and Thomas' knee splint applied.

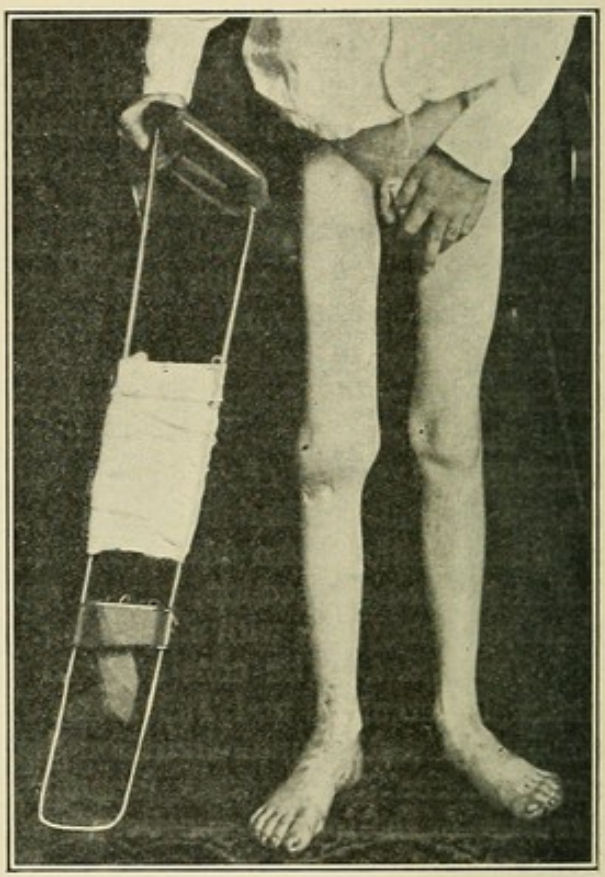


FIG. 91. Same case as Figs. 89 and 90 cured, with 10 degrees of motion in the knee.

around splint and limb. (See Figs. 90 and 91.) The ring at the top is padded, and when the patient steps upon the splint his weight is borne upon the tuber ischium. The sound foot is supplied with a high-soled shoe. Thus the limb is immovably fixed, while weight-bearing is prevented though the patient goes about. If there is flexion without real subluxation, it may be overcome by a gradual straightening process, by adjustment of the bands, or even by a bend in the uprights of the Thomas splint. Where there is alteration of the articulating bones and shortening of the posterior ligaments, as frequently results from flexion and contraction of muscles, simple

straightening does not reduce the subluxation. If it is desired to use traction in connection with the Thomas splint, it is very easily managed by applying side straps of adhesive plaster to the leg and attaching them to straps upon the crossbar at the bottom, as was described in traction with the Taylor splint for hip disease. When using plaster for fixation in a case with deformity by flexion, the knee is placed in as correct a position as is comfortable, no force being used, before the plaster is applied; and when, in a week or two, the plaster bandage is renewed, it will be found that the joint can be still further improved in position, until finally the deformity will be entirely corrected. The same thing can be accomplished with a splint hinged at the knee, with fly-nuts at the joints, so that ex-

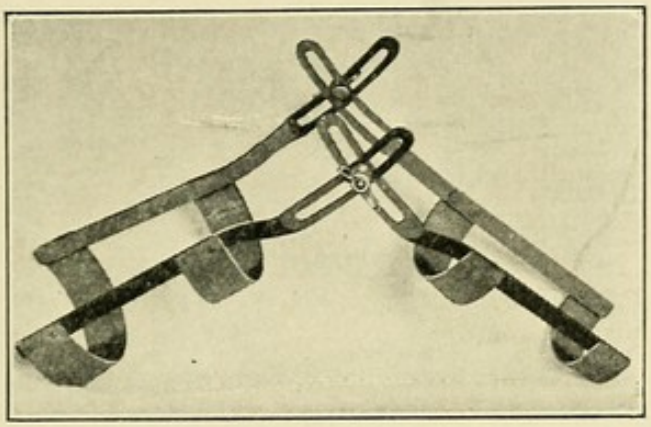


FIG. 92. SPLINT FOR GRADUAL EXTENSION OF KNEE OR ELBOW.

tension can be gradually brought about by a slight change at intervals of a few days, the limb being continuously quite immobilized by the splint. (See Fig. 92.) This appliance leaves the knee accessible for inspection or dressing in case of abscess or a discharging sinus.

Thus the measures employed for fixation usually also correct the deformity. It is not advisable to attempt to correct deformity by leverage upon the joint, and immediate correction by force is a dangerous procedure when there is any active tubercular disease present. If the disease has subsided, but the joint is left badly flexed with tibia subluxed backward, traction can effect little toward improvement. However, it should be given a trial, as some cases yield unexpectedly. A careful attempt may be made under anesthesia to break the adhesions; and in some cases the contracted hamstring tendons may be divided. But in cases where there has been much inflammation in the popliteal space attempts at forcible straightening may result in injury to the vessels. To effect reduction of these obstinate ankylosed dislocations a number of mechanical appliances have been invented, such as Goldthwait's genuclast and Peters' wrench. They

are powerful levers which make a fulcrum of the lower end of the femur anteriorly and apply the pressure close below the head of the tibia posteriorly. Ordinarily manual force furnishes all the power compatible with safety in work upon young children. If all attempts at straightening fail, resection or osteotomy by removing a wedge from the lower third of the femur may he resorted to.

The teatment of abscesses has been sufficiently discussed elsewhere.

When pain and muscular spasm and tenderness have been absent for a period of three to six months the patient may be allowed to use the limb for weight-bearing, at the same time protecting the joint by a splint. The splint may be removed daily and motion tried. If moderate walking and passive motion cause no return of symptoms after a few weeks the splint or brace may be laid aside entirely. If, however, there is any return of pain or muscular rigidity, the fixation apparatus should be resumed. Some surgeons consider weight-bearing admissible early in the treatment—as soon as the active symptoms have been quieted—claiming that it does no harm if fixation be maintained. This may be true in some cases. Yet in the majority of cases and in hands not extremely familiar with all the phases of the disease, it is safer to interdict both weight-bearing and motion until the case is cured. A degree of enlargement will remain about the joint after all pain, spasm and tenderness have disappeared, in fact, even after it is cured.

Arthrotomy.—But the joint will not always pursue the favorable course here described. Even after the most appropriate and faithful treatment, including skillful conservative management of abscesses outside of or within the joint, with evacuations or injections, suppuration within the joint may continue, with proliferation and degeneration of the fungous growth. In such a case, if the general health of the patient remains sufficiently good or at least does not demand immediate radical interference, it may suffice to open the joint and establish drainage at its lowest point and posteriorly.

Erasion; (Arthrectomy, Synovectomy.)—If arthrotomy has been tried and has not changed the behavior of the joint, or if the general health of the child is failing or amyloid disease appearing under prolonged suppuration, or if, without suppuration, the pulpy swelling increases, the best procedure to resort to is erasion. This operation was devised and executed and introduced by Wright of Manchester in 1881. Grieg Smith had previously performed erasion on an elbow, although his case was unknown to Wright, as it was not published at that time. Volkmann appreciated this operation highly and published, in 1885, a paper on "Arthrectomia Synovalis," as he called it. It was Ollier who described it as synovectomy. The operation is designed to substitute resection in cases

where only the synovial membranes are diseased, while the articular surfaces are intact or only partially involved, so that diseased points can be removed without removing the whole articular extremity. If erasion succeeds, the joint is as sound as after an excision but without shortening, either as an immediate result of the removal of the articular ends of the bones, or of accidental interference with the line of growth. The operation is appropriately described nearly in Mr. Wright's own words. The limb is Esmarched. The knee is opened freely by a semilunar incision as for an excision. The skin is reflected and the capsule removed on each side of the patella and patellar ligament, or, better, the patella is sawn across and the fragments turned upward and downward. If necessary, free vertical incisions must be made to reach as high as the upper limit of the synovial pouches. Next every particle of pulpy granulation tissue is carefully cut away with scalpel or scissors; all the infiltrated capsule and the semilunar cartilages are removed, and the articular cartilage scraped quite clean, any granulation tissue being carefully picked out from pits in the cartilage, and, if necessary, any foci of disease in the bone gouged away. This process must be most thorough, and extreme flexion of the limb is required to fully expose and clean the back part of the joint. The crucial ligaments are scraped, but if sound preserved. The lateral ligaments are divided. The upper synovial sac must be thoroughly cleaned. The most difficult part of the operation is getting away the posterior part of the semilunar cartilages and the synovial membrane at the back of the joint. After thoroughly removing all pulpy tissue it is a good plan to apply the actual cautery to any doubtful spots. Any fistulæ should be well cleared out. The process is tedious, requiring an hour and a half to two hours, including the subsequent putting up in a splint. As soon as all bleeding has been stopped, the limb is fixed on an excision splint and dressed antiseptically. Drainage should be at the back of the joint on each side as after excision, the tubes being carried through openings made behind the joint. More recently Wright used no drainage and closed the wound entirely. Usually healing throughout by primary union is obtained. Mobility after erasion is a possibility, but should not be attempted unless the interference with the articular surfaces was not extensive. If ankylosis without shortening can be obtained the outcome is gratifying.

Volkmann uses the Esmarch constrictor only in exceptional cases. If the bursa beneath the quadriceps is diseased he prolongs the incision to reach it and removes it entire. This exposes the femur several inches above the articular surface. All disease tissue is removed until healthy bone and muscular tissue are reached.

Excision. Resection.—If a case is too bad for erasion or that operation has been tried and failed, or if there is extensive deformity

of the joint, rendering it useless, there still remains a method of eradicating the disease and restoring or partly restoring function by excision. Typical excision is always to be avoided in children if an arthrectomy or an atypical resection can be safely substituted, because of the danger of interference with growth of the bone in length, as well as on account of shortening, as was first emphasized by Syme. Yet when the operation is unavoidable the results are better in children than in adults.

Concerning the questions of the effect upon the growth of bone, the reproduction of the articulation after resection, and the amount of shortening, there has been a great deal of discussion. Whatever may result in the exceptional case, in the majority of cases the dictum of Senn upon this point will be found excellent advice: "In children atypical resection should be practiced in all cases where all the foci in the articular extremities can be reached and removed by this method."

After the joint has been freely opened and all diseased soft parts cleared away, the bone surfaces are inspected for both superficial and deep-seated foci of disease or of infection. Usually several, and sometimes many, foci will be found. All cavities are exposed and all diseased or suspicious spots are removed with sharp spoon, chisel, gouge, or bone forceps. If the diseased parts are so situated as not to demand removal of the entire articular surface, a complete resection need not be made; but a portion of both bones can be sawn or sliced out in a shape to match or splice together. This will give less shortening and a firmer union than if both are divided clear across. If there are not sound portions of bone to spare in this or a similar manner, typical resection must be made by cutting both bones across.

Whether the typical or atypical operation is made, the tibia is sawn or sliced at such a deviation from the right angle to the long axis of the shaft as will place the limb in a slightly flexed position, as if in the act of walking, when it is brought in apposition with the squarely cut end of the femur. Splicing is neither so easily managed nor so necessary in young children as in older children or adults. In cutting off the ends of the bones it is not intended to go far enough back from the articulating surface to reach the bottom of every cavity. Only a thin slice is removed and the gouge used afterward on any diseased spot or cavity. The cross sections should not approach the epiphyseal lines. Wiring or pegging or nailing tibia and femur together is not necessary in children, but the patella which had been divided should be sutured with wire or chromicized catgut. Drainage should be provided for by two openings into the popliteal space. After all oozing is stopped and the wound thoroughly cleansed and dried, the incision is entirely closed, powdered with iodoform and

boric acid or camphophenique, dressed with iodoform gauze, bichloride, or sterile gauze and bandage and put up with a long splint interrupted at the knee. After a few dressings the limb should be put into plaster of Paris, fenestrated if there remains a sinus. Bony union should take place in one to two months, but a stiff splint should be worn for two to four years or the union will yield, causing great deformity.

TUBERCULOSIS OF THE ANKLE

This does not occur as commonly as one would expect from the hard usage to which this joint is subjected, its exposed situation and liability to trauma. Yet not very rarely it becomes the seat of tubercular processes similar to those which have been described in the knee. Named in the order of frequency the primary focus may be said to be situated in the astragalus, tibia, os calcis, or synovial membrane; although statistics differ on this point. The etiology is the same as that given for the hip and knee-joints.

Symptoms.—The symptoms are lameness, swelling, muscular spasm, wasting of the muscles of the leg, heat, pain, and tenderness. Usually limping will be noticed first. The child avoids flexing the foot, but rotates it outward in stepping forward. The limp is due partly to this and partly, but less, to avoiding weight-bearing. Swelling is an early symptom, especially if the disease is synovial from the beginning. It is most noticeable anteriorly at first, then posteriorly at each side of the tendo Achillis. Muscular spasm is not long in making its appearance, though it may not be easy to demonstrate early in the case unless the examination is made with great care. Later on, as is also the case with other joints, the flexors contract strongly. This produces deformity, the foot taking the position of equinus.

Muscular spasm does not long continue before wasting of the calf muscles is apparent. Careful measurement with a tape, comparing the two limbs in the same position, will detect it early, and flabbiness corroborates the finding. Pain is not near so marked a symptoms as in hip-joint disease. It is unusual to have severe pain or night-screaming, though these are not unknown. Tenderness to general pressure is not marked, the child may not complain on bearing the weight of the body, but certain tender points can often be located. Local heat is an uncertain symptom which may or may not be present.

Diagnosis.—The diagnosis is made upon the muscular spasm, wasting of the calf muscles, swelling without discoloration, the continued low-grade heat, and the tenderness. It is differentiated from disease of tibia or tarsus by locating the tender point, and by absence of early swelling in the joint itself. From teno-synovitis by locating the course of the tendons, and by the crepitus and friction sound in

the latter disease. In sprain there is a history of traumatism; and if there is swelling it is apt to be discolored. Sprain and its swelling are generally only on one side of the joint.

Prognosis.—If treated early the prognosis is very good. If the disease has progressed so far that operative measures are necessary it is unpromising. Treatment of cases seen early will require from six months to a year or more.

Treatment.—The treatment is rest. This is secured in young children by keeping them lying in bed, with fixation of the joint by means of a plaster bandage or leather or felt splint. Older children may, after the acute symptoms have abated, be fitted with a Thomas splint in addition to the plaster bandage, a pair of crutches, and a high sole on the sound foot, and allowed to go about. A plaster bandage to immobilize the ankle should extend well up the calf and down to the toes, and have no padding beneath it. The foot should be placed as near at right angles with the leg as the contraction will allow before each application of the plaster bandage. If these means fail, and suppuration occurs in the joint, arthrotomy, erasion, or resection must be resorted to as described for the knee-joint, though the prospects of recovery are not so good as in the knee.

TARSAL TUBERCULOSIS

Tarsal tuberculosis is usually synovial in its origin unless located in the os calcis. It should be treated by rest and fixation, as with disease of the ankle joint. If this fails, there is a choice of amputation or an attempt to remove the diseased parts only. If any operative interference whatever is attempted it should be very thorough. Scraping and gouging are usually unsuccessful and are certainly dangerous. If the disease is definitely located, and especially if there be sequestra in one or more of the tarsal bones, these bones should be removed. But the use of probes in attempting to locate or to define the limits of tarsal disease is very uncertain and unsatisfactory.

If synovitis and caries are general among the bones of the tarsus it is best to remove them all. Wright considers this better than either a Pirogoff's or Syme's amputation. A transverse incision is made on the dorsum and a flap turned upward, the bones removed, the tendons reunited; hemorrhage controlled, and flap sutured. After dressing, the foot is put upon a back splint with foot-piece. This is changed later to plaster bandage or other portable fixation splint.

TUBERCULOSIS OF THE ELBOW

Tuberculosis of the elbow is common in children between the

ages of two and five years or more. It is primarily a synovitis or an osteitis in about an equal number of cases. Sometimes it seems to start in the olecranon bursa, and presents the usual symptoms of tubercular joint disease, excepting pain. Stiffness, muscular tension, and wasting of the muscles, swelling, and sometimes heat, are present. While there may be pain, it is often absent, and tenderness is not marked. In some cases there is very little increase of local heat. The swelling in a typical case is fusiform, and the joint is held about two-thirds extended. The stiffness may be the first symptom of all.

If seen early, the joint (including the arm and forearm) should be brought as near as possible to a right angle with the forearm, half way between pronation and supination, and fixed in a splint of plaster, felt, leather, wire, or other material, and supported in a sling. Treatment will require from four months to a year. If abscesses be present, they must be evacuated, and the splint interrupted or fenestrated so as to allow for dressing, while fixation is continued. If the bones have become carious or pulpy, the synovial membrane destroyed, and the soft parts riddled with sinuses, excision may have to be done. If the case is not too bad, erasion or an atypical excision should first be tried before excision is resorted to.

The elbow joint is best exposed by the long straight posterior incision of Langenbeck. It passes just inside the tip of the olecranon. All the soft parts are then separated from the internal condyle. The ulnar nerve should be carefully guarded. The anconeus should not be cut across but loosened from the olecranon and turned aside. Instead of severing the tendon of the triceps, the olecranon may be cut across, which gives easy access to the joint. If the olecranon is subsequently removed, the tendon should be attached to the ulna, but if removal of the olecranon is not necessary, when the work upon the joint is completed by removal of all diseased tissues, the olecranon can be wired or nailed in place. After hemostasis and dressings, the extremity is put up with a right-angled splint, with the forearm half supinated. The first dressing is made in a month, if all goes well. Some advise passive motion after two weeks, but nothing is to be gained by attempting passive motion until healing is complete. If ankylosis results, the extremity is in the most useful possible position. Oftentimes motion and a surprising degree of strength are obtained.

TUBERCULOSIS OF THE SHOULDER

This joint is a rare location for tuberculosis in children. The disease in the shoulder presents the usual characteristics of tubercular arthritis, and should be treated on the principles already laid down.

WRIST-JOINT TUBERCULOSIS

When the disease attacks the wrist there is an additional feature in the presence of extensive synovial sheaths. Of the bones the radius is most frequently affected, and after that the proximal ends of the metacarpals.

The symptoms are those usual in all tubercular joint affections, with a rather unusual amount of tenderness and pain on motion. The most of the swelling is on the dorsal surface.

Diagnosis is not difficult if one exclude teno-synovitis, in which the swelling is shallower, and the trouble not so chronic and persistent.

If seen and treated early, the probability is that a cure will result in four or six months. Most cases do remarkably well with the rest treatment. After suppuration, caries, and sinuses, the outcome is uncertain.

Treatment consists in rest secured by a plaster bandage extending from the metacarpo-phalangeal joints to the bend of the elbow, allowing free motion of the phalanges. The arm is carried in a sling with the forearm halfway between pronation and supination. It is very unusual to have tuberculosis of the wrist progress seriously if the rest treatment is instituted before the disease is already far advanced. If it does not yield to conservative methods but extends, forms abscess, cavities, sequestra, it must be dealt with in an operative way, removing all the diseased tissues. Mere scraping or partial removal will be useless or worse than useless.

SACRO-ILIAC DISEASE

A disease very rare in childhood, but when it does occur it is a very serious condition. It may involve the synovial membrane first, but is thought to originate more frequently in the ilium and extend into the joint. In some cases it may be rather acute for a tuberculous bone or joint disease, running quickly to suppuration and hectic, but generally is quite chronic. If the patient does not die of exhaustion, some other form of tuberculosis or an inter-current malady, the sacro-iliac disease may go on to destruction of synovial membranes, ligaments, and bones.

Symptoms and Diagnosis.—The list of symptoms of sacro-iliac disease repeats exactly that of hip-joint disease, with the exception that muscular rigidity is omitted, namely, lameness, pain, muscular wasting, swelling, altered position of the limb, tenderness. The limp lacks any characteristic that would give it differential diagnostic value. Pain is often severe, or at least a prominent symptom. Pain may be felt near the joint or extending down the back of the thigh or in the groin or front of the thigh, or about the knee or in the

rectum or bladder. It may be dull or aching. Pain is caused by pressing together the sides of the pelvis or by pressing them apart. There is wasting, slight or greater, of the muscles on the affected side, of the gluteal region and the limb. Swelling is not always very perceptible, excepting in a lean patient, or in an advanced case, or in the presence of abscess, when fluctuation also may be detected. Abscess from spinal disease may appear in this locality. The swelling or the abscess may be located on the inside of the pelvis. There is either no alteration of the position of the limb, or else apparent lengthening, from tilting of the pelvis, with marked eversion. The limb is fully extended. In standing the patient rests his weight mostly on the sound limb. Tenderness on pressure in the sacro-iliac

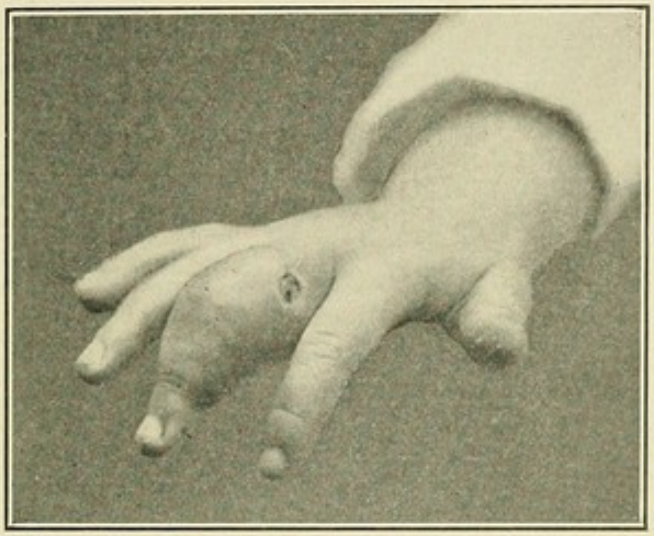


FIG. 93. TUBERCULOUS DACTYLITIS.

region is usually present and aids in locating the trouble. Although the symptoms are apt to mislead, a diagnosis can be made from the pain produced by pressing the pelvic bones together or apart, the absence of any pain or limitation of motion about the hip-joint and the absence of any rigidity or angular deformity in the lumbar spine. (See Diagnosis of Spinal Caries.) Pott's disease has also a peculiar gait, but no limp.

Prognosis.—The prognosis is grave. At the best the disease will be very tedious, and the percentage of recoveries is small.

Treatment.—Treatment consists of rest in the horizontal position, with fixation by plaster bandage, leather, felt, or similar jacket or splint. If suppuration ensue the abscess should be drained antiseptically. Encouraging results have been obtained by cutting down upon and removing the diseased tissues, irrigating thoroughly, and packing with iodoform gauze. When the disease shows a tendency to extend, notwithstanding rest and general treatment, it is better to

interfere thoroughly than to allow abscesses to burrow or suppuration to exhaust the patient.

TUBERCULAR DACTYLITIS (SPINA VENTOSA)

This is a very common form of tubercular disease in children, in which the bones of the fingers or toes or of the metacarpus or metatarsus are affected. It furnishes a marked exception to the rule that tuberculosis prefers the spongy bones and the epiphyses of the long bones and seldom attacks the shaft or its medulla.

It is primarily a diffuse central tubercular osteomyelitis of the rarefying form, followed by osteoplastic periostitis, resulting in cheesy degeneration within the bone and deposition of new bone externally so that "expansion" takes place. It begins as a firm swelling of the phalanx or metacarpal bone, with tenderness but without much pain. The swelling becomes large and fusiform. (See Figs. 93, 94 and 95.) "Abscess" forms and discharges through a rounded opening with dark red skin margins. A probe finds a comparatively large cavity within the expanded small-bone. After a tedious chronic course the disease process may come to an end, leaving a shortened

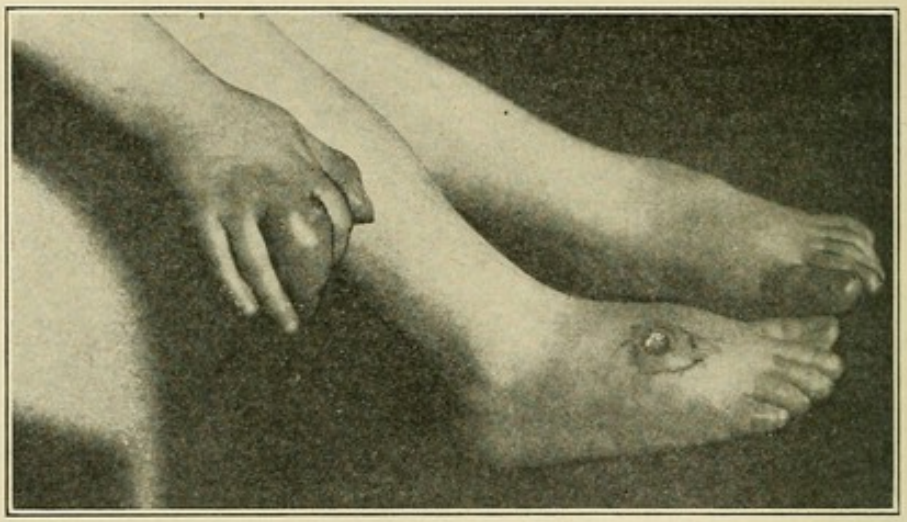


FIG. 94. TUBERCULOSIS OF PHALANGEAL AND METATARSAL BONES.

and deformed finger or toe, or an ugly puckered scar upon hand or foot.

Dactylitis is also one of the manifestations of syphilis. It occurs far more rarely than tubercular dactylitis. It is quite easy to mistake the syphilitic for the tubercular disease, but there are usually other evidences of syphilis and there is more tendency to attack the periosteum and less tendency to invade joints. The X-ray shows less atrophy in the histological structure of the bone.

Treatment.—Some advise excising the bone early, but that surely will result in deformity. Later, if one attempt to scrape out

the diseased tissue he may find that he has removed the entire bone, or so much of it that it will collapse. Patient, conservative treatment is best in these cases. If treated early the trouble will gradually subside with rather firm bandaging upon a splint, and leave very little impairment in appearance or usefulness. If not seen until the swelling has opened, it is best to give the same plan of treatment a very thorough trial before resorting to any attempt at eradi-

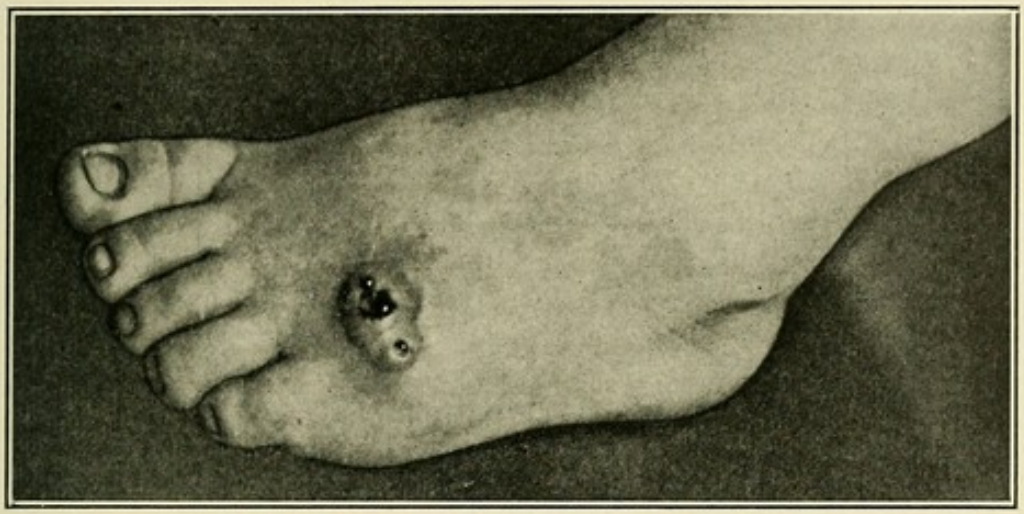


FIG. 95. TUBERCULOSIS OF METATARSAL BONES.

cation. Iodoform and boric acid dressing, and firm pressure, with fixation and rest by means of a splint, are still the best treatment.

TUBERCULOSIS OF THE STERNO-CLAVICULAR JOINT

The sterno-clavicular joint is occasionally, though very rarely in children, attacked by the tubercle bacillus. When beginning in bone it is usually the clavicle, though it has been known to begin in the sternum. It may be primarily synovial. The symptoms are pain, swelling, and tenderness. The pain may be sufficiently severe to excite suspicion of traumatism; but when the swelling appears it is the characteristic tumor albus, firm or putty-like. When the clavicle is attacked the swelling takes an oblong shape. It somewhat resembles sarcoma, but is more tender.

Treatment.—On account of its situation it is unfortunate to have suppuration occur, for it may take place internally and descend into the mediastium or pleura, or into the sheaths of the blood-vessels and involve the veins.

It is best, as soon as a diagnosis can be made, to open the swelling and eradicate the tubercular infection, pack the cavity, and let it close by granulation. Rarely, complete removal of the clavicle has been necessary, or a resection of the sterno-clavicular joint.

TUBERCULOSIS OF RIBS AND OTHER BONES

Frequently in adults but more uncommonly in children, it tends to attack the costochondral junction and extend along the rib. It may begin inside or outside the chest, and, being almost painless, attracts little attention until abscess occurs. (See Fig. 96.) One has seen tuberculosis of the ribs with circumscribed abscess of the pleura which simulated empyema. Ordinarily there is some external swelling which has a long diameter in the direction of the length of the rib. It should be thoroughly cleared out and packed, to heal by granulation.

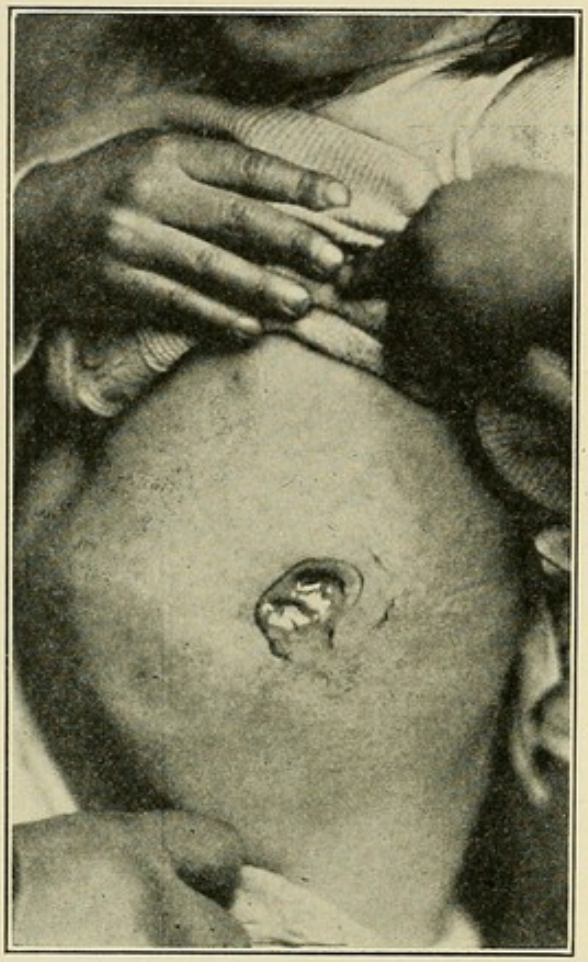


FIG. 96. TUBERCULOUS OSTEO-CHONDRITIS OF RIBS.

Tuberculosis of other bones, for instance, sternum, face or skull, occurs in children, and if untreated result in tubercular abscess with consequences varying with the situation. Upon the face deformity and sometimes disability result. Of the skull bones the mastoid most frequently diseased. The frontal, the parietal or process of the temporal is occipital, though very rarely involved before the adult life, may produce serious results. The inflammation, beginning either as a periostitis or in the diploë may involve the entire thickness of the bone, with caseation, suppuration and formation of small sequestra. The symptoms are pain, local tenderness, swelling, and fluctuation or evidences of pressure on the brain if the abscess presses inward. Or complete perforation may occur. Syphilis bears the nearest resemblance. Usually other tuberculous lesions are present. As a rule tuberculosis of facial and cranial bones should be dealt with actively by local eradication with the sharp spoon, gouge or drill.

CHAPTER X

FRACTURES AND SEPARATIONS OF EPIPHYSES

Intra-Uterine and Congenital Fractures—Incomplete or Greenstick Fractures—Traumatic Separation of Epiphyses—Refracture for Vicious Union—Fractures of the Skull—Fractures of Nasal Bones—Fractures of the Superior Maxillary and Malar Bones—The Inferior Maxilla—Clavicle—Injuries of the Humerus near the Elbow—Fracture above the Condyles of the Humerus—Separation of the Lower Epiphysis of the Humerus—T or Y Fracture—Fracture of the Internal Condyle—Fracture of External Condyle—Fracture of the Internal and External Epicondyle—Separation of the Upper Epiphysis of the Humerus—Shaft of the Humerus—Separation of the Upper and Lower Epiphysis of Radius—Fracture of Shaft of Radius or Ulna—Fracture of Separation of Olecranon—Fracture of Shaft of Femur—Fracture of Shaft of Radius or Ulna—Fracture or Separation of Trochanter Major—Separation of Lower Epiphysis of Femur—Fractures of Shafts of Tibia and Fibula—Separation of Tibial and Fibular Epiphyses—The Patella and Tubercle of the Tibia—Metacarpal and Phalangeal Fractures—Fractures of Ribs—Fractures of Sternum.

If certain anatomical and physiological differences which are present in the infant and child are borne in mind, the variations in their fractures as compared with similar injuries in the adult are readily accounted for. First, there is the softer consistencey of the bones in early life, due to the lesser percentage of lime salts and the greater relative proportion of animal matter which they contain. Next, there is the thicker, stronger, more vascular and more easily "stripped" periosteum in the young. A third condition peculiar to the young is the loose attachment of epiphysis to diaphysis in the long bones; and a fourth, the smaller, softer and less powerfully contracting muscles. There are others of minor importance.

The different consistency of the bones renders them less brittle, consequently less liable to comminution, and more liable to the in-

complete or the greenstick fracture. The thick periosteum, and, to a certain degree, the rarity of sharp splintering, decreases the number of compound as compared with simple fractures and lessens the liability of over-riding of the broken ends, and of injuries to vessels, nerves or viscera. (See Fig. 97.) But if the violence is sufficient to force the fragments through the periosteum, then the delicacy of fasciæ, muscles and skin permits extensive laceration of the soft parts. The absence of bony union between the articular end and the shaft in the immature skeleton permits a separation to take place

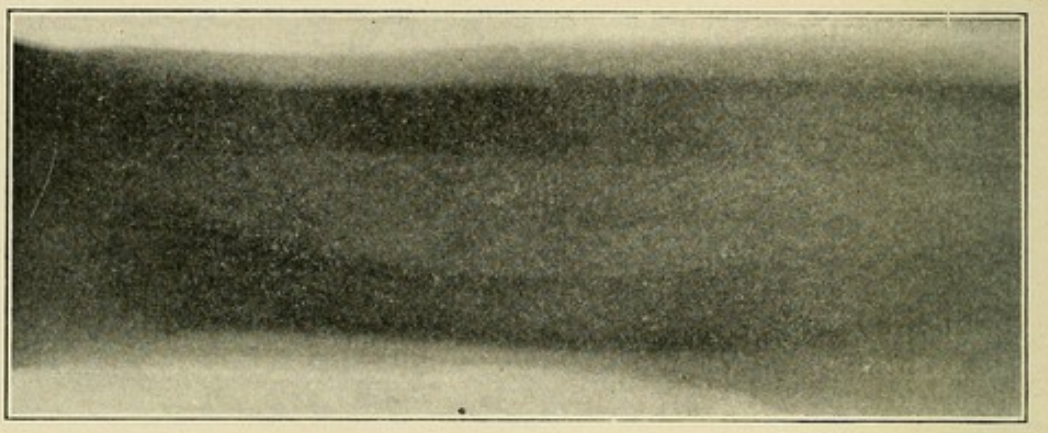


FIG. 97. FRACTURE OF RADIUS AND ULNA, fragments held by periosteum. So little deformity, mobility or crepitus that it escaped the notice of an experienced surgeon.

at the epiphyseal line as a result of traumatism which in an adult would probably have caused a fracture or a dislocation. The smaller size and weaker contractile power of the muscles modify greatly the amount of the deformity, the tendency to which is also diminished by the more transverse line of fracture. A fracture of a soft bone or an epiphyseal separation gives a crepitus that is less sharp and grating than with the dense, compact, completely ossified bone of the adult, or in greenstick fracture gives no crepitus at all. The weak musculature allows of a readier reduction of the deformity; but the lack of the angularity, of the distinctness of the surface landmarks in the undeveloped bony and muscular systems of the child, together with the presence of the thick, soft layer of subcutaneous fat and the tender skin render it difficult to maintain accurate adjustment and perfect immobilization. These difficulties are in no way lessened by the natural restlessness and thoughtlessness of childhood.

Another peculiarity is the quick repair that takes place under ordinarily favorable conditions; and still others, the failure of growth in length which sometimes follows injury at the epiphyseal line, and, contrary to Mr. Holmes' opinion, the unlooked-for obsti-

nacy of a pseudo-arthrosis in a child. These peculiar conditions are undergoing continuous change from fetal to adult life, each stage of development being in some particular point different from all the others. Certain morbid general conditions, as rachitis and fragillitas ossium, in their connection with fractures, deserve separate consideration. Fractures in utero and of the new-born will be grouped together.

Diagnosis.—The diagnosis is sometimes extremely easy, as it often is in fracture in adults, but it may be quite difficult in some cases of incomplete or greenstick fractures and of epiphyseal separation. Moreover, fracture may be overlooked or unsuspected in infants or young children, who give no aid in locating pain and drawing attention to the injury; and pain is not as prominent a symptom of fracture in the early years of life as it is later. If the child, through fear or pain, will not allow a satisfactory examination, anesthesia should be used; and if there is any doubt whatever as to the nature of the injury or the probability of a favorable result, it is best for the patient, and for the surgeon's reputation, that consultation with a surgical friend be had and a few notes of the case be recorded.

Treatment consists in prompt and accurate adjustment and the application of fixation apparatus, sometimes with extension. Numerous materials are used for this purpose, the most common being binders' board, plaster of Paris and wood, with adhesive straps, cotton and bandages. If the fracture is simple and without shortening, not near or into a joint, so that little swelling is to be expected, it may be put up in plaster from the beginning. If swelling is to be expected, it would be better to use plaster splints, held in place by a muslin roller, as this can readily be removed for inspection and adjustment. Frequently plaster is not at hand, and binders' board is usually obtainable, and having been cut to shape and dipped in hot water and applied over a layer of cotton, perhaps reinforced with a strip of wood and held with a bandage, serves a useful purpose, either temporarily or throughout the treatment. Sometimes extension and counter-extension are necessary, but less frequently in children than in adults, and very seldom, if ever, in infants.

Amputation or excision should almost never be resorted to without an effort to avoid it and save the limb. It is only justifiable if the limb or joint are crushed and pulpified or the main vessels and nerves hopelessly injured. Comminution of bone and extensive laceration of soft parts does not preclude the possibility of preserving a useful member. The reparative power of the young organism often surprises those who are not familiar with surgery among children. If, after a faithful effort by hot wet dressings to revive and maintain the vitality of the injured tissues, gangrene super-

venes, the surgeon cannot censure himself, nor can the child's friends censure him, for sacrificing the limb to save the life.

INTRA-UTERINE AND CONGENITAL FRACTURES

It is well known that fractures may occur in utero from violence to the mother; or in parturition, either by the natural expulsive forces or as an unintended result of the efforts of the attendant. Intra-uterine fractures sometimes unite before birth, either in good position or in deformity, as it may happen, or they may remain ununited at birth, even though sufficient time had elapsed. These points sometimes have a medico-legal, as well as a surgical, interest. Fractures of the bones of the skull may be either linear, in the form of a gutter produced by the blade of the obstetric forceps or from being forced past an exostosis or the sacral promontory; or of the spoon-bowl variety, from continued pressure upon one point. Any of the bones of the cranial vault may be fractured either in spontaneous or assisted delivery, but the parietal most frequently suffers this injury. Quite frequently no symptoms result and no treatment is necessary beyond careful manipulation upon delivery. But if there be pressure symptoms due to depression of bone or intra-cranial hemorrhage, trephining should be resorted to. This is seldom done. Often slight depressions disappear spontaneously or remain, but produce no symptoms. However, the effects may be so late in developing as not to be attributed to their real cause. The time may come when professional opinion will demand operation in all cases of depressed bone or intra-cranial hemorrhage in the newborn whenever there are enough symptoms to make a diagnosis. The lower jaw may be fractured or its lateral halves separated at the chin by efforts at extraction. It should be put up in a plaster of Paris or molded binder's board splint; or a plaster cast should be made and a vulcanite splint shaped upon that. One of the not uncommon injuries is separation of the upper epiphysis of the humerus, produced by attempts to bring down the arm which has remained alongside of the head in a head-last delivery, or by pulling upon an arm with rotation at the same time. For symptoms and treatment see section on separation of epiphyses, and of the special bone.

Fracture of the shaft of the humerus occurs in the same way as epiphyseal separation. It should be dressed by splints encircling the arm and the member flexed to a right angle, and fastened to the side of the thorax by adhesive straps and a bandage.

Obstetric fracture of the femur is usually caused in attempts at podalic version or in breech presentations during attempts to bring down a thigh by finger, blunthook or fillet. There is very little deformity or tendency to override. Union usually takes place

in ten or fifteen days if the limb is properly put up at once, and gives a good result without shortening or other deformity. Binders' board is always at hand; or sheet vulcanite can be secured, as Nancrede suggests. Either of them, after dipping in hot water, can be modeled upon the limb and abdomen, and then, after careful adjustment of the broken ends, bandaged on, or plaster of Paris can be used, or light wooden splints around the thigh. If the precaution be taken to carry the splinting above the hip-joint to abdomen or chest, and below the knee, a straight limb will be obtained. Some prefer the suspension treatment in fractures of the thigh, even in the new-born. But one has often had results that could not be improved upon, and never any bad ones from the simple straight splinting without any form of extension.

SPONTANEOUS AND PATHOLOGICAL FRACTURES

Spontaneous and pathological fractures occur, but very rarely, as a result of muscular action or trifling accidental force acting upon bone weakened either by local disease, such as osteitis or sarcoma, or a general disease like scurvy or rachitis, osteopsathyrosis, and, still more rarely in children, by osteomalacia, diabetes and the osteoporosis accompanying central nervous disease and phosphaturia. It has been reported, but must be rare also, in hydrocephalus and infantile paralysis. Spontaneous separation of epiphysis occurs in syphilis in young infants; it has been mentioned under epiphysitis and syphilis. Epiphysis and shaft reunite under anti-syphilitic treatment.

Rickets and scurvy produce a friability of the bones which sometimes leads to spontaneous fracture or to fracture from slight violence. Union is usually obtained, although it may take place slowly, and there may be a larger callus than in normal bone.

Osteopsathyrosis, a form of fragilitas ossium, is an hereditary disease, in which there is a tendency to fracture. The nature of the disease is unknown. It does not present the epiphyseal enlargements nor the pliability of rickets, nor the softness of osteomalacia. The bones are small, and, being deficient in lime salts without having an increase of organic matter, they are brittle, and repeated fractures occur from very slight violence. The muscles, fasciæ and ligaments are also lax, although the child appears in good health. There is very little pain, swelling, or deformity as a result of the fracture. The prognosis as to union of the fracture is good, but as to the general condition it is unpromising. The treatment is that of any fracture, locally, and for the general pathological state, cod-liver oil, phosphorus, iron, manganese, arsenic, hypophosphites of lime and soda, good nourishing food, and hygienic mode of life.

Osteomalacia is extremely rare in children. The bones are deficient in lime salts, their inorganic matter having been absorbed from the medullary surface. There is no beading of ribs nor enlargement of epiphyses of the long bones, nor osteoplastic activity of the periosteum, as in rickets. The bones are thus exceedingly soft and friable, and spontaneous fractures occur, as well as very numerous curvatures. If union takes place there is superabundant callus, and if a false joint is formed there is little prospect of its cure.

INCOMPLETE OR GREENSTICK FRACTURES

Incomplete fracture, or fracture in which there is not complete solution of continuity, occurs in children. By this is meant fracture in which there is solution of continuity through a part of the bone upon the convexity, while the remainder of the bone upon the concavity is only bent. It is not very apt to be accompanied by longitudinal fracture or fissure of any extent.

A variety of fracture which is far more frequent in children than in adults, though it does occur in the latter, is the true incomplete, the "greenstick" fracture, sometimes called infraction, in which there is only angulation at the seat of injury, but no solution of continuity, unless the bent bone be straightened again, which may make it a complete fracture. The most common situations of this fracture are the forearm and the clavicle; and more rarely the arm, leg, and thigh. In the forearm or leg one bone may undergo complete, and the other an incomplete or a greenstick, fracture. The deformity and tenderness on pressure at the angulation are the only symptoms, mobility and crepitus being absent, and deformity not very marked. Thus greenstick fractures, if slight, are very easily overlooked until the presence of the callus or its interference with pronation and supination, if the injury is in the forearm, draw attention. (See Figs. 98 and 99.)

The treatment of greenstick is the same as for simple complete fracture. If seen early the deformity should be corrected (even if this act completes the fracture) and the limb put up in fixation splints. If not seen until there is considerable swelling or a callus has formed, one has often succeeded in straightening the bone by following Mr. Holmes' advice and putting it up in straight splints, well padded, and readjusting them frequently so as to avoid ulceration from pressure.

TRAUMATIC SEPARATION OF EPIPHYSES

This occurs, as would be expected, much more frequently at that time of life and stage of development which find the epiphyses and diaphyses not yet made one by bony union, as should take place in the female at twenty-two and in the male at twenty-five years of

age. It has long been believed and demonstrated by clinicians and investigators that the line of separation does not often follow exactly the epiphyseal line, but deviates into the diaphysis or into the epiphysis. The younger the patient the more probable it is that the separation will take place accurately in the epiphyseal line; while in

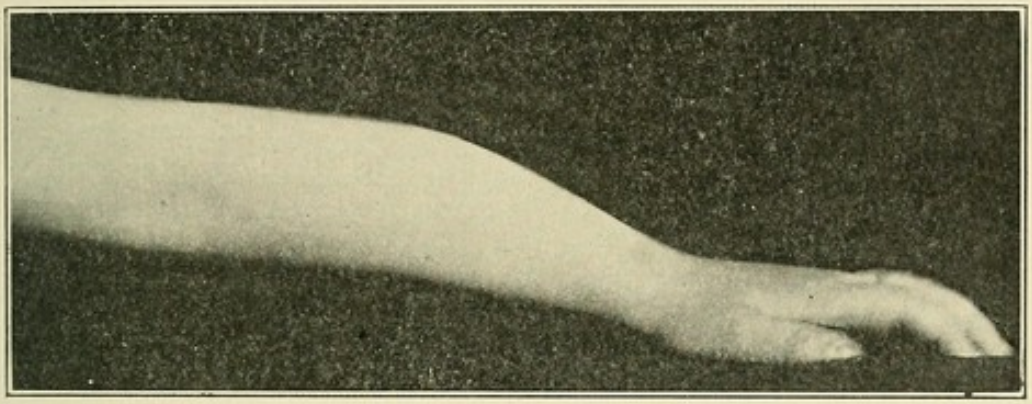


FIG. 98. GREENSTICK FRACTURE RADIUS AND ULNA. Brought for treatment three weeks after the accident. Refracture and straightening was necessary. Girl six years old.

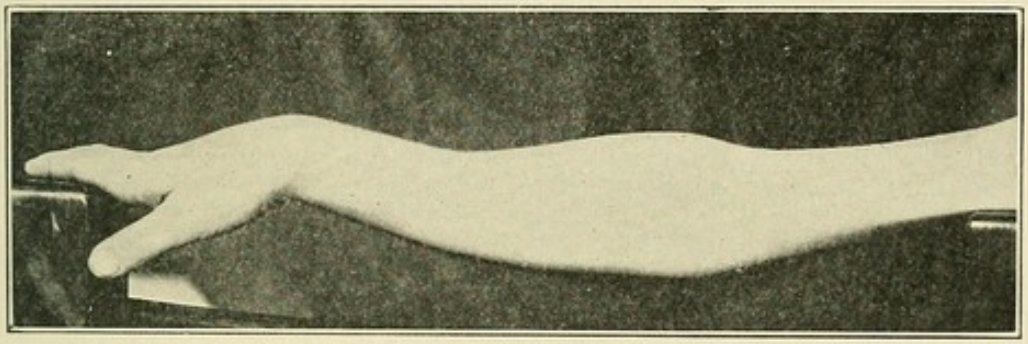


FIG. 99. GREENSTICK FRACTURE BOTH BONES OF FOREARM. Boy 8 years old.

patients approaching the age when epiphysis and diaphysis are joined by bone it becomes more probable that a portion of bone will be torn off with the cartilage. So that observations with the X-ray made more recently only serve as corroborative evidence. The attempt to deny the propriety of classifying epiphyseal separations as a special variety of injury because the fracture does not adhere precisely to the epiphyseal line, but has a few granules or more of bone upon the separated cartilage or of cartilage upon the end of the bone, has no tenable ground. And the following opinion, written in 1868 by Timothy Holmes, has scarcely been improved upon: "The conclusion to which my experience of this injury would lead me is that fracture occurs not very rarely at or in the immediate neighborhood of the epiphyseal line; that the line of fracture coincides in these

cases partially with that of the epiphyseal cartilage, but seldom completely; that the general symptoms are therefore the same as those of fracture, while the special symptom must be sought for from the anatomy of each joint; and, finally, that, as the epiphyseal cartilage is severely injured, loss of growth is very liable to follow."

The injury is generally produced by cross-strain. The diagnosis is made upon the history of the injury, the deformity, the size and shape of the fragment, the local tenderness, undue mobility, loss of function and crepitus. The displacement may be so slight as to eliminate it entirely from the diagnosis, or it may be complete.

The epiphyses are not very deep and the fracture line is very near the joint, so that if there is no displacement it may be overlooked, or if there is displacement it may be mistaken for a dislocation. The edges of the fragments are less sharp in outline than with ordinary fracture. Crepitus may be absent, or very indistinct, or soft, sometimes described as " false " or " dummy " crepitus or a " mortary " feeling.

The thick and vascular periosteum of a child is very easily separated from the shaft of a bone, but is more firmly adherent to the margins of the articular cartilages and about the tendinous and muscular attachments, so that if an epiphysis is detached and displaced it often carries with it the periosteum which strips from the shaft, thus robbing it of a portion of its vascular supply and possibly resulting in necrosis. Or this loosened periosteum may, if there is great displacement, become interposed between the fragments and prevent reduction. Or if the displacement remains for a time unreduced, ossification beneath the separated portion of periosteum may produce a layer of bone which renders reduction impossible without operation for its removal. The liability of displacement lies not only in the degree and direction of the violence, but in the muscular attachments about the joint which draw upon the fragments. Another danger is the implication of the near-by joint, especially when the epiphyseal line lies within it. Suppuration is more common after separation of an epiphysis than after an ordinary fracture, for the same reasons that so many inflammations attack the epiphyseal line. (See Sections on Osteo-Myelitis and Epiphysitis.) The danger of arrested growth in length is to be borne in mind and is to be explained to the parents. If such arrest occurs it will, of course, cause greater deformity the younger the child, and be more marked if the injury be located in one of those epiphyses which contribute most to the length of the bone; namely, " the upper end of the humerus and tibia and the lower end of femur and radius." (Stimson.)

These injuries are more common at the lower and upper ends of the humerus, the lower end of the femur, the lower end of the

radius, occasionally at the upper end of the tibia, and more rarely elsewhere. The authors vary as regards frequency. My own experience would place the lower end of the humerus as the most frequent.

REFRACTURE FOR VICIOUS UNION

Refracture has been alluded to under the heading of greenstick fracture which has been undiscovered and been allowed to unite in deformity. If, after greenstick or any other fracture, there is deformity which seriously interferes with function or is very unsightly and is not so near a joint as to make the refracture impossible without imperiling the joint, refracture should be undertaken. With the child under anesthesia it may be found that the union in the faulty position is not very strong. If it resists safe efforts at refracture it may be necessary to cut down upon it and use the saw or osteotome. Of course an open wound is not without some danger, and cases have occurred of failure to secure union after refracture. Refracture of one bone where there are two—for instance, of radius or ulna—will not be found an easy task. Nor will a correct alignment after it is fractured or cut through. There is redundance of bone at the point of angulation, which, together with the presence of the sound bone in proximity, prevents straightening. A knowledge of these difficulties will deter the surgeon from attempting interference in cases of slight deviations from the correct line. In growing bones, nature may do a good deal to round off angularities and accommodate deviations, so that function will be less impaired.

FRACTURES OF THE SKULL

These will be considered in the Chapter on Malformations, Injuries and Diseases of the Head and Brain.

FRACTURES OF NASAL BONES

Fractures of nasal bones are not uncommon, resulting from direct violence. It is important that they be recognized and treated —not merely because of the external deformity which may result, but because of possible encroachment upon the lumen of the nostrils, and because the fracture may have implicated the lachrymal bone and interfere with the nasal duct. Hemorrhage is apt to be sharp for a time, but usually does not call for plugging the nares. Attempts at blowing the nose may cause subcutaneous emphysema. Effusion of blood or, later, swelling externally, and swelling and blood clot in the nostrils, may obscure the conditions. It may be necessary to give an anesthetic in order to make a satisfactory examination and replace the fragments. A stiff probe, grooved director or the like, passed into the nostrils is of the greatest service in ascertaining the

condition, and, used in conjunction with the finger and thumb upon the outside, in lifting the bones into place. If the septum is displaced, a dressing forceps, with each limb covered with rubber tubing, passed into both nostrils at once may serve to replace it. The nasal bones may usually be held in position by placing a small roll of gauze or adhesive at each side of the nose, with a strip of adhesive crossing over all. If the bones persistently fall flat they may be held up by passing a hare-lip pin through, well back, cutting off its ends and winding silk thread from end to end across the nose. A rubber band has been used for this, but is not recommended. The pin should be removed in about a week. If the nasal duct is implicated in the break its patency should be maintained by passing a probe each day or two, or wearing a lead wire stylet or silver canula during the healing. The displaced septum may require to be pinned in position or held by a vulcanite tube in either nostril or by a small clamp devised for the purpose.

The nares will require cleansing daily with carefully-warmed normal salt solution or sodium bicarbonate solution of the same strength. Great difficulty will be experienced in preventing the child from picking at or blowing the nose unless the hands are restrained.

FRACTURE OF THE SUPERIOR MAXILLARY AND MALAR BONE

This injury I have never met but once. The boy had fallen under a wagon. It was said the wheel passed over his chest and head, and the marks had that appearance, though it seemed almost incredible that greater harm was not done. There was contusion and crepitation at the cheek bone. He recovered, with slight depression of the malar.

If the superior maxilla is fractured with displacement it is recommended to support it by bandaging the inferior maxilla firmly against it with a four-tailed bandage. A dentist can often be of great assistance by making a gutta percha plate or wiring the teeth so as to steady the fragments.

THE INFERIOR MAXILLA

This bone is much more frequently fractured than the upper jaw. One has seen it caused by a fall upon rafters, by an accidental blow with a baseball bat and other direct violence, and the alveolar process fractured in the hands of a dentist extracting a tooth.

The fracture is generally not difficult to locate, especially if dentition is complete. A single fracture is kept in adjustment without much trouble. Double or multiple fractures cause difficulty.

The approximation of the lower and upper teeth is an important matter in this adjustment. Ordinarily it is sufficient to mold a splint of poroplastic felt or leather to fit the jaw, and hold it in place with a four-tailed bandage. Better than a bandage is a snugly fitting muslin cap, which the child cannot displace, with sides extending under and in front of the chin. Or the ordinary four-tailed bandage or sling of the chin can be covered with adhesive strapping, or supplemented with cross bandages on the head, sewed in place. If wiring of fragments is attempted the location of the sacs of the developing teeth should be carefully avoided. If there is more than one fracture, or difficulty in keeping the fragments in position with correct occlusion, the assistance of a dentist should be obtained. A wax impression is taken, from which a gutta-percha splint is made, fitting accurately between upper and lower sets or alveolar processes, and held by a stiff wire emerging at each angle of the mouth and fastened upon the outside near the rami. The outside splint before described then holds the lower jaw firmly closed upon the upper. Young children can be fed through a nasal tube passed into the stomach, or liquid refreshment passed inside the teeth to the space behind the molars. Great care should be taken to keep the mouth cleansed by drinking water after feeding, and by the use of mild antiseptic washes.

CLAVICLE

Fracture of the clavicle is the most frequent fracture of childhood. It is estimated that it comprises from 10 to 15 per cent. of all fractures, and that one-third of them—some say one-half of them—are in children under the tenth year. The site is usually somewhere in the middle third. It is the most frequently overlooked of all fractures. Not uncommonly, after a little tumble, the child refuses to use his hand or forearm, and, after the mother has examined these and found nothing wrong, his crying is attributed to fright or peevishness. Or, perhaps, the "sprained" arm is put in a sling and the injury not located until, in about a week, the enlargement of callus appears. Even when examined by a surgeon a simple fracture, which did not tear the periosteum, or a greenstick fracture is easily overlooked.

In infants and young children a sufficient dressing is a bandage which holds the extremity snugly against the thorax, with the hand toward the opposite shoulder. Cotton should be placed between the limb and the chest and drying powder sifted in, lest chafing occur, but no axillary pad is necessary. In two or three weeks a sling is sufficient. In older children, Sayre's method may be employed. A wide strap of adhesive is sewn around the upper arm, with its adhesive side out. The arm is then drawn backward,

while the strapping is carried across the back and around the chest, adhering to the skin, and, passing under the elbow, it is sewn to the encircling strap in the middle of the back. The elbow is drawn firmly forward against the chest. A thin pad is introduced to the axilla and the hand carried up as near as possible toward the opposite shoulder. A second strap of adhesive has a slit in its middle, which receives the point of the elbow, and the straps are carried over the sound shoulder, where they overlap. A roller bandage is then applied over all. Whether the humerus really acts as a lever to draw the shoulder outward and prevent overriding of the fragments may be questioned, but this dressing certainly effects fixation as satisfactorily as any that is easily applied. A perfect result without a small enlargement at the site of the fracture should not be promised. Three weeks is generally sufficient time to secure union.

INJURIES OF THE HUMERUS NEAR THE ELBOW

These are very common and very important, being more numerous than injuries of any other portion of the bone, and, together with dislocations of the elbow, constituting a large percentage of the bone accidents which bring the surgeon difficulty and anxiety.

They are grouped together on account of their being all located so near the elbow and so often requiring differentiation. I have made no attempt to arrange them in the order of their relative frequency, for authors are not agreed upon that point, but only with a view to convenience in description.

At birth the lower extremity of the humerus is cartilaginous. Ossification of the epiphysis commences at the end of the second year in the capitellum, and this center forms the greater part of the articular surface of the bone. Ossification begins in the internal condyle in the fifth year, and in the trochlea at the twelfth; in the external condyle about the thirteenth year. The ossific centers of the capitellum, trochlea, and external condyle join, and then all three, as one, unite with the shaft at the sixteenth or seventeenth year. Finally the inner condyle joins at the eighteenth year.

One should be perfectly familiar with the appearance and " feel " of this troublesome joint in all its positions, for it often presents the most puzzling conditions in cases of injury.

As in all examinations where it is possible, the affected member should always be compared with its sound mate. The most useful maneuver in examining an injured elbow is to ascertain the relative positions of the olecranon and the condyles. If the end of the thumb be placed upon one epicondyle and the middle finger upon the other, with the end of the index finger upon the tip of the olecranon, while the joint is alternatively flexed and extended and

held at a right angle, these positions can be readily appreciated. It is noted that when the joint is fully extended the end of the olecranon is midway between the two epicondyles and all these three are in a straight line. But if the joint is flexed to a right angle the point of the olecranon forms the obtuse apex of a triangle. Notice whether either of the condyles can be moved independently of the other. Now, if the distance between the two epicondyles is too great, as compared with the normal elbow, evidently there is a fracture somewhere between them. And if, besides, the olecranon has ascended from its point of the triangle it has entered this split between the condyles. But if they are not too wide apart, but the tip of the olecranon has ascended, it has parted company with the ulna. The relative position of these three points, the condyles and olecranon as a group, to the long axis of the shaft of the humerus should be noticed—whether they are forward or backward from its axis, or deviate laterally. By grasping the shaft of the humerus in one hand, while still holding the condyles in the other, abnormal mobility may be tested, and if fracture or separation of epiphysis exists, crepitation may be detected. The position of the head of the radius should be located; flexion and extension, pronation and supination all be systematically examined. At the risk of being tiresome I here venture to repeat the caution that in any possible doubt or difficulty about an injured bone or joint, a friend should be called in and an anesthetic administered for the examination and dressing; and a few notes made of the condition and subsequent treatment. Many a practitioner has regretted omitting such thoroughness and precaution.

I cannot agree with those who advise waiting until the swelling subsides before attempting a thorough examination, or before reducing and applying splints. Instead of subsiding, even with the use of evaporating lotions and the like, the swelling may become more dense and brawny, rendering the landmarks more obscure than ever and remaining until the formation of callus has begun with the deformity uncorrected.

The injury of the humerus near the elbow (if dislocation be excluded) may be a fracture above the condyles; it may be a separation of the lower epiphysis, and either of these may be made a T fracture by a vertical break extending into the joint; it may be a fracture of the internal or of the external condyle, or of the internal or of the external epicondyle, or through the trochlea, or through the capitellum.

FRACTURE ABOVE THE CONDYLES OF THE HUMERUS

Violence acting near the lower end of the bone, either forward or backward, or with the elbow over-extended, or by torsion, may

produce this fracture. The fracture may be oblique in any direction or nearly transverse, and the deformity will vary somewhat accordingly.

Symptoms and Diagnosis.—The symptoms are deformity, loss of function, undue mobility, crepitus and pain. The deformity is usually a projection at the back of the elbow, caused by the lower fragment. (See Fig. 100.) Rarely the obliquity may be downward and backward and cause a projection of the upper fragment in the same direction, while the lower fragment points forward and upward.

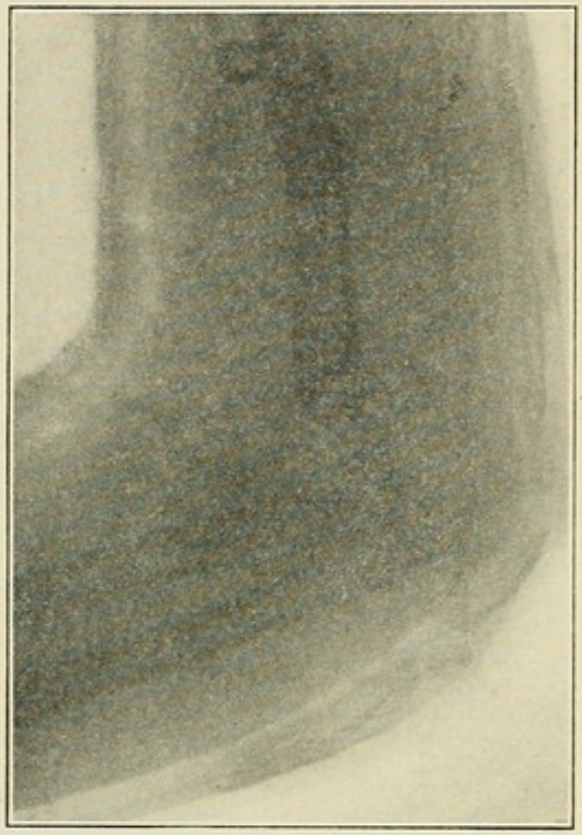


FIG. 100. FRACTURE OF RIGHT HUMERUS above the condyles. Boy aged 5 years.

The injury will somewhat resemble dislocation, especially when the point of the elbow projects backward from the line of the humerus. But it will at once be perceived that the position of the olecranon, with relation to the condyles, has not changed; it remains the same as in the sound elbow; and that the abnormal angulation is not in the joint, but perceptibly above the joint, and that, upon traction upon the flexed forearm and pressing the elbow forward, the deformity can easily be reduced, but immediately returns upon release of the traction. There is also abnormal lateral mobility, and perhaps crepitation.

Treatment.—The sooner the fracture is reduced and put up in splints the better. The proper application of a padded splint bandaged in place does much to prevent swelling and inflammation, and does it better than liniments or lotions. The pressure does some of this work, but the fixation—the enforcement of rest upon the irritated tissues—does more. Gerster uses an Esmarch bandage, the patient being anesthetized, to rapidly reduce the swelling so that a diagnosis can be made, and then puts up the fracture. Swelling that can be removed by an elastic bandage in the course of a few minutes can be prevented, or, if present, more gradually removed by the supporting pressure of a well-applied dressing.

The therapeutic effect of cold can be utilized if necessary by the use of ice bags applied outside of the dressings.

Very numerous methods for the treatment of supracondylar fractures of the humerus are recommended. They vary all the way from double splinting of arm and forearm with weight extension—the patient kept in bed—to laying the arm on a pillow and putting on no apparatus at all. The position advised also varies from complete extension, through moderate flexion, flexion to right angle, up to forced flexion. The limits of time and space preserve us from a discussion of all these. No doubt excellent results have been obtained by every one of the different plans. If the surgeon examines carefully and perceives the condition, and adapts means to meet the indication, rather than by rule, he will usually succeed. In my own practice I prefer, in the majority of these cases, the anterior hinged splint, reaching from the level of the armpit to the fingers, with a molded or sometimes a straight back splint for the arm. The splint is smoothly rounded at the angle and well padded along its whole bearing surface. Two adhesive straps are placed along the anterior and two along the posterior aspect of the forearm, adhering as far as the wrist, their free ends extending beyond the fingers. With the elbow three-fourths extended, the hinged splint is laid upon its anterior surface and the upper end of the splint strapped with wide adhesive to the upper arm. Seizing the condyles with thumb and fingers, the fracture is reduced and fragments adjusted. By pulling forward upon the forearm and pressing backward upon the splint this adjustment is maintained, while the extension straps upon the forearm are tied over notches in the lower end of the splint. By flexing the extremity toward the right angle any desired degree of extension can be produced. The back splint is then put in place and held by two or three encircling straps of adhesive. The whole extremity is carefully bandaged, from fingers to armpit. If there is much contusion or swelling or joint injury the patient is put to bed, with the arm elevated on a pillow, with an ice bag beneath and one on top of the elbow. Ordinarily he goes about with his arm in a sling, elbow at right angles. The bandage can be removed and the limb inspected at any time without removing the splints, and then rebandaged. There is no hurry about passive movements. Three weeks or four is soon enough, and by that time the limb is nearly well.

SEPARATION OF THE LOWER EPIPHYSIS OF THE HUMERUS

This injury is more apt to occur in children under four. As Mr. Owen says, it seems to take the place, to some extent, of dislocation or fracture, the junction of epiphysis and diaphysis yielding more readily than either the bone or the ligaments. But it happens

up to the thirteenth or fourteenth year, becoming less frequent as the period of complete ossific union is approached. It appears, too, that as age advances the separated portion is less likely to be the entire epiphysis; in older children it may be only the external condyle and capitellum.

The symptoms of separation of the lower epiphysis are the same as those of supracondylar fracture, with displacement of the lower fragment backward, excepting that the angulation is immediately above the joint (the epiphysis being but a thin layer extending no higher than the epicondyles), and the margins of the fragments are less sharp, abnormal mobility less evident, and crepitation less distinct. The injury bears some resemblance to dislocation of the forearm backward. But the olecranon and condyles keep their normal relative positions. The backward displacement can readily be corrected by holding the shaft of the humerus in one hand and bringing the condyles and olecranon downward and forward—but it will not stay corrected. At the same time one notices the abnormal lateral mobility and the crepitation. Epiphyseal separation occasionally presents so little displacement and consequent deformity, such slight mobility and doubtful crepitation that it is likely to be overlooked or considered a sprain until the presence of callus, interfering with motion, reveals the diagnosis. In any case of doubt it is better to treat the case as one of epiphyseal separation or fracture than to declare them positively not present. This fracture is put up just like the supracondylar, but is more easily held in place. It can be held by a molded splint of binders' board, felt or plaster. I usually use the anterior hinged splint, sometimes omitting the traction straps on the forearm and using molded binders' board as a back splint. Union takes place somewhat more quickly than with supracondylar or a shaft fracture, and passive motion may be begun somewhat earlier.

T OR Y FRACTURE

When, in addition to a supracondylar fracture or a complete epiphyseal separation, there is a vertical fracture into the joint it is called a T or Y fracture, according to the direction of the upper line of cleavage. In addition to the symptoms of supracondylar fracture or epiphyseal separation we have a widening across the joint. The condyles are too far apart, and they move independently of one another and of the shaft. Sometimes the fragments are separated and the ulna is between them, shortening the upper arm and greatly widening the elbow. The joint is filled with blood and swells rapidly, distorting its outlines. There is free mobility and great pain. With this extensive traumatism there is apt to be injury of nerve trunks or vessels. An anesthetic is always necessary in this fracture. It is put up with the anterior hinged splint, the

adhesive extension on the forearm like the supracondylar fracture, but with a molded back splint well up the arm and down on the forearm, coming round from behind. Care should be taken to have the splint not too wide at the joint, for when the forearm is pulled down and the separated condyles pressed together, they must be held together by the molded back splint, which extends forward to cover them. This is the only elbow fracture which is at all likely to need weight or other extension, and it can be used if shortening is not overcome. But I have never seen a case in a child in which a good position could not be maintained and a satisfactory result secured by the method here described. Elevation and ice bags are in order for some days.

In these fractures, near and into joints, there has been much discussion concerning the time to begin passive motion. After considerable observation on this point, my own conclusion is that to begin passive motion before union is sufficiently firm not to be disturbed by it, and the inflammation so far subsided as not to be re-excited by it, is a mistake. It only leads to more callus, inflammatory exudate and scar tissue, and invites, rather than averts, ankylosis. Four weeks is probably soon enough to begin it. But if it can be done without pain it can be begun in three weeks. Splints are used four to six weeks. With the hinged splint the straps and bandages can be slightly loosened and the joint slightly flexed or extended upon alternate days, the desired angle being maintained by the adjustment of the sling. If, after a few weeks more, there seems to be fibrous ankylosis, an anesthetic may be given and the adhesions broken. But this is seldom needed.

FRACTURE OF THE INTERNAL CONDYLE

The line of fracture begins above or upon the internal epicondyle or epitrochlea and extends downward and outward to the articulating surface of the trochlea. Crepitus is usual. Swelling may be greater on the injured side, but soon becomes general. The most characteristic symptom is independent mobility of the condyle. Lateral mobility of the forearm is sometimes noticed, and the fragment may push up higher than its proper position. The fragment remains attached to the olecranon unless there is also dislocation, which may occur. There is usually not enough displacement to disturb very noticeably the relative positions of the condyles and the olecranon. It is said that late displacement may occur by pushing up of the fragment and the ulna by a sling, and thus adduction of the forearm may be produced. But this may be due rather to stunted growth on that side of the bone through injury of the cartilage. (Stimson.)

Treatment is by a molded splint to hold the condyle outward,

but not to press it upward. The joint is placed at a right angle and the molded posterior elbow splint embraces both the lower two-thirds of the arm and the entire forearm, bandaged snugly in position. A plaster of Paris roller should not be used at first, lest swelling render it too tight. The arm is carried in a sling, but the sling does not include the elbow. After about three weeks the splint may be left off or worn but loosely for protection. Three weeks is plenty soon for passive movements. The sling may be discontinued in about four weeks.

FRACTURE OF EXTERNAL CONDYLE.

This is a common injury in children. The fracture extends from above or upon the external epicondyle downward and inward to the articulating surface. There are independent movement and crepitus, elicited by moving the external condyle while the humerus is held. The condyles are too wide apart. The fragment adheres to the radius and ulna unless there is dislocation, and it is very easy to cause displacement of the fragment by movements of the forearm. Swelling appears first upon the outer side, but soon becomes general about the joint. Occasionally the fragment is displaced by rotation and is almost impossible to reduce. It may also either be pushed up the arm or fail partially in its after development and occasion abduction of the forearm.

It should be very carefully reduced and a posterior molded splint applied as described for fracture of the internal condyle.

FRACTURE OF THE INTERNAL EPICONDYLE

This is an injury more common in children than in adults, and occurs from falls upon the elbow, and in dislocations from the pull of the attached muscles. The ulnar nerve may be injured at the same time, or may afterward be pressed upon by swelling or by callus. Swelling and crepitus are common. There may not be great displacement unless the injury accompanies dislocation, or the joint be fully extended.

The fragment is so small that it is hardly possible to reduce it or to hold it in exact position after reduction. But if the joint is at a right angle there is not much displacement of the fragment. The joint should be flexed to a right angle and put up in a fixation splint. Any fixation splint will serve; the anterior angular or the posterior molded are commonly applied if at hand. In fractures of the epicondyles, as well as other injuries about the elbow in children, I have often improvised a splint from a pasteboard box.[1] The box is cut into two right-angled triangular halves and their ends

[1] Cleveland Medical Gazette, Jan., 1893.

trimmed to the proper length for arm and forearm. The two angular portions are nested together, thus doubling the strength. If desired, a corner is cut from the lid of the box and applied on the other side of the elbow. Another angle of pasteboard can be applied anteriorly if necessary. If there are symptoms of pressure upon the ulnar nerve there should not be too great haste to cut down upon it. With the subsidence of the inflammation and the removal of callus these symptoms may disappear. Union is obtained in about two or three weeks.

FRACTURE OF THE EXTERNAL EPICONDYLE

This takes place less frequently than that of the internal, and more frequently in children than in adults. A molded binders' board, or pasteboard box splint, securing immobilization for a couple or three weeks, will be all that is necessary.

SEPARATION OF THE UPPER EPIPHYSIS OF THE HUMERUS

This injury has been referred to as an obstetric accident, presenting in the new-born, but it also occurs later as a result of a blow or a fall with the arm back of the axillary line, or by pulling the arm upward and backward. It is not a very common accident. The head only or the entire epiphysis may be separated. Complete displacement does not readily take place.

The elbow projects somewhat backward and outward, and a protrusion can be felt under the coracoid process. This is the lower fragment, which is pulled inward and forward by muscular action. There is slight flattening of the outer aspect of the upper arm, but no distinct depression under the point of the shoulder. The head of the bone can usually be felt, and on moving the arm the shaft may be found to move separately with the production of soft crepitus. The edges of the fragments may be felt, but are more smooth or rounded than those of a fracture. But the symptoms are not always so definite.

If complete displacement of the fragment has taken place, reduction may not be easy. It may be facilitated by strongly abducting the arm and making traction, and then manipulating the fragments. Usually displacement is not complete, and yet it is difficult to maintain exact apposition. However, the functional result is usually good in these cases. An inside splint should be fitted to extend from the elbow high into the axilla; this should be well padded. A shoulder cap of binders' board, plaster, felt, or leather, with the arm-part extending nearly to the elbow, should be applied, and the two splints and arm and shoulder firmly fixed with adhesive straps. The elbow should be conveniently flexed, laid comfortably

at the side of the thorax, a layer of cotton or linen intervening and having the hand toward the opposite shoulder, and should be snugly bandaged in that position. Drying powder can be sifted within the dressings from time to time, or the chest bandage changed if necessary, and the skin made comfortable. The splints are worn in this position ten to twelve days in a new-born babe, or four weeks in an older child.

SHAFT OF THE HUMERUS

Fractures of the shaft of the humerus are by no means as common as fractures of the lower end of the bone and present only such differences from similar injuries in adults as are common to all fractures in children, as described in the opening of this chapter. The diagnosis and reduction usually present no difficulty. The padded anterior angular and the posterior straight, or a molded splint, held by a few encircling straps of adhesive plaster, and a roller bandage over all, fix the bone sufficiently. With the elbow flexed at a right angle the extremity is carried in a sling. From ten days or two weeks in the new-born to three or four weeks in children gives good union.

SEPARATION OF LOWER EPIPHYSIS OF RADIUS

This is not an uncommon injury in the young. It takes the place of Colles' fracture of adults, which it much resembles. The line of separation may follow the epiphyseal line quite closely or it may angle somewhat into the radial shaft. It is usually caused by a fall upon the palm. The lower fragment, the epiphysis, projects backward; the separated end of the diaphysis projects forward. Pronation and supination are prevented. Flexion and extension of the hand are painful. The phalanges can be moved voluntarily. The periosteum adheres to the epiphysis, but is stripped up from the posterior surface of the radius, and by its tension helps to maintain the position of the fragments in deformity. If left in this position a layer of bone would be produced between the periosteum and the end of the shaft, which would prevent subsequent reduction. The diagnosis is made from the deformity and loss of function. Crepitation can readily be elicited if necessary.

Reduction is effected by over-extending the hand, traction, pushing the epiphysis forward while the lower end of the shaft is pushed backward, then straightening or flexing the hand. There are many good splints and dressings. The ready-made splints seldom fit children. As good a dressing as any is a straight, flat posterior splint from well up on the forearm to the metacarpo-phalangeal articulation, with a molded pasteboard splint anteriorly extending from the same distance above down to the middle of the palm.

The splints, after being encircled with three or four adhesive straps, are bandaged from the hand up. Then the hand is gently closed and bandaged in that position. This prevents finger movements which are painful and quiets the muscles. In a week or so the fingers and thumb are given freedom. Union is complete in three or four weeks, and there is no trouble about stiffness of the fingers or wrist. But there may be interference in the growth of the radius in length. And parents should be informed concerning this possibility, lest such a result later be charged to the surgeon. Fig. 101 shows the result, in a man, of an injury of the epiphyseal cartilage of the lower end of the radius, received when he was a boy of thirteen years.

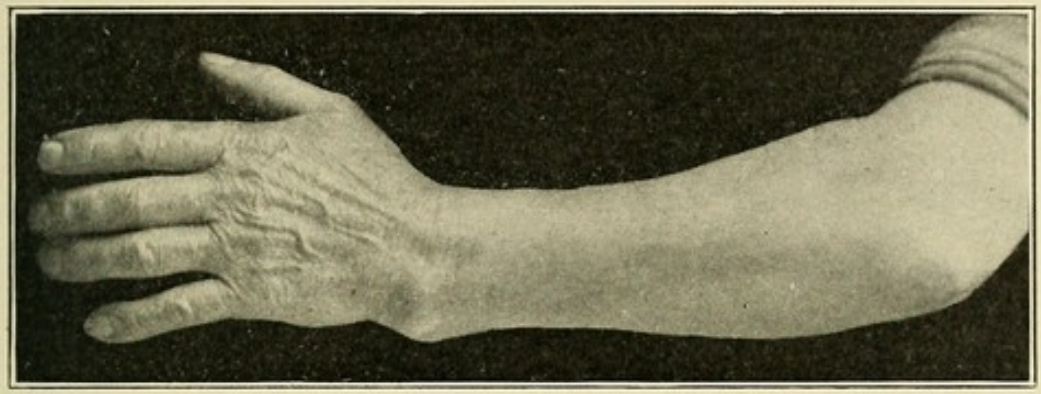


FIG. 101. RETARDATION OF GROWTH OF RADIUS IN LENGTH BY INJURY OF EPIPHYSIS. Forearm of man aged 60, showing result of injury of lower epiphysis of radius by a fall at the age of thirteen years.

SEPARATION OF UPPER EPIPHYSIS OF RADIUS

This is said to occur. I have never recognized it. Most of the descriptions correspond to what seems more probably the ordinary subluxation of the radial head, which will be described under dislocations.

FRACTURE OF SHAFT OF RADIUS OR ULNA

Fractures of shaft of radius or ulna or of both bones may occur, by direct violence, as by the patient or another person or a weight falling upon the forearm, or by indirect violence. Twisting the forearm into extreme pronation or supination may break one bone across the other, usually with a spiral subperiosteal fracture. Subperiosteal fracture is very apt to occur in the bones of the forearm, and, like greenstick fracture, is likely to be overlooked or neglected, especially when only one bone is fractured. Fig. 98 shows a greenstick fracture which was allowed to go unnoticed by the

parents until the weekly bath revealed a bend in the forearm. Fig. 97 is from a radiograph, showing fracture of the radius and ulna which was overlooked by an experienced surgeon of this city. The child was brought to me next day, and perhaps movement in the meantime had loosened the subperiosteal fissure sufficiently so that crepitus was detectible. At least, I so explained it to the parents, who were threatening trouble to the doctor. As is well known, an angulated deformity of one of the bones of the forearm or a union between them may prevent pronation and supination; and callus in the interosseous space may do the same. And as large a callus may be produced by a fissure or a subperiosteal fracture as by a complete, or even a compound, fracture.

If the surgeon has any misgiving, after a careful examination, he would better put up the arm like a fracture for at least a week, when the presence of callus will confirm a well-founded suspicion. If an X-ray apparatus is within reach, advantage should be taken of its revelations in the first instance.

The bones should be carefully straightened and paralleled, and a straight, flat splint, well padded, applied anteriorly and posteriorly. The splints should be as wide as or a little wider than the forearm, so that the bandage cannot press the bones together. It is not necessary for either splint to have a longitudinal ridge supposed to press into the interosseous space. About three weeks is required for union.

FRACTURE OR SEPARATION OF OLECRANON

This is not a very common fracture. It is caused by direct violence, together with contraction of the triceps. There is distinct loss of function, as the arm cannot be extended. Large effusion is present in the joint. The upper fragment is pulled upward by the contraction of the triceps, leaving a gap at the back of the elbow.

The gap just mentioned should be closed by extending the arm and pressing down upon the upper fragment. It should be held down by a strip of adhesive plaster passed across just above it. This is the only fracture or epiphyseal separation which should be dressed with the arm in complete extension. An anterior splint of any material bandaged on maintains the position and affords fixation. Elevation on a pillow and an icebag at the joint will aid in limiting the swelling and in reducing it. Plenty of time for firm attachment should be given before any attempt at flexion is made. Three weeks should be sufficient. Then the arm should be gently flexed to half way between full extension and the right angle, and fixed in that position for another week. After that the angle should be changed daily and the arm massaged and brought into use. With this injury there is danger of getting only fibrous union. Even this may afford a useful arm; but if the extremity is put up as just

described and passive motion not attempted too soon, perfect bony union may result.

FRACTURE OF SHAFT OF FEMUR

The shaft of the femur is not infrequently broken by direct or indirect violence, and, it is said, even from muscular action. This latter must be very rare indeed.

The symptoms are obvious, although there may not be much pain or crepitus, and the treatment is simple, considering the size and importance of the bone. In the new-born infant the thighs may simply be bandaged together with a folded towel between knees and ankles (Owen); or straight splints of binder's board applied around the limb and retained by adhesive straps and a bandage. Some are fond of the suspension treatment for broken thigh. Buck's extension is put on both limbs and they are elevated perpendicularly, being raised just high enough to partly raise the pelvis from the mattress. The extending cord is fastened to a cord or pole placed from foot to head of the bedstead, or to a screw in the ceiling. Weight and pulley are not necessary. Stimson tried an elastic cord, but discontinued it. It is just as well or may be better, simply tied at the right elevation. Excellent results are obtained in this way, and a child is easily taken care of in this position. Perfect results are also obtained by simple straight splints from waist to ankle. Extension and counter-extension are unnecessary in young children. If a child is unruly a long side splint from axilla to ankle will control him. If suspension is used both the fractured and the sound limb must be hung up and the fracture splinted. I have seen failure of union from suspending only the fractured one. Also in a case in which the doctor had suspended both limbs but left the fracture unsplinted, in three weeks firm union had not taken place, but a very large callus formed. The thigh was then fixed and in ten days union was firm. In female children vaginitis may occur during the suspension treatment, perhaps from failure of discharges to drain from that passage.

FRACTURES AND SEPARATIONS AT UPPER END OF FEMUR

Not very numerous but decidedly obscure injuries occur about the upper end of the femur in children. There is no doubt that some of them are epiphyseal separations and some are fractures of the neck or of the base of the neck. They are very apt to produce permanent partial disability even with the best of treatment; and if overlooked at the time lead to subsequent mistakes in diagnosis, being taken for congenital dislocation, acquired dislocation, or even for paralysis.

The symptoms of intracapsular fracture are loss of function, shortening of the limb, usually eversion, elevation of the trochanter, pain and crepitus. It will be impossible in many cases to ascertain

without a resort to the use of the Roentgen ray, whether the injury is a fracture or an epiphyseal separation, and whether the cleavage has occurred at the head, neck or base of the neck. Very forcible manipulation for the purpose of ascertaining the condition or eliciting crepitus or of correcting deformity is not to be undertaken without due consideration. A greenstick or an impacted fracture may be rendered complete, or fragments separated or periosteum torn through by injudicious handling.

Treatment is immobilization in as natural a position as it is possible to attain without undue force. This immobilization should be secured by the method most comfortable for the patient and most convenient for preserving cleanliness. Full extension, traction to make the injured limb of equal length with the sound one, slight abduction, which is a more useful attitude in case of ankylosis, and pressure upon the trochanter sufficient to hold it in contact with the upper fragment, are the indications to be met. The means best adapted must be chosen to suit the individual case. In infants and bedwetters it is very difficult to keep the skin in good condition under fixed dressings; but by varnishing plaster cases or muslin or cotton-flannel roller bandages, and the use of oil-silk or rubber sheeting properly placed, and by watchful care, it can be done. A good dressing is a plaster case from the ankle to the chest, a reinforcement of a wooden slat or two in front and at the side of the joint. Traction should be kept on while the plaster hardens, and may with advantage be kept on until the muscles cease all resistance. A Liston long side splint from axilla to ankle, with an anterior splint from knee to abdomen, will answer the purpose. In a very unruly patient the plaster or the long splints can be applied to both sides, and a foot-piece across the lower end prevents all twisting. Buck's extension, as described for hip-joint disease, supplemented with a spica to fix pelvis and thigh, is convenient and efficient. A Thomas hip splint can be used if obtainable, or a Taylor hip splint as in morbus coxæ.

SEPARATION OF TROCHANTER MAJOR

This may take place any time between the third and eighteenth year. It is due to direct violence and causes pain, swelling, tenderness, with mobility of the fragment and crepitus if it can be brought in contact with the point of separation from the femur, as may be accomplished by abducting the limb. Neither the length of the limb nor its free passive mobility is altered. An unusual liability to suppuration accompanies this injury, and a number of cases of fatal pyemia have been reported. The treatment is fixation with the limb slightly abducted and rotated outward. Any of the methods described for fracture of the hip, omitting the traction, will serve for this injury.

SEPARATION OF LOWER EPIPHYSIS OF FEMUR

This is sometimes an obstetric injury due to traction. It may occur during the *redressement force* for genu valgum, or in efforts at fracturing the femur before sufficient use of the osteotome, or by very severe violence, often with twisting or wrenching. In the slighter cases there may be little or no displacement, only undue mobility and perhaps crepitation, with pain, loss of function, and later, swelling. But in the severe accidental cases there is considerable displacement. It is most usual for the epiphysis to be displaced forward and the end of the shaft backward; but this position may be reversed. In either forward or backward displacement there is great danger of injury to the great popliteal vessels and nerves. Lateral displacement may occur which is less likely to cause complications of that kind. With displacement there may be shortening. The margins of the displaced fragments can readily be felt, and by their position distinguish the injury from dislocation of the knee, even without crepitus. The knee is generally slightly flexed and the foot everted.

With the patient under anesthesia the reduction presents no great difficulty. With extension and counter-extension the fragments are manipulated into place, and the limb is put up in a fixation splint. This may be of molded plaster or binder's board, well padded to allow for swelling, especially in the popliteal region. The splint should extend from ankle to perineum. To hang up the splinted limb under a cradle keeps it out of harm's way. In the new-born union is very prompt, in ten or twelve days. Older children require a month. In some cases the injuries to blood-vessels or nerves form very serious complications, which may have to be dealt with. This injury has occasionally led to infective thrombosis or to gangrene, requiring amputation. In the uncomplicated cases the results are always satisfactory.

FRACTURES OF SHAFTS OF TIBIA AND FIBULA

Not quite as common as fracture of the femur, they usually take place in the middle and lower thirds. The most common cause is direct violence, and fracture of the tibia is probably more likely than any other to be compound. (See Fig. 102.)

Careful antisepsis if the fracture is compound, and accurate adjustment of the fragments are the first steps in treatment. Then fixation, for which nothing is better than plaster of Paris. In case of a wound the plaster bandage is fenestrated. The foot should be steadied by including it in the plaster, and if the half-flexed knee also is included it is so much the better. If no plaster is at hand, binder's board or a whittled wooden splint may be used. Ready-made splints seldom fit.

SEPARATION OF TIBIAL AND FIBULAR EPIPHYSES

The upper epiphysis of tibia or fibula may be separated by violence, but the accident is rare. Separation of the lower epiphysis of the tibia occurs occasionally in the hands of an accoucheur, or by accident, direct violence, cross strain or twisting in older children. It is equivalent to Pott's fracture in the adult, and has the same tendency to be compound. It is sometimes followed by interference in growth of the tibia, with overgrowth of the fibula and consequent inversion of the foot. Treatment is usually by a posterior or lateral molded plaster splint. A Volkmann splint is excellent if a small enough one can be had.

THE PATELLA AND TUBERCLE OF THE TIBIA

The patella is not broken in children; but instead the tubercle of the tibia may be torn off, and give much the same appearance

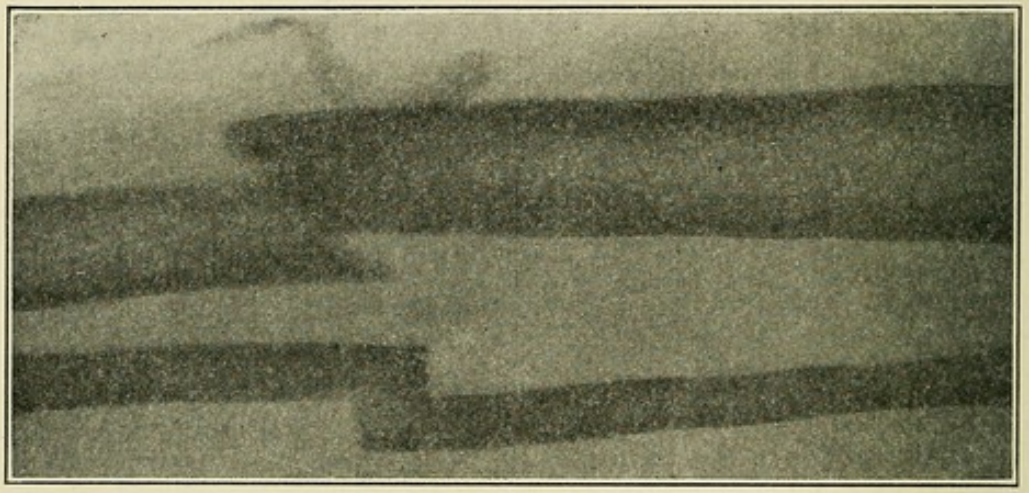


FIG. 102. RADIOGRAPH OF BADLY REDUCED COMPOUND FRACTURE OF MIDDLE THIRD OF TIBIA AND FIBULA. Admitted to St. Clair Hospital four days after the accident. The ribbon-like shadow is iodoform gauze drainage. The fracture was then properly reduced and made an excellent recovery. Boy of nine years.

as a fractured patella. The treatment is by full extension of the knee, and half extension of the thigh, with cross strapping to hold the patella down and a posterior splint and a bandage. The union should not be trusted under five to eight weeks.

FRACTURES OF THE BONES OF THE FOOT

These may occur from direct or indirect violence, and unless compound may be mistaken for strain or contusion. In case of any doubt or difficulty anesthesia should be used in both diagnosis and reduction. With X-rays the injured and uninjured feet should

be compared. All fragments should be reduced or if irreducible or projecting should be removed. Fragments of os calcis may require pegging or suturing. No foot or part of a foot of a child should be sacrificed without an effort to save it by strict antisepsis, careful dressing, immobilization and elevation. Temporary dressings may be necessary for a few days until swelling has been reduced, when firm fixation usually by plaster bandage or plaster splints is in order. With an open wound the fixed dressing can be fenestrated. Children should not be trusted on crutches too soon. Hot baths, massage, involuntary and voluntary movements are useful measures, and come before weightbearing.

METACARPAL AND PHALANGEAL FRACTURES

These fractures are not very common in children, and when they do occur are apt to be epiphyseal separations. They are more frequent in boys as a result of baseball or football or other rough games, or in machinery accidents. They should receive very careful attention, and even a bad compound fracture with careful antisepsis and adjustment of fragments and splinting may give a good result. No finger or hand should ever be sacrificed without an effort. The reparative power in the upper extremity of a child is remarkable.

FRACTURES OF THE RIBS

In children one seldom sees fracture of ribs. They are so elastic they bend without breaking. When fracture does occur, generally more than one rib is broken. A blow or pressure that will break a child's ribs will generally do damage to the contents of the thorax. In fact, there may be serious injury to thoracic viscera with no broken ribs and not even a bruise externally to show for it. Fracture may be of the greenstick variety, and the deformity afterward corrected so that upon examination nothing is found, or there may be perceptible solution of continuity. Crepitus may be found by palpation, or by ausculation with the stethoscope; but if not found fracture is suspected if pain and tenderness be distinctly localized at a point known to have been injured. The subsequent appearance of callus will confirm the diagnosis. Separation of a rib from its cartilage may also occur. Treatment is by cross-strapping with overlapping strips of adhesive, thus immobilizing the whole injured side. Look for hemothorax.

FRACTURE OF STERNUM

Fracture of the sternum is in the nature of a diastasis or separation of the segments of bone which have not yet become joined by bony union. Fracture of sternum would be treated as in the adult by cross-strapping with adhesive over the affected area, immobilizing as much as possible. Watch for hemothorax.

CHAPTER XI

DISLOCATIONS, CONGENITAL AND ACQUIRED

Abnormal Laxness of Joints—Congenital Dislocations of the Hip, Knee, Shoulder and Various Other Joints—Traumatic Dislocations—Dislocation of Radius and Ulna Backward, or Laterally—Dislocation of Radius and Ulna Forward—Subluxation of Radius—Dislocation of the Radius Forward and Backward—Dislocation of the Shoulder—Dislocation of the Hip—Dislocation of the Patella—Dislocations of the Phalanges—Dislocation of the Thumb—Dislocations of the Sternum and of the Ribs—Compound Dislocations.

Dislocations are congenital or acquired. Acquired dislocations are traumatic or spontaneous. Spontaneous dislocations have been discussed under arthritis. The congenital dislocations are not very unusual in children. They belong pathologically among the malformations, but for convenience will receive some attention in this chapter.

ABNORMAL LAXNESS OF JOINTS

Children are sometimes brought for examination, under the supposition that they are "double jointed." Sometimes only a pair of joints is affected, or one more than all the others, and it is feared a dislocation has occurred. Or every joint in the skeleton may be loosely put together. Upon examination neither traumatism nor actual malformation is found; nor is the condition always an evidence of rickets; but the articular cartilages are not very well developed and the ligaments are loose, allowing a great deal of play in the joint movements. Often the bones of such children are small and the muscles delicate. Some, however, are quite strong and sinewy but present this abnormal laxness of the joints. Fig. 103 shows the foot of an infant that is not rickety, rotated outward so that the toes almost point backward. Fig. 104 shows the elbow of a boy at least ten degrees in hyper-extension. These are but common examples. Infants or young children with this unusual laxity may develop ordinarily well-knit joints. But often the condition persists to a degree throughout life, especially in women.

This natural peculiarity of conformation is sometimes cultivated and increased for exhibition purposes.

CONGENITAL DISLOCATION OF THE HIP

The most important of the congenital dislocations is that of the hip. It is by far the most common, occasions marked deformity, and has received a great deal of attention in efforts for its relief. It occurs much more frequently in females than in males. Ketch

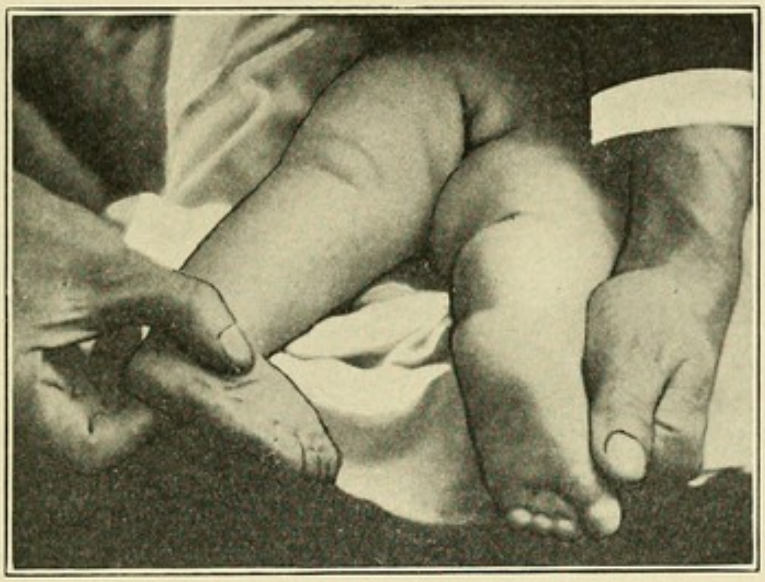


FIG. 103. ILLUSTRATING LAXNESS OF JOINTS not uncommon in infancy and childhood.

and Hubbard, in Keating's Cyclopedia, place the proportion at $3\frac{1}{2}$ to 1. Many writers state it to be more often bilateral than unilateral, but the authors just quoted in an analysis of 55 cases found both joints affected in 20 and only one in 35 instances; and in the unilateral cases the left side was affected five times as often as the right.

Numerous theories as to causation have been advanced, but none of them are satisfactory. Formerly many of the cases were attributed to obstetric manipulations, producing a dislocation which was undiscovered at the time. But while traumatic dislocation at birth is a possibility, as is also epiphyseal separation, both of these are quite different from that condition which is called congenital dislocation, and should not be confused with it. The theories of the origin do not after all explain. They are, ultimately, only confessions of ignorance. When we say that there is some "alteration of the primitive germ," or "a change in the nerve centers which leads to perverted development," the etiology has reached its limit for the present.

After much controversy it is generally conceded that malformation of the acetabulum, particularly of its iliac portion, is present, although the degree of this malformation varies; and that the head of the femur is stunted and misshapen, being, however, often too large for the acetabulum. The acetabulum may be a mere depression or it may have an abortive ridge of bone for a rim; or in the new situation of the femoral head upon the dorsum ilii there may have been an attempt at the formation of a new acetabulum.

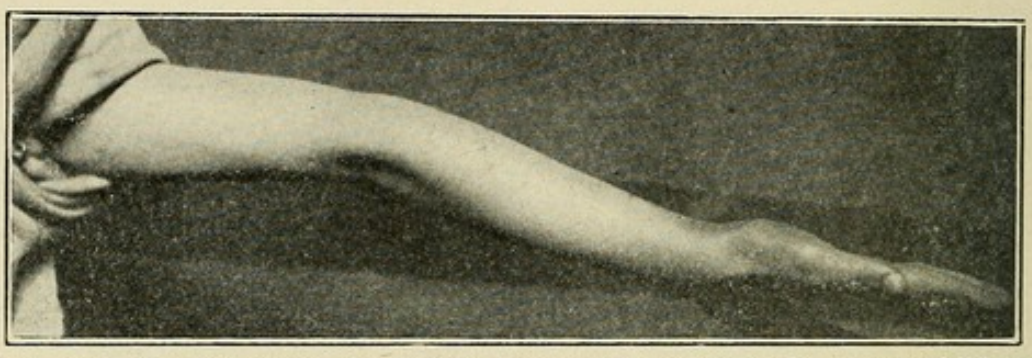


FIG. 104. ILLUSTRATING ABNORMAL LAXNESS OF JOINTS in many children. Hyperextension of elbow, boy ten years old.

The capsule of the joint usually retains its attachment to femur and pelvis, being stretched sufficiently to allow the dislocation; or the head may have escaped through an opening in the capsule and have a new fibrous investment resembling a capsule, and this may or may not be lined with synovial membrane at the location of the new rudimentary acetabulum. The usual displacement is upward and backward upon the dorsum ilii, but it may be in other positions. The condition varies much in different cases, and also changes take place as the patient gets older. Often the shallow acetabulum is filled up with a fatty cushion, the ligamentum teres is attenuated, the muscles atrophic, the fasciæ and capsular structures contracted, excepting as weight-bearing has stretched them and thrust the femoral head still farther above its normal location. The condition is often not discovered until the child learns to walk.

Symptoms.—The most obvious symptom is the rolling gait, which is most marked if the trouble is bilateral. At each step the body is swung outward over the limb that is put forward, which causes a remarkable waddling or swaying in the walk, while the heels scarcely touch the ground. The hips appear wide, with a space between the thighs or broadening of the perineum. The buttocks project outward and backward, with the great trochanters above Nelaton's line. The femoral heads being behind the acetabula, the pelvis is tilted forward, that is, with the pubis lowered; consequently, to maintain the shoulders upright the lumbar spine is curved into lordosis. (See Figs. 105, 106, 107, 108.) If the dislocation

is unilateral the gait and appearances are modified accordingly. The affected limb being shorter than the sound one, a limp is added, and to the lordosis a lateral curvature. In bilateral cases the shortening of the limbs is usually about the same on both sides, and there is no limp, but more swaying. With the child lying down it can be readily demonstrated that the joint is freely movable, excepting perhaps in the extreme range of adduction and outward

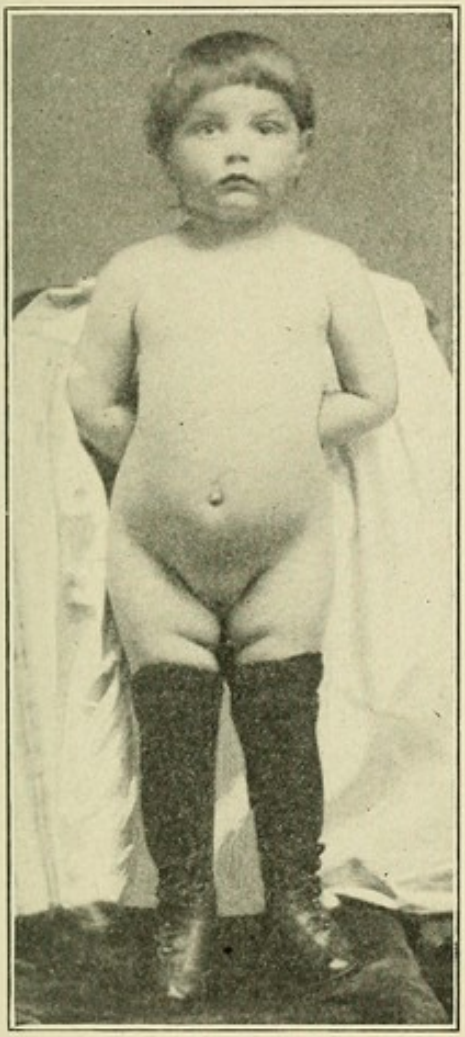


FIG. 105. CONGENITAL DISLOCATION, BOTH HIPS. Front view. Same case as FIG. 106.

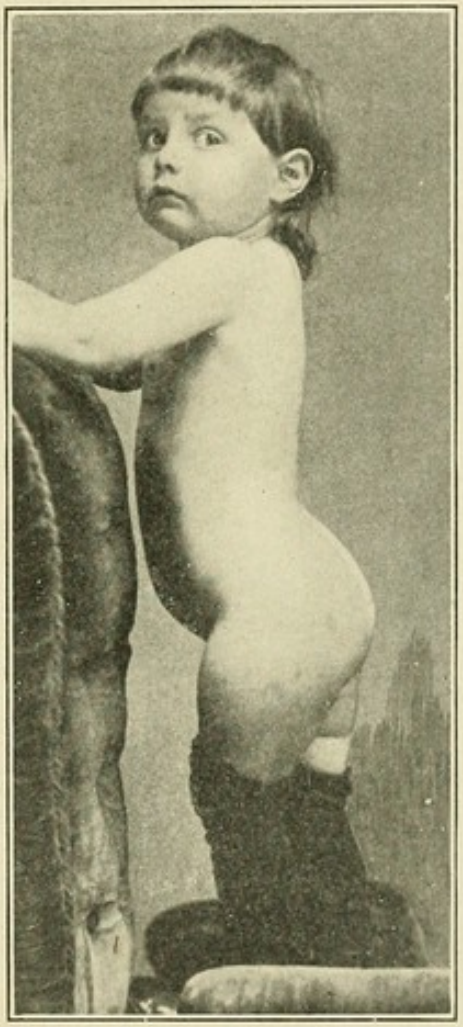


FIG. 106. CONGENITAL DISLOCATION, BOTH HIPS. Side view. Same case as Fig. 105.

rotation, and that the affected limb or limbs can be lengthened a half inch to two inches by pulling; but the original position is immediately resumed on relaxing the traction, thus moving down and up on the ilium, with a slight "knocking" as it does so.

Diagnosis.—The diagnosis should present no difficulty, especially if one has the history.

Prognosis.—The prognosis is not favorable for improvement with age and use. Nor can one be sanguine of permanent cure with any plan of treatment yet devised. With a favorable case there

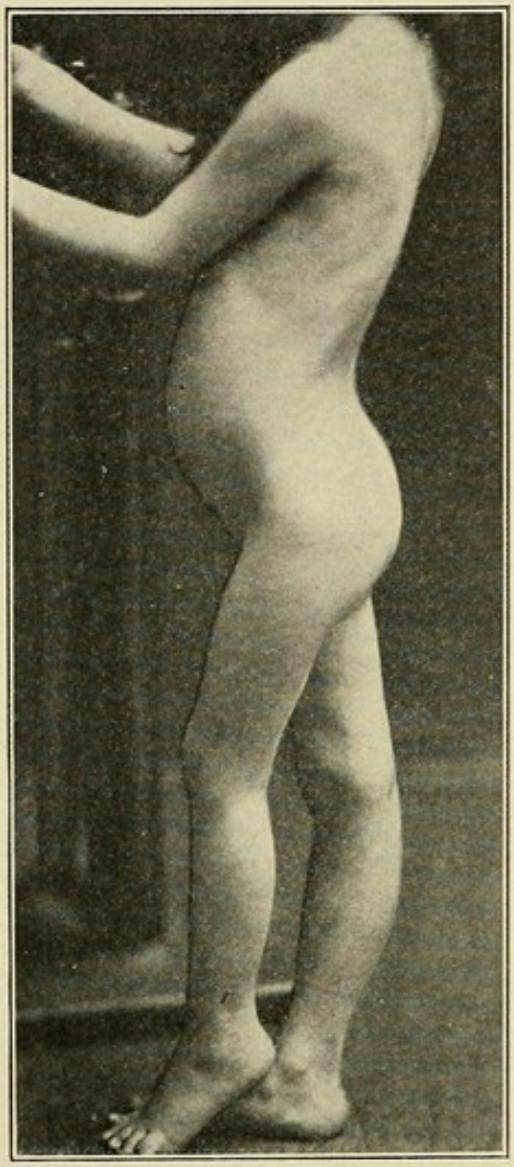


FIG. 107-A. CONGENITAL DISLOCATION, ONE HIP. Side view. Same case as 107-B.

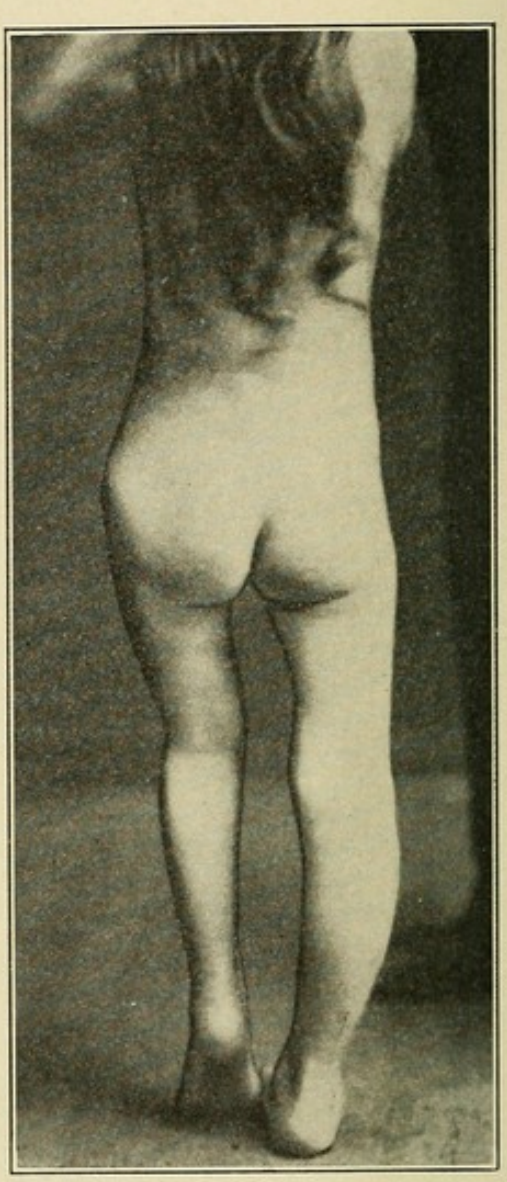


FIG. 107-B. CONGENITAL DISLOCATION. Back view, same case. Girl 8 years old.

is a fair prospect of great improvement and possibly cure after operation.

Treatment.—There are not many topics connected with pediatrics, surgery or orthopedics which have been more discussed by the profession (and the public too) in the last few years than this one. The literature is voluminous and still augmenting. To trace the history of the controversy is outside the scope of this work. The question is not yet settled to the satisfaction of the majority of

professional minds. Nor shall I attempt to present the variations and modifications of the different operations and methods of treatment.

There are those who follow an altogether expectant plan in these cases. And there are cases of so mild a grade, affecting both sides alike and causing so little deformity, that they are best left alone. If there is only slight shortening in one limb a slightly thicker sole upon the shoe may supply the difference and correct the limp, so that with a little management of the clothing the deformity gives no trouble and passes unnoticed.

Another method endeavors to hold down the trochanters by a wide firm band or corset held down upon them by perineal bands which take their bearing upon the tuber ischii. Numerous cases treated in this way are prevented from growing worse and get along with little show of deformity while they wear the apparatus.

Still other plans employ traction. It may be applied by ambulatory braces similar to the traction splints used for morbus coxæ, or a combination of this with the trochanteric corset just described; or traction by weight and pulley with the patient confined to the horizontal position for years, gradually bringing down the head of the femur to the acetabulum and then holding it there until it will stay there without the traction or any apparatus, or with the aid of apparatus; and then bringing it into use by passive motion. A number of cases treated by this mild, patient and painstaking method have been reported cured; but as Bradford has shown, after a few years more they are in much the same condition as when the treatment was begun. About the same report can be made of various postural methods—they cure temporarily, but relapse follows.

The methods remaining to be mentioned are either cutting operations or the so-called bloodless method. Operations consist of tenotomies of the shortened tendons that interfere with traction or postural methods; or of division of the muscles about the joint so as to allow of its reduction; or this with opening the capsule and replacing the head of the femur in the acetabulum, sometimes also cutting deeper the acetabulum to receive the head; or resection of the articular extremity of the femur. These operations all have many variations and modifications.

Hoffa's Operation.—The operation that is perhaps most commended by those who advise any open operation at all, is that which bears the name of Hoffa, and it has modifications too numerous to describe. Some advise preliminary traction, for some days previous to the operation, with weight and pulley or other apparatus. This brings the head of the femur down from its position on the dorsum ilii to a point below the iliac crest. If necessary the adductor tendons are divided close to their pubic attachment. Arrangements

are made for extension and counter-extension during the operation. A strong and thick perineal band covered with a wetted antiseptic towel is connected with a ring in the floor or wall of the room for counter-extension. And a similar band, which may be a long towel, a rolled sheet or the like, should be fastened with a clove hitch to the thigh for making extension. Then after complete antiseptic preparation an incision is made beginning just below the anterior superior iliac spine and extending downward and backward along the outer margin of the tensor vaginæ femoris. Dissection is carried between that muscle and the gluteus medius, down to the capsule. The wound being retracted, the capsule is incised and the head and neck exposed. The attachments of the capsule around the neck of the femur are divided. Any constriction, "hour-glass" contraction, or adhesion about the capsule which would prevent the reduction is cut, or stretched by a dilator, but the anterior part of the capsule and the ilio-psoas tendon are spared. The ligamentum teres may be cut if it interferes with the inspection of the joint. The extension being released, the acetabulum is examined, and if it is to be deepened this is done with a large curette. The femur is now pulled down and placed in the socket. This may be accomplished by maneuvers, or the limb may have to be abducted and traction made, and when the head is opposite the cavity, lateral pushing upon the trochanter puts it into place. In some cases the bone is twisted forward so that strong inversion is necessary to point the head into the cavity. An essential point is that no portion of the capsule shall be folded in between head and acetabulum. The reduction should be so complete that when the limb is extended it stays in place. The incision in the capsule is now closed so far as possible with catgut sutures. Some surgeons drain the joint, and others only drain down to the capsule with a small drain. The deep and superficial fasciæ and the skin are sutured. After the antiseptic dressing with the thigh strongly abducted, the whole limb from the foot up is put up in a plaster spica and this extended to the thorax. Some make it a double spica including the other limb also, even in one-sided cases. In three months or more the spica is removed and another put on after straightening the limb somewhat. In one-sided cases the sound limb is not included in the plaster this time. At a subsequent dressing the knee and leg are left free, and with crutches the child may go about carrying the thigh in the plaster spica still in wide abduction. In nine months to a year or more the cast is left off. If the inversion persists, a subtrochanteric osteotomy may be done.

Bloodless Reduction.—Although this method of treatment was not originated by Lorenz, he systematized and elaborated and advocated it until it is usually spoken of as the Lorenz method. The

preparatory treatment not invariably used is moderate traction in the position of abduction, which is kept up for several days. Then under anesthesia powerful traction is made downward in abduction. This may be effected by counter-extension bands around the thigh and across the perineum (not pressing upon the genitals) fastened to a stationary table or a ring in the wall of the room, while the extension is made manually or with block and tackle attached to bands upon thigh and leg. Or the limb may be placed in a traction apparatus such as that devised by Bradford at the Boston Children's Hospital, which consists essentially of a very strong Thomas knee splint well padded at the upper end for the counter-traction, and having a windlass at the lower end for the traction. The limb is pulled down until the trochanter is at Nelaton's line when the limb is straightened. The thigh is then flexed straight forward to a right angle, rotated inward, and then abducted to almost a right angle. If the maneuvers are successful the head should pass over the margin of the acetabulum and into its socket with a distinct impact, and it should stay there when the limb is brought down straight. If it does not, but slips out again, more stretching is necessary. Sometimes at this point tenotomy of the adductors is required. When certain that reduction has been effected the thigh is held in extreme abduction and flexion at a right angle, while a plaster spica is applied to limb and pelvis and up to the thorax. The child is soon allowed to go about with crutches, carrying the plaster. It is kept in this position six to eight months, the casts being renewed when necessary, then gradually straightened. As after the open operation, if great inversion persists, subtrochanteric osteotomy must de done.

Among the many methods, modifications and apparatuses that have been presented to the profession, one of the most recent is that of Hibbs, of New York.[1]

He has devised an apparatus which consists of a board two inches thick, six feet long and two feet wide, with two windlass pulleys on the under surface. This is shown in Figs. 108 and 109, and with the operation, described substantially as follows:

In this board or table-top, the two larger openings, A and B (Fig. 108), are made for the trochanteric pad. At C and D are attachments for the pelvic straps, and at E is a roller over which the straps run. The child is placed on the solid board between the two openings, A and B. The two padded pelvic straps are attached at C and D, which are widely enough separated for the straps to pass just internal to the crest of the ilium, down over the ramus of the pubis running over the roller just in front of the perineum at E to the under surface of the board, where they are attached to the two

[1] N. Y. Med. Jour., Apr. 25, 1908.

windlass pulleys. By means of the windlass sufficient pressure may be made on these straps to hold the pelvis immovably, without the slightest damage to the skin or any other part. The holding force

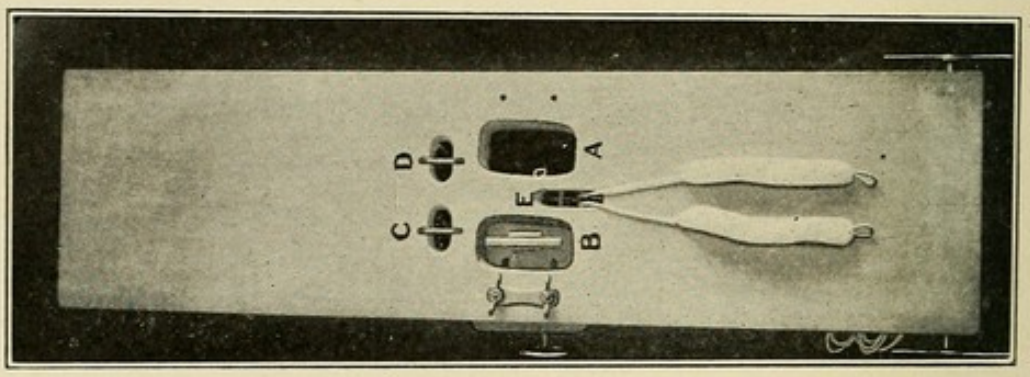


FIG. 108. HIBBS' APPARATUS FOR REDUCING CONGENITAL DISLOCATION OF HIPS as seen from above.

is exerted laterally against the sides of the pelvis as well as backward. The trochanteric pad is 5 inches by $1\frac{1}{2}$ inches in size, and hollow. It is made of highly polished steel, as such a surface slides over the skin with the least possible friction. The pad is attached to

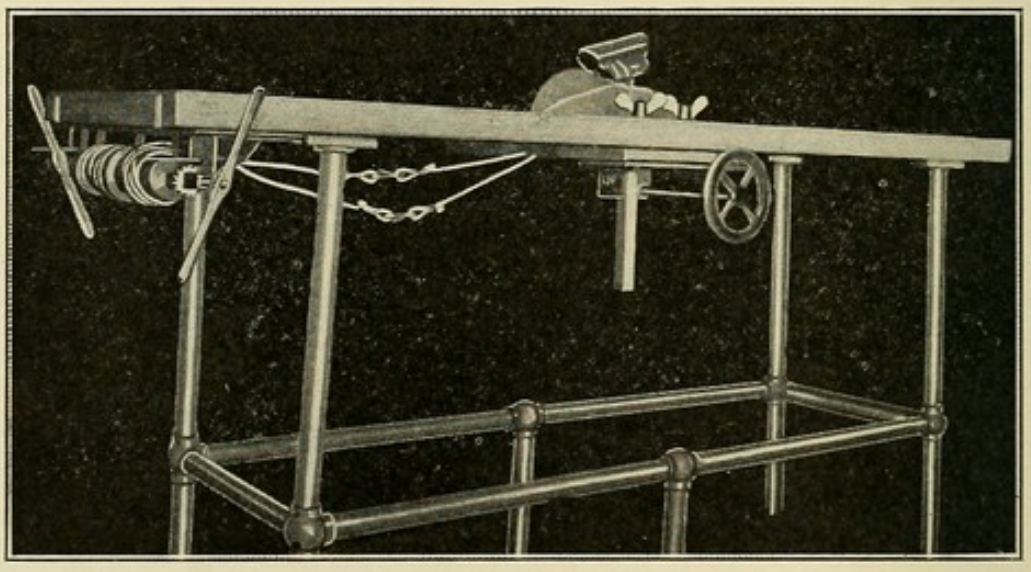


FIG. 109. HIBBS' APPARATUS FOR REDUCING CONGENITAL DISLOCATION OF HIPS. Side view.

the under surface of the table, and by means of a wormscrew mechanism it can be forced up through either opening A. or B. against either the right or left trochanter and fastened at any point, immovably. The steps of the operation are shown in Figs. 110, 111 and 112. First, the child is placed upon the table and the pelvic straps attached, then the leg to be operated on is flexed on the ab-

domen. The pelvis is made immovable by tightening the straps with the windlass. Secondly, the leg is extended on the thigh with the thigh held in adduction and flexion on the abdomen, thus forcing the head below the acetabulum. At this point the operator, by means of the wheel and wormscrew mechanism, forces the trochanteric pad upward and forward through the opening in the board against the trochanter, where it is fixed immovably. The thigh is then extended and abducted, forcing the head to travel upward anteriorly

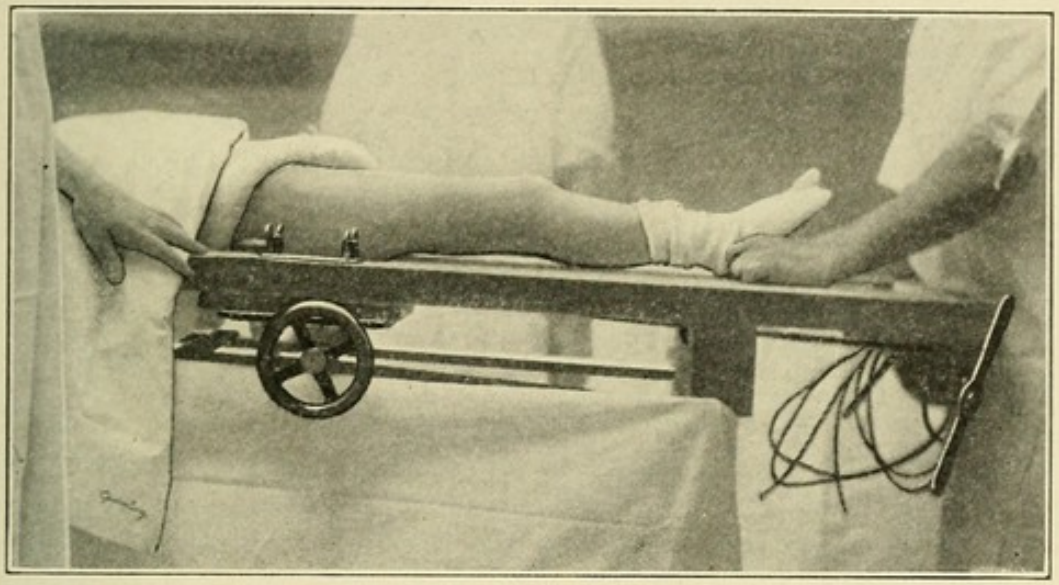


FIG. 110. FIRST STEP OF OPERATION.

into the acetabulum. The degree of extension of the thigh necessary before the head reaches the acetabulum in its course upward will depend upon the distance below the acetabulum at which it rests when the thigh is in flexion and adduction on the abdomen and the leg extended, and will be less in the older cases. The lower the head is gotten, the easier will be the reduction, as when it is well below the acetabulum, it is forced into the anterior route more gradually. The reduction is accomplished often with an audible snap, and the sensation to the hands of the operator can hardly be mistaken. The muscles become taut and the leg is flexed.

Thirdly, the plaster is applied with the thigh in abduction and flexion, so as to put considerable tension on the muscles, and the knee is included in the plaster with the leg extended so that the ham strings are tense. (See Figs. 113 and 114.) The angles of abduction and flexion will vary with the age of the patient, being greater in those with most shortening. However, in some cases the leg is brought to a position of 10 degrees abduction and 80 degrees extension in the first plaster, as seen in Fig. 115. The first plaster should be changed at the end of two weeks, when it will be found

possible to place the limb nearer the normal position, and the plaster should be changed every two weeks until its removal. Dr. Hibbs doubts the necessity of any case wearing plaster more than two months, and at the most three months. In many a shorter time is sufficient.

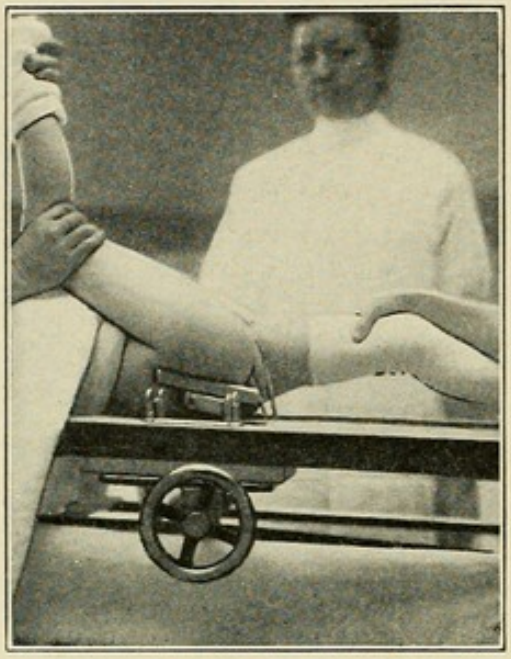


FIG. 111. SECOND STEP OF OPERATION.

With this apparatus fourteen hips have been reduced in thirteen children, varying in age from twenty-one months to eleven years, and no evident traumatism has been produced. It seems reasonable to expect if the acetabulum is large enough to receive the head and both are fairly developed that the result should be stable, from the fact that the integrity of muscles and structures about the joint remains unimpaired by the operation.

Ridlon of Chicago uses a method of manipulation that is a little different from that of any of the other surgeons that I know about.

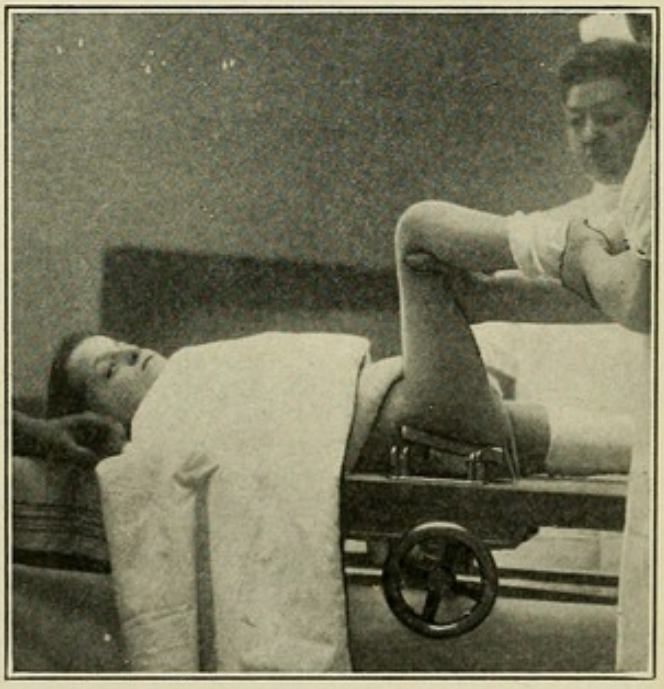


FIG. 112. THIRD STEP OF OPERATION.

He does no preliminary stretching of any kind, neither by weight and pulley traction in bed before the day of the operation, nor by

hand or any mechanical device to pull the limb outwards at the time of the operation, nor to stretch the capsule as Lorenz did by extreme flexion of the limb with the knee straight and by extreme hyperextension. He has not used the Koenig block which used to be em-

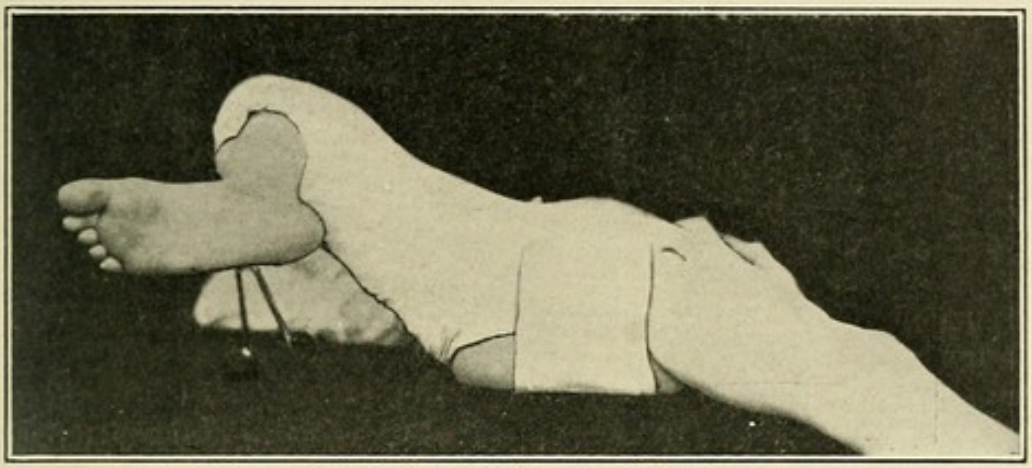


FIG. 113. CONGENITAL DISLOCATION OF HIP, after reduction. First plaster, showing degree of abduction. Case of Dr. R. A. Hibbs.

ployed by Lorenz for more than four years. But in extremely difficult cases he rests the patient's pelvis on a sandbag some three inches thick in order to get a better leverage for the manipulation. The manipulation is as follows: With the pelvis on the opposite side

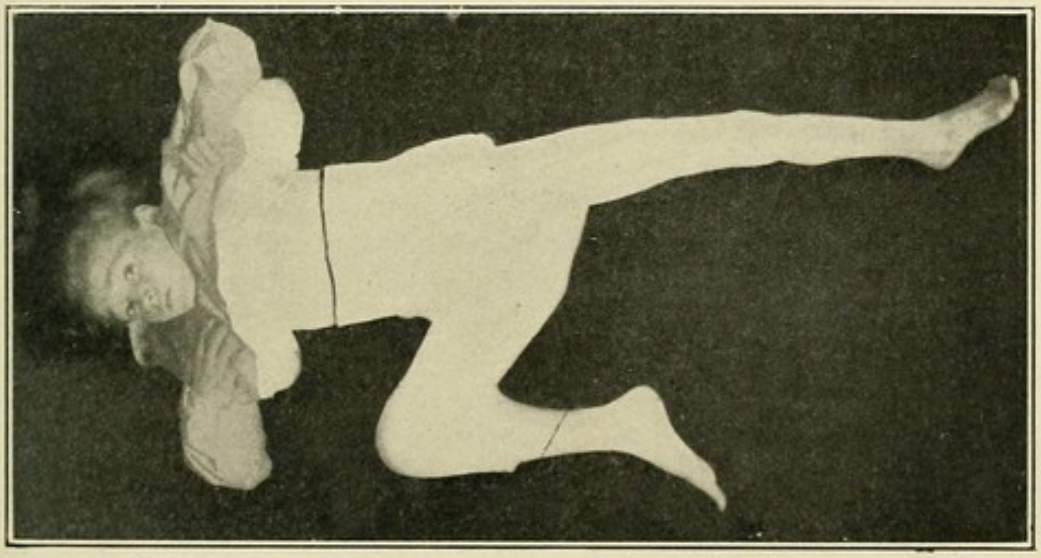


FIG 114. CONGENITAL DISLOCATION OF HIP after reduction, put up in first plaster showing degree of flexion. Case of Dr. R. A. Hibbs.

held down by an assistant he fully flexes the thigh on the side of the dislocated hip, the knee also being flexed. Then with one hand on the knee pushing the head of the femur downwards and with the fingers of the other hand beneath the greater trochanter, neck and head of the femur so that the direction of the head in relation to the

greater trochanter can be felt, the thigh is rotated inwards by turning the foot and leg outwards, thus throwing the head a little lower down and in the direction of the lower and posterior border of the acetabulum. In this position the thigh is abducted with the hand on the knee, the head and neck of the femur are lifted upwards (forwards) with the fingers that are underneath it, the thumb being in place on the groin until the head passes into the acetabulum. The head is then pressed into the acetabulum, and at the same time the thigh is rotated with the hand on the knee. Ridlon claims that by this manipulation it is possible in almost all cases to effect a reduction without tearing or greatly stretching the adductor muscles, as occurs in the Lorenz handling, and there can be no doubt that the less tearing and stretching that occurs in the muscles surrounding the joint the more securely will the replaced hip be held. He then tests what position seems most secure, and usually finds it to be the Lorenz position, which has been called the position of right-angled abduction, but it also includes outward rotation of the thigh to about 90 degrees, so that when the child lies on its back the outer side of the foot and the leg lies on the same plane as the back, resting upon the table or bed. But occasionally the Lange position is found to be the more secure one. This is right-angled abduction without outward rotation, so that when the child lies on its back on the table the back of the thigh muscles rest on the table and the leg below the knee hangs directly downwards at the side of the table. Obviously this is a difficult position, both while the child lies in bed and after he gets up to walk. Ridlon does not, when using the Lange position, carry the plaster splint below the knee, as many surgeons have done, in order to retain the limb absolutely in this position and prevent the thigh from rotating. He has observed that so long as the child lies in bed with the leg below the knee hanging over the side of the bed and downwards

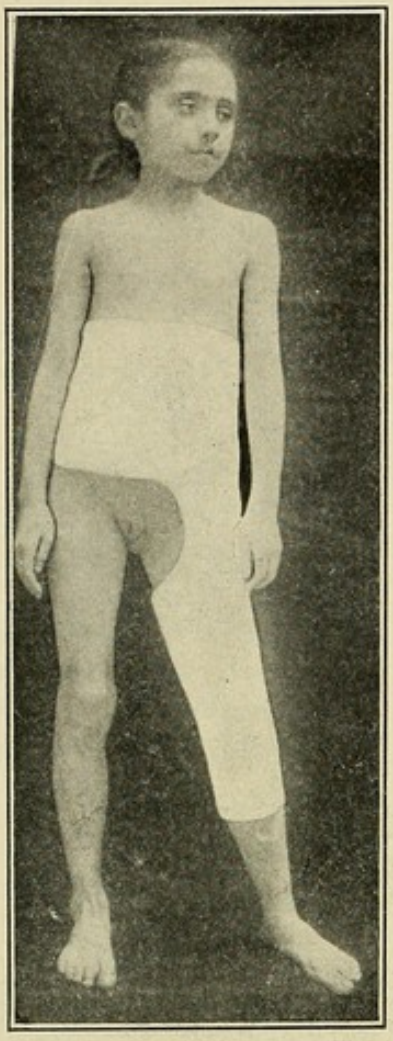


FIG. 115. AFTER REDUCTION OF CONGENITALLY DISLOCATED HIP. Limb put up in first plaster with 10 degrees abduction and 180 degrees extension. Girl 11 years old. Dr. R. A. Hibbs.

towards the floor, that the original position in regard to absence of rotation is maintained; but that as soon as the child is let up and allowed to walk the thigh gradually rotates into practically the same position that it has when the limb has been put up in the typical Lorenz position. In other words, the thigh gradually rotates outwards from the position of no rotation when the Lange position is employed, as it rotates inward somewhat from 90 degrees of outward rotation of the original Lorenz position when the child begins to walk.

The dangers of laceration of muscles, rupture of vessels, fracture of bones or separation of epiphyses, injury of nerves, contusions, with resultant hemorrhages, paralyses, contractions or sometimes gangrene, which are associated with the "bloodless" method, are not to be ignored; nor is the fact that relapses frequently occur. With the open method the great danger connected with the operation is sepsis, which may of course prove fatal; or in the way of an unfavorable result, ankylosis. It is to be hoped and expected that further study will fix the indications, set the limitations, and perfect the technique of all these procedures so that a safe and satisfactory line of treatment can be laid down.

The open operation is used in the older cases, some say in children from four to ten years; others place it at seven to ten or more years; but all agree that after puberty the prognosis is poor, and the choice then lies between excision if the joint is painful or troublesome, and the corset for holding down the trochanters. The age limit for the bloodless reduction is seven years for the unilateral cases, and four or five years for the bilateral cases. It is sometimes said that the bloodless reduction should be tried first, and if it does not succeed, arthrotomy should be resorted to; but it may occur that the effort at reduction and its results have so changed the conditions that reduction by arthrotomy is impossible.

CONGENITAL DISLOCATION OF THE KNEE

This is much more rare than congenital dislocation of the hip.

Fig. 116 shows the lower extremity of a babe in which the knee could be hyperextended about forty-five degrees. Such cases are sometimes called congenital dislocation of the knee. But the joint is not entirely dislocated, or is only a mild grade of deformity. It is readily brought into normal position either by passive or active motion. A knee held continuously in that position by congenital deformity with contracted tendons is called genu-recurvatum, and is similar in its origin to talipes calcaneus, which sometimes accompanies it.

Hyperextension of the knee in some cases does amount to a dislocation, and this is the more common of the two principal forms.

It may extend to or beyond the right angle, or so that the toes are near the groin. The articular surface of the tibia in these cases lies upon the anterior edges of the condyles. The patella may be small or absent. In the other principal form the tibia is luxated or sub-

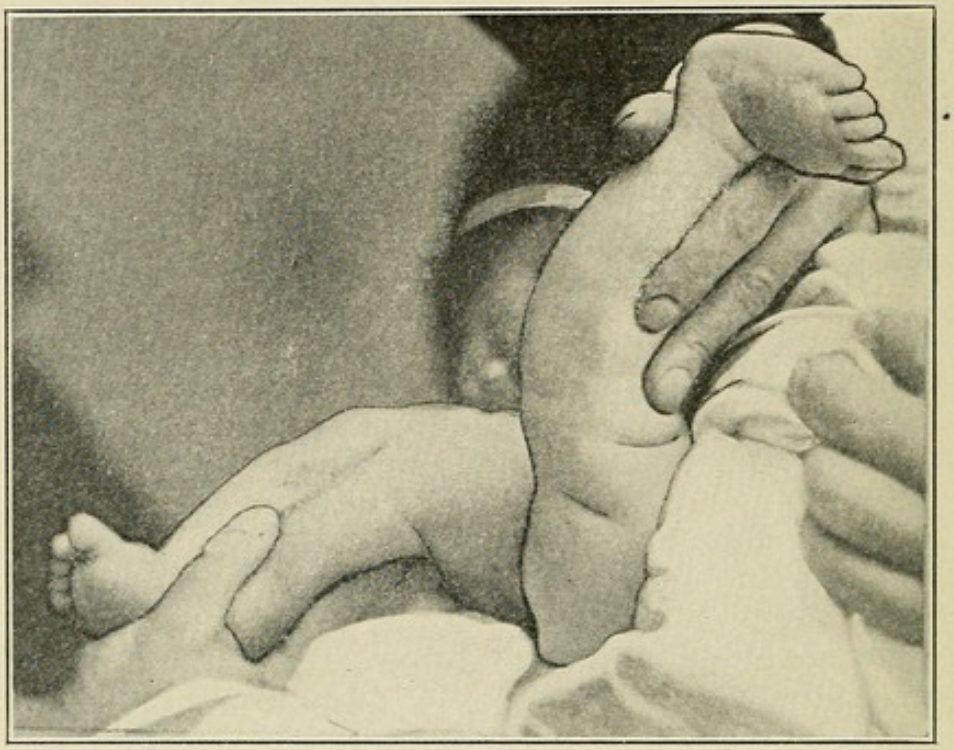


FIG. 116. HYPEREXTENSION OF THE KNEE. Genu-recurvatum.

luxated backward. Lateral displacements are extremely uncommon, yet such have been reported. Most cases are readily reduced, although ankylosis has been known to accompany the condition.

Treatment is reduction and the use of a splint of suitable form to prevent its recurrence, but to allow normal motion. An anterior splint attached by encircling bands only to the leg or only to the thigh, but extending also upon the articulating bone, will answer the purpose.

CONGENITAL DISLOCATION OF THE SHOULDER

Many of the cases which have been described under this heading prove upon examination to have been the results either of injury at birth, with or without resulting paralysis, or of paralysis alone. Yet cases of undoubted congenital dislocation do occur, though they are extremely rare.

Figs. 117 and 118 are from photographs of a case in my own practice. It occurred in association with a congenitally dislocated hip. The infant died when eight months old of acute intestinal in-

fection, and I was able to secure only the shoulder joint. It shows imperfect development of the glenoid cavity and also of the head of the humerus, which rested in, or rather upon, the rudimentary

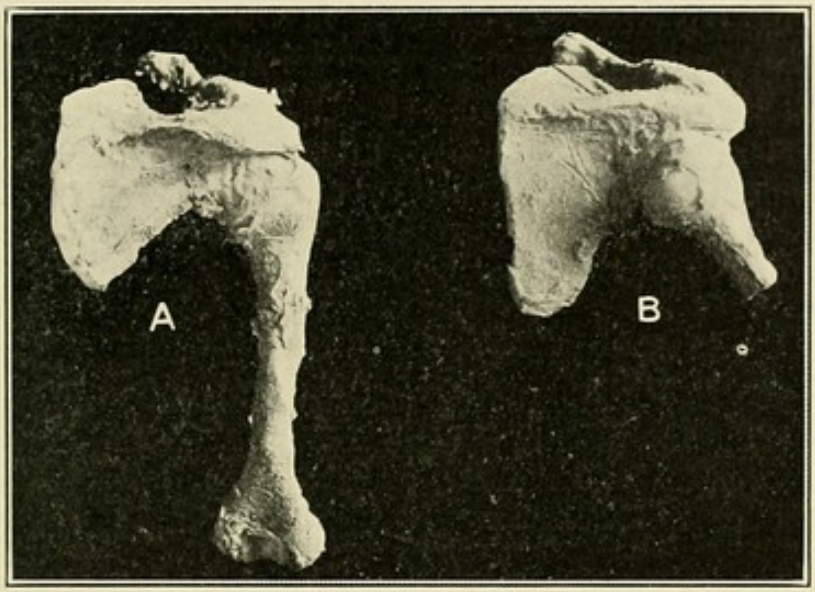


FIG. 117. B shows a specimen of congenital dislocation of the shoulder. A is a normal joint for comparison.

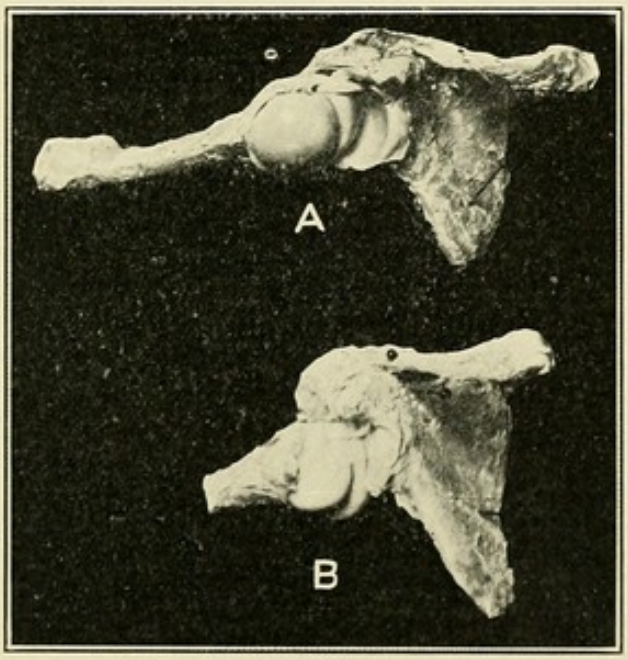


FIG 118. Same case as above, with joints laid open. B, congenital dislocation of shoulder. A, normal joint for comparison.

cavity, but low with reference to the acromion, and projected backward.

Treatment.—Treatment of congenital dislocation of the shoulder

has thus far proven very unsatisfactory or a total failure. None of the published results can fairly claim anything more.

CONGENITAL DISLOCATION OF VARIOUS OTHER JOINTS

Congenital dislocations of the elbow and wrist joints, the temporo-maxillary, occipito-atlantoid, of the ankle, of the phalangeal, in fact, of almost any joint, are occasionally reported; but possess no surgical interest. They are usually capable of being reduced, so far as the formation of the joint allows reduction in its usual sense, and retained by some form of apparatus; or in some situations resection or arthrodesis might be preferable.

TRAUMATIC DISLOCATIONS

Traumatic dislocations are less common in children in comparison with adults, apparently for two reasons, the elasticity and freedom of movement in the joints, and the yielding of the epiphyseal junctions in case of violence.

DISLOCATION OF RADIUS AND ULNA BACKWARD, OR LATERALLY

Dislocations of one kind or another at the elbow joint are the most frequent of all the dislocations in children, and are not uncommon. With any of them there is apt to be also separation of an epiphysis or a fracture. Dislocation is either backward or forward, or it may be backward and laterally, or only laterally, either toward the inside or outside, often accompanied with a fracture or epiphyseal separation of one or the other condyle. (See Figs. 119 and 120.)

When the radius and ulna are displaced backward the coronoid process of the ulna is likely to be detached. (Owen.) It is most commonly caused by a fall, but it is not always possible to say exactly in just what direction the force was applied. I once had a case of backward displacement of both forearms produced simultaneously in an overgrown boy by a fall from an old-fashioned high velocipede. The boy said he pitched over the handle-bars and struck on his hands with arms outstretched.

Symptoms and Diagnosis.—The symptoms of dislocation backward are a shortening of the forearm on its anterior aspect, with projection of the olecranon beyond the line of the humerus at the back of the elbow. The arm is held half way between full extension and flexion to the right angle, and is more or less rigid in that position, unless the injury is complicated with fracture above the condyles or epiphyseal separation. On examining the relative position of the epicondyles and tip of the olecranon (as described under Injuries of the Humerus Near the Elbow), it will be seen that the ole-

cranon projects not only backward but above a transverse line extending from one epicondyle to the other. It should be on a level

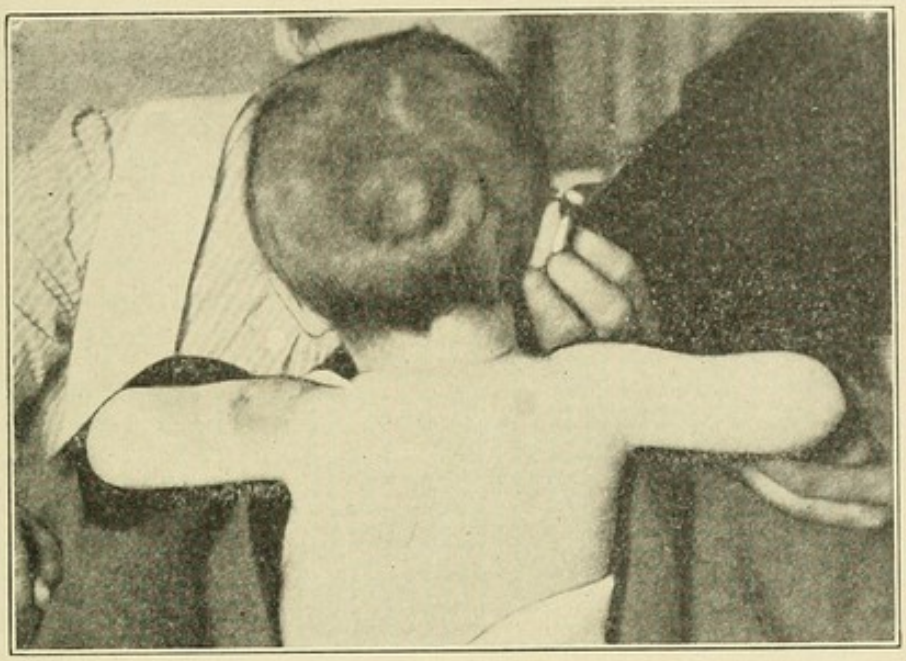


FIG. 119. INCOMPLETE DISLOCATION OF BOTH BONES OF FOREARM INWARD UPON HUMERUS. Boy of three years. Injury by fall five weeks previously. Elbow squared instead of pointed, and upper arm shortened. Olecranon internal to normal position. Flexion and extension slight. Pronation and supination of forearm free. Considerable lateral motion of forearm upon arm. See radiograph, Fig. 120.

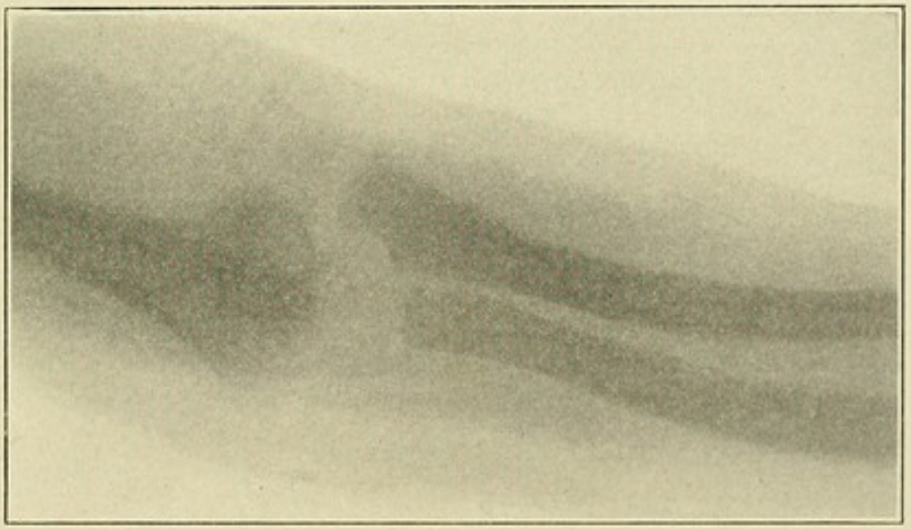


FIG. 120. INCOMPLETE DISLOCATION INWARD OF RADIUS AND ULNA UPON HUMERUS. Boy aged 3 years. Radiograph left elbow from behind. Attempts to flex forearm separated ulna still farther from radius, due to wedging between them of the cartilaginous trochlea.

with that line when the elbow is extended and below it when the elbow is flexed. The only injury likely to be confused with dislo-

cation is separation of the lower epiphysis of the humerus. In dislocation, to flex the forearm renders the projection of the olecranon more prominent, while in epiphyseal separation, flexing the forearm decreases the prominence at the point of the elbow. Dislocation has flexion and extension interfered with, and has no crepitus. In epiphyseal separation motion is free, there is too free lateral motion, and crepitus is found.

Treatment.—One has usually found reduction easy by taking humerus in one hand and radius and ulna in the other, straightening the arm, pulling down and suddenly flexing while the traction is continued. It must be very seldom in a child that it is necessary to bend the elbow around one's knee. Ordinarily one would use chloroform if it be at hand. But one has a number of times had occasion to reduce an elbow without it. The reduction is done in a few seconds and relief is obtained. However, one should always use chloroform if there is any question about the diagnosis or any complication. When reduced, the joint is freely movable, both passively and actively; and there is no reappearance of the deformity. With fracture above the condyles or with epiphyseal separation, the deformity reappears when released from the surgeon's grasp. The patient should be made to demonstrate that he can flex the arm voluntarily to a right angle. In that position it should be wrapped in cotton and put up in a right-angled splint or in molded binder's board or a pasteboard box splint, with a roller bandage, to secure fixation, and carried in a sling. In a week or ten days passive movements and light massage are begun and used only cautiously, the splint being replaced, with slight pressure if edema continue. I have never had ankylosis from dislocation at the elbow; but think it can be induced by too early and too much motion, and leaving off the splint and rest treatment before the joint has fully recovered.

DISLOCATION OF RADIUS AND ULNA FORWARD

This injury is a rare one. Stimson, writing in 1900, says the recorded cases are less than twenty-five. "Of the thirteen cases in which the age is mentioned, one was six years old, two were eight, two fourteen, two fifteen, and one each eighteen, twenty, twenty-four, thirty-eight and forty years old. One was an 'adult' and one middle-aged." Thus seven out of thirteen presenting this rare form of dislocation were under fifteen years of age.

The most common cause is a fall upon the point of the elbow with the arm flexed; but various forms of violence are recorded. The dislocation may occur without or with fracture of the olecranon; and it may be incomplete or complete. When the upper end of the olecranon rests against the under and anterior surface of the humerus it is said to be incomplete; but if the end of the olecranon

passes up in front above the end of the humerus the dislocation is called complete.

Symptoms.—In the incomplete form the forearm is lengthened when the arm is extended or only slightly flexed. In the complete form the forearm is lengthened when flexed near the right angle, but more or less shortened when extended. The sides and back of the elbow are flattened and a space can be felt there between the humerus and the ulna, unless there is too much swelling present. If the two epicondyles can be located the presence or absence of the end of the olecranon from its normal relative position can usually be determined.

Treatment.—Reduction can be effected in the incomplete form by pulling the arm in overextension and then flexing; or by flexing it round the surgeon's knee. In the complete form, while the joint is full flexed over the surgeon's index and middle fingers, he pulls the upper end of the forearm downward and backward. Or a strap may be used instead of the fingers. The elbow is then put up as for dislocation backward.

SUBLUXATION OF RADIUS

This is the most peculiar as well as the most frequent dislocation of the radius in the young—admitting that it is a dislocation of the radius. The question of the exact nature of this injury has been long and frequently discussed. One has met it again and again in dispensary and private practice. Every surgeon and every pediatrist has seen numerous cases. Yet there has never been an opportunity for an autopsy. Here is a typical case: A man playfully takes a three-year-old child by the wrists and proceeds to "waltz," half lifting the little one from the floor. The child cries, and being released, refuses to use one arm. The arm hangs at the side slightly flexed and half pronated. The arm presents nothing abnormal on inspection or on palpation. Flexion and extension are free. Pronation is also free, but when we attempt supination there is a cry and something prevents. And there is tenderness over the head of the radius. If now slight force be used to supinate the forearm and the radial head be pressed backward, there is a snap, and the trouble is gone. Reduction can also be effected by traction on the forearm with pressure backward on the head of the radius, followed by flexion; and sometimes by supination alone. The offered explanations for this injury are curiously various—displacement forward, displacement backward, paralysis from injury to the nerves, catching of the bicipital tuberosity behind the ulna, separation of the head of the radius, and others. The most satisfactory explanation, it seems to me, is that of Duverney, who considered it due to the escape of the head of the radius downward from the orbicular ligament by trac-

tion. It seems probable, however, that a slight twist forward of the radius tends to catch the head at the edge of the ring once it is out. In several of my cases a slight fullness in front of the radial head was detected; and the manner of the production of the injury seemed to render it probable that in addition to traction upon the radius there was twisting of the forearm. For instance, a child was grasped by one forearm and lifted across a muddy street. Again, a mother putting an unruly child to bed undertook to make him fold his arms. The accident may occur by forcible adduction of the forearm as well as by traction in the long axis. I believe the experiments of Goyrand and Pingaud, as quoted by Stimson, corroborating the experimental findings of Duverney, together with clinical observation, satisfactorily account for the phenomena observed in these cases. Yet the question is not considered by the majority to be definitely settled.

Treatment.—If left entirely to itself the forearm would gradually recover its function, possibly with the formation of a new orbicular ligament or something resembling it. But reduction is easily accomplished as before described and at once gives relief. An anterior rectangular splint well padded is applied and the arm rested for a week.

DISLOCATION OF THE RADIUS FORWARD

Dislocation of the head of the radius forward occurs from falls upon the hand or upon the elbow or from a blow upon the outer and back part of the forearm or from twisting the forearm. The head of the bone projects in front of the humerus, and flexion beyond a right angle is impossible. The tendon of the biceps is felt to be relaxed.

Treatment.—Reduction is readily accomplished by flexing the forearm and pressing the head of the radius back into place. It has probably torn the orbicular ligament, and three or four weeks must be given for its repair. The dislocation would readily recur unless prevented. A rectangular splint applied anteriorly, with the arm well flexed, and carried in sling, prevents this.

DISLOCATION OF RADIUS BACKWARD

This occasionally occurs, but rarely. It can generally be recognized by feeling the head of the radius below its normal place, or below and behind it when the elbow is flexed, and behind it when the joint is extended. It can be replaced by pressure on the head of the bone; or by extension, supination and pressure; or by extension, traction, adduction, and then pressure upon the head of the bone. The splint just described for dislocation forward will answer.

DISLOCATION OF THE SHOULDER

This is not at all common in children. The force which in an adult would dislocate a shoulder would probably in a child separate the upper epiphysis of the humerus or cause the elbow or collar-bone to yield, as any of these injuries are more frequent.

DISLOCATION OF THE HIP

Dislocation of the hip, of the traumatic variety, is very seldom met in children. When it does occur, it presents no peculiarities which require attention here. It is generally easily reduced by manipulation; and the same treatment would be suitable as in the adult.

DISLOCATION OF THE PATELLA

Wright reports a case of habitual dislocation of the patella, probably due to congenital weakness and ill-development of the parts. Through an incision he anchored the patella to the capsule by two catgut sutures at its inner border.

DISLOCATIONS OF THE PHALANGES

These are rather frequent in children, and as a rule receive too little surgical attention. They are pulled at by parent or neighbor, and unless easily reduced further damage is done. When incomplete they may be manipulated into place with great ease. When complete the finger should be still further bent in the position in which it is found, while the margins of the articular surfaces are placed and held evenly together; then with extension the reduction is effected. If a portion of the torn capsule intervene and prevent the reduction, the joint must be opened antiseptically, the capsule withdrawn, reduction effected, and the incision closed.

DISLOCATION OF THE THUMB

Only the complete form of the backward dislocation of the proximal phalanx of the thumb will be mentioned, as that is the one that is notoriously likely to prove difficult of reduction. Stimson considers that Farabeuf, in his famous and much-quoted presentation of the subject, has overestimated the importance of the sesamoid bones in opposing reduction. He considers it to be the torn edge of the anterior ligament tightly drawn across the back of the metacarpal behind its head.

Treatment.—The muscles of the thumb should be relaxed as much as possible by holding the hand in straight extension and slight abduction, and the thumb strongly adducted, pressed into the palm.

Then with the phalanx standing in overextension at right angles with the metacarpal its base is pressed forward, that is, in the distal direction, until its dorsal surface is level with the end of the metacarpal, when it is straightened. If the reduction does not occur by this means, the phalanx may be rotated while it is being extended and flexed. This may free the ligament if it has been caught. Not succeeding by this maneuver, arthrotomy must be resorted to as preferable to violent efforts at reduction by extension. In arthrotomy the incision is made longitudinally upon the projecting head of the metacarpal, the wound retracted and an effort made to lift the long flexor tendon and with it the torn edge of the ligament from the side of the head around to the front. If this does not free the bones the margin of the ligament should be nicked with a knife, when it will be released.

DISLOCATIONS OF THE STERNUM AND OF THE RIBS

Very unusual in children, owing to the softness and elasticity of the chest walls. Dislocation of the manubrium upon the body of the sternum has been recorded, and also dislocation of the ziphoid or ensiform cartilage. The ribs may, by great violence, be dislocated from the vertebræ; and occasionally by less force from their attachment to the sternum.

COMPOUND DISLOCATIONS

Compound dislocations will occasionally occur in children as in adults, often with very serious tearing of the ligaments and tendons about a joint, as well as injury of vessels and nerves, and of course adding the dangers of sepsis of an open wound. Yet one has often seen joints opened by dislocation, or dislocation complicated with fracture, not only escape gangrene or suppuration, but even very great deformity by ankylosis. A single example will illustrate: Carl D., a boy of twelve years, fell to the ground with a heavy plank, producing a compound dislocation of the right elbow. No doctor could be found at once and my arrival was two hours after the accident. Meanwhile the wound, filled with dirt, was wrapped in a soiled towel. The elbow was overextended, the articular end of the humerus was thrust out through a wound across the front of the elbow; the anterior and both lateral ligaments and the tendon of the biceps were torn through. The brachial artery was the only structure in front of the articulating surface of the humerus, and was stretched as tight as a bow-string. Forearm pulseless. Severe bruising about the joint caused by the edge of the plank. Under anesthesia the joint was very carefully cleansed with antiseptics, put in place, the torn structures approximated with sutures, drained with a strand of catgut, dressed with iodoform and sterile gauze,

put up in a right-angled pasteboard box splint and elevated, with ice bags. It was not dressed for ten days. After very slight passive motion it was put up for another week. After twenty days from the accident passive motion was carefully practiced regularly. Pronation and supination became perfect, and flexion and extension lacked but little of the normal, and the arm appears strong as ever. (See also remarks upon Amputation for Compound Fracture, in the Chapter on Fractures.)

MOTION AFTER DISLOCATIONS AND OTHER JOINT INJURIES

There seems to be a tendency on the part of many practitioners to exaggerate the dangers of ankylosis after dislocation and other injuries of joints; and their fear is that ankylosis can only be prevented by putting the joint to use very promptly after the injury with passive and active movements. My own belief, founded upon observation is that so long as inflammation remains active in or about an injured joint or so long as the condition is aggravated by movements, such attempts at motion not only gain nothing in mobility but actually lessen the chances of a satisfactory end-result. It is far better to allow the traumatic inflammation to subside, and the wounded soft parts, the lacerated capsule, the sundered ligament to become reunited before attempting to establish function. More attention should be centered upon accurate reduction without further violence to the structures, upon thorough asepsis in compound injuries, and upon retention in a fixed dressing when reduced. The adhesions depend upon the injury and the inflammation, and attacking them soon does not lessen their number; while there is little danger that more time will render them too strong to be broken. It may give more confidence in nature's power to preserve a joint to remember that a new joint can be produced by interposing fibrous tissue and fat between bone ends and beginning movements not sooner than two weeks after the operation; and that false joints are sometimes spontaneously produced after fracture; and that when false joint occurs in a child it is a matter of difficulty to eradicate it and secure rigid union.

CHAPTER XII

SURGICAL DISEASES OF THE LYMPHATICS

THE STATUS LYMPHATICUS (LYMPHATISM)—HYPERPLASIA OF THE LYMPH TISSUES OF THE PHARYNX AND NASO-PHARYNX—PRIMARY AND SECONDARY TUMORS OF THE LYMPH VESSELS AND OF THE LYMPH GLANDS—LYMPHANGIECTASIS, LYMPHADENOMA AND LYMPH VARIX—SIMPLE ACUTE LYMPHADENITIS—ACUTE SEPTIC LYMPHADENITIS—SIMPLE CHRONIC OR SUBACUTE LYMPHADENITIS—TUBERCULAR LYMPHADENITIS—SYPHILITIC LYMPHADENITIS—HODGKIN'S DISEASE.

IT seems to be natural for the lymphatic tissues to be very active in early life. To this normal activity are added very numerous causes of irritation, such as inherited dyscrasiæ, local inflammations upon the skin and upon the mucous linings of the naso-pharynx, the mouth, the respiratory and gastro-intestinal tracts, and to a lesser degree the genitalia; besides the many infectious agents that find a fertile soil in the tender organism of the young, which has as yet developed no immunizing power; moreover, there are sometimes new growths in connection with the lymph glands. So that we find these glands very often the seat of morbid conditions requiring the attention of the surgeon. Some of the lymph-nodes are so situated as to preclude surgical interference; but all those externally located are accessible, and constantly dealt with surgically, while the internal are frequently to be considered in diagnosis and sometimes in treatment. Different groups of glands are most affected at different ages and stages of development as well as pathological history, which is more or less a matter of accident as well as of heredity. For instance, enlargement of post-pharyngeal adenoids and tonsils may be found at any age up to puberty, when there is a tendency to atrophy. During infancy, when gastro-intestinal and bronchial mucous membranes are so frequently diseased, the lymph-nodes in their proximity keep pace. A little later, when carious teeth are common and diphtheria, measles, scarlet fever, and other acute infections affect the mouth, nares, pharynx and ears, and parasites infest the scalp, the lymph-nodes near by in the cervical region present the most pathological

conditions. At any age, but more especially after the catarrhal inflammations of the mucous surfaces already mentioned have rendered them vulnerable, the lymph-nodes afford a lodging place for the tubercle bacillus, and become the seat of its activity.

Pediatric surgery of the lymphatics will be considered under the following headings: The status lymphaticus Hyperplasia of the lymph tissues of the pharynx and naso-pharynx; Primary and secondary tumors of the lymph vessels and of the lymph glands; Lymphangiectasis, lymphadenoma and lymph varix; Simple acute lymphadenitis; Acute septic lymphadenitis; Simple chronic or subacute lymphadenitis; Tubercular lymphadenitis; Syphilitic lymphadenitis; Hodgkin's disease.

THE STATUS LYMPHATICUS (LYMPHATISM)

By some writers lymphatism is used to designate that which we formerly called struma or scrofula after all that is due to the tubercle bacillus has been differentiated from it—in other words, an overdevelopment and vulnerability of the lymphatic system and with it of the mucous membranes. Others use lymphatism as synonymous with status lymphaticus, which latter, perhaps, would best be reserved, as the name of an extreme expression of that diathesis in which, in addition to the lymphatic hyperplasia, there is hypertrophy of the thymus, called by some the status thymicus.

Etiology.—The "status lymphaticus" may or may not be a variety of "lymphatism" or "struma" (used in its modern sense); nor is it known whether it bears a relationship to rickets, although frequently associated with it. Nor is it certainly known how much the enlargement of the thymus has to do with the disease, nor what causes the enlargement, nor, if it produces the symptoms, how they are brought about. The disease is most frequent in the second half year of life, but may be found at any age. The pathological findings are hyperplasia of the lymph-nodes, especially those of the tracheobronchial region and the pharynx, enlargement of the solitary follicles of the intestines and of Peyer's patches; enlargement of the spleen, and of the thymus gland. This last is very remarkable. Accordng to Bovaird and Nicoll, as quoted by Holt, the weight of the normal thymus at birth is from 6 to 7 grams; from birth to five years from 3 to 4 grams, and anything over 10 grams should be considered as distinctly abnormal. In marked cases of the status lymphaticus the thymus weighs from 30 to 40 grams; in the less marked, from 10 to 20 grams. It shows no other change than hyperplasia. Some observers have found also hypoplasia of the heart and aorta; but whether this is a coincidence or bears any relation to the lymphatic state is not clear. (22)

Symptoms.—In some cases nothing of the kind is suspected

as being present, until some trivial operation such as paracentesis thoracis or the administration of antitoxin or of chloroform is undertaken, when the child promptly dies. In other cases symptoms appear like the onset of an acute illness—with convulsions as a prominent feature, or it may be dyspnea with cyanosis or asphyxia, with high fever, and death in a day or two without the development of any recognizable disease aside from the status lymphaticus. Or the disease may be recognized in life by the tendency to convulsions, the dyspneic attacks, the lymphatic hyperplasia, enlarged spleen and thymus gland, which latter may sometimes be so large as to cause substernal dullness.

It is not known whether the dyspnea is due to pressure of the large thymus upon the recurrent laryngeal nerve, or upon the trachea or the lungs, or the auricles of the heart; or whether death occurs from pressure on the pneumogastric or the heart or aorta. It has been demonstrated in at least one case that a hypertrophic thymus can compress the trachea and cause mechanical stenosis. (Jackson.) In other cases there are no characteristic symptoms in the fatal illness, but the child shows but feeble resistance to an apparently trifling ailment and soon succumbs, and the findings at the autopsy are those of the status lymphaticus. (See also section on Thymic Tracheostenosis.)

Diagnosis.—If the disease is sufficiently well marked for diagnosis it can be recognized by the symptoms just described. The greatest importance to the surgeon in its diagnosis is to avoid anesthesia or operation or any possible cause of shock in a child of this type, unless the condition is such as to justify far more than the ordinary risks attendant upon such procedures. (23)

Treatment.—The dyspnea may apparently call for intubation or tracheotomy, but these operations do not give relief. There have been a few cases operated upon, opening the chest by raising a portion of the sternum, attaching the thymus thereto, and so relieving the pressure of the weight of the organ and the intra-thoracic pressure. The general treatment is by fresh air, sunlight, nutritious food, cod-liver oil and iodides, especially the syrup of ferrous iodide.

HYPERPLASIA OF THE LYMPH TISSUES OF THE PHARYNX AND NASOPHARYNX

These will be discussed in the chapter on Surgery of the Air Passages.

PRIMARY AND SECONDARY TUMORS OF THE LYMPH VESSELS AND OF THE LYMPH GLANDS

These are considered in the chapter on Tumors, in the sections on Lymphoma, Lymphangioma and Carcinoma. The differential diagnosis from adenitis will appear in the present chapter in the

section on Tubercular Lymphadenitis. Primary Sarcoma will be considered here.

Primary Sarcoma of the lymphatic glands is rare. It is an elastic swelling, perfectly smooth and movable as long as the capsule of the affected gland remains intact. The glands adjacent to the first one become involved, and, later, the cells of the sarcoma migrating in the lymph current, general infection takes place and metastatic tumors, with the same small round cells in a very fine lattice stroma, appear in various regions. The primary tumor escapes from the gland capsule and involves the periglandular tissue and finally the skin and ulcerates and sloughs.

Lymphosarcoma is differentiated from Hodgkin's disease by the absence of general lymph hyperplasia in all parts of the body, including enlargement of the liver and spleen, and absence of the anemia; from leukemia by absence of the blood picture characteristic of the latter disease; from tubercular glands by the rapid growth of the sarcoma.

Treatment is by extirpation, and even this gives a grave prognosis, as recurrence is the rule, unless the operation is done early, while the growth is still within the capsule of the gland. Senn makes it particularly emphatic that sarcomatous glands should never be enucleated even if the capsules have not been perforated by the growth; as sarcoma cells have undoubtedly already passed out into the surrounding connective tissue. Therefore the connective tissue, as well as the glands, should be excised. No blunt dissection should be used, and not only glands and connective tissues, but even arterial and nerve trunks and every structure implicated in the growth, should be removed. (See also general Section on Sarcoma in Chapter on Tumors.)

LYMPHANGIECTASIS, LYMPHADENOMA AND LYMPH VARIX

Lymphangiectasis is a condition of local dilatation of the lymph vessels due to damming their flow. The obstruction may be due to inflammation affecting the vessels themselves or to pressure from an outside source, such as a tumor—primary or secondary, ascites, a ligature or surgical appliance, or to scar tissue.

Lymphangiectasis, or, as it is sometimes called when affecting the glands, lymphadenoma, may be parasitic in origin, being most frequently due to the presence of the filaria sanguinis hominis, a minute nematode worm native in the tropics, which lives in the lymphatics and blood-vessels. Elephantiasis is a form of the disease.

Lymph varix is a dilated tortuous lymphatic vessel resulting from any occlusion, mechanical or parasitic.

SIMPLE ACUTE LYMPHADENITIS

This is an acute inflammation of the lymph-nodes which terminates in resolution, in suppuration, or in chronic inflammation, according to the age of the patient, his vital resistance and the nature of the infecting agent.

The external nodes of the cervical region, axilla and groin are the ones with which the surgeon most frequently has to deal in acute inflammation. This occurs from simple catarrhs of the mucous membranes, in connection with measles, German measles, scarlet fever, diphtheria, in any form of stomatitis producing a solution of continuity, in tonsilitis, in connection with carious teeth, herpes, ecthyma, eczema, wounds, otorrhœa. In the axillary glands it is often produced from slight trauma upon hand or arm or from vaccination; in the inguinal region from wounds of the lower extremity, balanitis or vaginitis. In some of these inflammations, no doubt, the irritation is produced by the absorption of toxins which are carried to the gland, while in others the germs themselves, possibly the specific organism of the infective fevers, but usually staphylococci or streptococci, are lodged there. The affected glands become acutely congested and swollen, hyperplastic, edematous, and the result will depend on the nature of the irritant and the resisting power of the cells.

In infants such inflammations more frequently result in suppuration than in older children. But at any age the presence of pyogenic organisms, especially a mixed infection or the scarlet fever poison, may overpower the resistance of the cells and abscess will result.

Quite frequently one can discover by searching the field drained by the affected gland or group of glands the atrium of infection. But sometimes the primary disease or lesion has passed by and left only the lymphatic inflammation as a sequela. The symptoms are those of the original disease, and of swelling and tenderness over the inflamed glands. If the inflammation is not very severe or advanced, the gland, although large, perhaps as large as a filbert or an olive, is quite movable. But if the inflammation become so severe that suppuration threatens, the periglandular cellular tissues are involved, and gland and cellular tissues become a brawny mass, tenderness increases, with heat and pain, finally fluctuation, and if left to itself redness and breaking down of the skin, discharge of pus and later healing. Redness may be present before fluctuation in the dense mass can be detected, and the whole process may require two to four weeks before the abscess has discharged or suppurated ready to be opened. Sometimes the inflammation is communicated from gland to gland and the process greatly extended in area and

prolonged in time. It sometimes appears as though the cases which do not suppurate take as long to recover as those in which suppuration occurs, and even then their state of health may not be quite satisfactory.

Treatment includes that of the field of absorption, which should be cleansed and rendered sound as speedily as possible to avoid further poisoning of the lymphatics. For the swollen glands themselves many applications are recommended. None of them seem to have the power of preventing suppuration if it is ready to occur, but treatment may moderate the inflammation and mitigate the discomfort, and if it cannot abort may hasten the process to a favorable termination. Cold in the form of an ice bag is useful in sthenic cases, that is, in fairly robust children with high fever and considerable reactive power, and especially early in the case before suppuration becomes inevitable. Heat is better in the opposite class of cases, the feeble children of low vitality, and in all cases in the later stages. The drug applications one sees recommended are iodine, in the form of the tincture painted on, or of the ointment of the iodide of lead, the unguentum Crede, etc. I have seen as good effects from the use of guiacol, 10 to 25 per cent., with lanolin and lard, or of mercurial ointment, as from any other application, and think these have some power to limit the spread into cellular tissues. But my rule is never to apply anything which makes the skin sore or will interfere with its proper examination or incision at the proper stage. The proper stage for incision is not until suppuration has occurred and the abscess has pointed. The early incision of these inflamed glands can do no good and may do harm and does not hasten the cure. The only condition at all similar in which early incision is useful is Ludwig's angina—a diffuse septic cellulitis (which see). In lymphadenitis the disease process is being limited by nature's barriers. And to excise early an inflamed gland, while it might eliminate the trouble, is not devoid of danger, and may fail to eradicate the disease which probably has already found its way to other glands. When the abscess has formed, before waiting for destruction of the skin, an incision should be made. General anesthesia is not usually necessary for the opening of such an abscess. The ethylchloride spray locally is sufficient. That point should be chosen for the incision which, while it will enter the abscess directly and afford the best drainage, will be the least conspicuous. The situation of the abscess, of course, may vary, but a frequent site is in the sub-parotid lymphatics, and the abscess points at that level, but behind the sterno-mastoid. It may burrow under that muscle, especially if allowed to wait too long, and point in front of it but lower down. The posterior situation is usually the better situation for opening. The incision should be made in the

direction of the skin-folds, which in that situation run obliquely upward and backward. In opening a submaxillary abscess one should avoid the facial artery, and also avoid the inframaxillary branch of the cervicofacial nerve, by keeping a finger-breadth below and parallel with the ramus of the jaw. The abscess being emptied, it is not necessary nor always safe to curette it. A small drain of catgut should be introduced, and moist dressing used to facilitate drainage. Healing is usually prompt and the scar insignificant.

Many surgeons are now treating adenitis with suction hyperemia by means of cupping glasses. (Bier-Klapp method.) If pus is present it is evacuated through a small incision (1 to 1.5 c. m.) and suction applied. If abscess has not formed the cup is applied at once, and suction made strongly enough to induce a red, not a blue, swelling and to cause no pain, the cup being left on five minutes. The cup is then removed and after an interval of three minutes is again applied as before during five minutes. This alternate suction of five minutes and rest of three minutes is continued for twenty to forty-five minutes daily. No drainage is used. Cures are noted in seven to ten days, without scar, in cases which in the judgment of the surgeon would have persisted two or three times as long and caused much pain, extension of the inflammation and destruction of tissue if left untreated or treated by other methods.

ACUTE SEPTIC LYMPHADENITIS

This will be found described in the Section on Cellulitis in an earlier chapter.

SIMPLE CHRONIC OR SUBACUTE LYMPHADENITIS

This is a simple hyperplasia of the lymphatic glands, excited in the same manner as the acute form, and kept up by the continuous irritation of a chronic disease of mucous membrane or skin, or by some constitutional dyscrasia, often that which is called struma yet is not tuberculosis, or is sometimes called lymphatism. The cervical glands again are the ones most often involved, especially in the cases with post-nasal lymph growths and enlarged tonsils. There is no fever nor pain nor tenderness. The swelling increases slowly during several weeks or months. The enlarged glands are movable and feel elastic, almost resembling fluctuation. They do not suppurate nor mat together nor implicate the skin, nor caseate. After weeks or months they slowly subside to the size of navy beans or split peas.

Diagnosis.—The diagnosis of this condition is a matter of some importance on account of its resemblance to tubercular adenitis. It may be impossible to distinguish between the two without a tuberculin test. Yet if one can get a reliable history or keep the patient

under observation long enough a diagnosis can usually be made. In the simple form one can generally find an exciting cause either past or present; and treatment directed toward that cause, for instance, removal of adenoids or tonsils, or constitutional treatment for lymphatism, makes an impression on the enlarged glands. Although the glands enlarge slowly, the process is not as slow as that which occurs in the tubercular form, unless the latter be a mixed infection. The simple subacute form shows no tendency to suppurate unless lighted up by a re-infection rendering it acute. The glands do not adhere to each other and to the cellular tissues nor to the skin.

Treatment.—Removal of local exciting causes and the same hygienic management as that recommended for lymphatism or struma; open air, sunlight, warm clothing, nutritious food, active excretions, often if possible a change to the seaside, the country or the mountains. Among drugs there is nothing better than the syrup of ferrous iodide, and cod-liver oil. In dispensary practice a mixture of these two, with syrup of the lacto-phosphate of lime, shaken together, makes a very inelegant but efficient preparation. No operation upon the nodes is called for. There may be something to do in the naso-pharynx, the mouth, Eustachian tube or middle ear.

TUBERCULAR LYMPHADENITIS

This is the principal feature of what was formerly called scrofula and later struma, but is now named in accordance with its cause, the tubercle bacillus. Lymphadenitis may be present in conjunction with other manifestations of the infection or it may be the only one. While any of the lymphatics may be the seat of tuberculosis it is only those of the neck, the axilla, groin and abdomen that concern us surgically. Of these the cervical by far the most frequently need attention. The periods of childhood and youth present the most cases, infants seldom showing tuberculosis in this form, although they frequently have mesenteric or bronchial tubercular lymphadenitis, especially the latter. The frequency with which the cervical lymph-nodes are involved is accounted for by their proximity to the oro-naso-pharynx and accessory cavities, which form the gateway for the entrance of the germs; and the age at which these glands are most frequently attacked by tuberculosis is just the age at which the mucous linings of those tracts are most frequently in a state of catarrhal inflammation, and they, as well as the lymphatics, most frequently irritated by the poisons of the exanthemata and other infections. In the case of the mesenteric lymph-nodes there has almost invariably been previously an ulceration of the mucous lining of the intestines. As to the order of involvement, Holt quotes Nicoll's statement that the first affected are most frequently the upper set of the deep cervical group; sometimes the

superficial nodes of the submaxillary, or the parotid group, and occasionally the submental of the preauricular. One's own observation would lead to the belief that the subparotids are probably the most often affected in the beginning, judging by their showing the most advanced changes.

Pathology.—There is usually if not invariably more than one gland involved, and quite frequently it is a group or a complete chain, the disease gradually extending. Since lymphadenitis, which finally proves to be tubercular, so often follows subacute or chronic lymphadenitis, the question arises whether such cases were originally tubercular. Doubtless many cases begin with the tubercular infection, and many pursue a very chronic course, with no tendency to cheesy degeneration, and then later show more of the characteristics of tubercular inflammation. But there is nothing to prove that a simple chronic inflammation may not have preceded a tubercular involvement. It is also true that nodes, the seat of either simple chronic hyperplasia or of tuberculosis, may take on an acute inflammation and change their slow course to the rapid formation of abscess. It should be stated, however, that experiments have proved that sometimes chronically enlarged nodes, like the melon seed bodies in synovitis, which do not betray tuberculosis to the microscope, produce the disease by inoculation into guinea-pigs. The bacilli can generally be found in the early and active stages of the inflammatory process. When the stage of complete softening has been reached the abscess contents may be quite sterile.

Tuberculous nodes enlarge to the size of birdshot or peas or beans, or even of olives or hickory nuts. It is usual to find one or two quite larger than all the rest. Dowd [1] gives a good description of the appearances on section of these enlarged nodes. First, those showing soft pinkish gray surfaces of almost uniform consistency, but with the trabeculæ of the nodes faintly marked. This variety appears early in the inflammation, and may be not a separate variety but rather a stage which will, after a shorter or longer time, merge into the second variety, which shows spots of necrosis of greater or less extent, the tissue surrounding the spots being similar to that of the first variety. This second or necrotic variety is by far the most common. The third variety of node shows the interior entirely broken down into granular grayish material which is retained by the capsule of the node. This is regarded as an uncommon variety. In the single case observed each node capsule was filled with material which looked like caked meal, no proper node-parenchyma being apparent. The microscope showed this soft material to be studded with tubercle. The changes which take place in the glands, as recorded by many observers, resemble those usual in tubercular inflammations

[1] Bryant and Buck, American Practice of Surgery, Vol. II., p. 545.

elsewhere, namely, the proliferation of the epithelioid and the giant cells, the surrounding zone infiltrated with round cells, and the cheesy degeneration beginning at the center of the focus. There may be a single focus in a node or numerous foci which in the destructive process coalesce, producing an abscess cavity. The content of tubercular abscess in glands as in other tissues is not true pus. Unless there is a mixed infection, it contains no pus, but the softened material of the broken-down node. As the inflammation approaches the gland capsule the periglandular structures become involved, neighboring glands, the sheaths of vessels and nerves, the intermuscular fasciæ, cellular tissue, or skin, become matted together in an irregular mass in which the softening glands are embedded. When the capsule opens, the "pus" escapes, and if not immediately beneath the skin it burrows in the cellular tissues until it finds the surface. The skin becomes livid or deep red, softens and breaks down. The abscess discharges, and sometimes continues discharging for weeks or months, closing temporarily and reopening. The edges of the opening are bluish red, and undermined. If the abscess has healed there is left a puckered and unsightly scar, adherent and contracted, with pits and ridges, and a purple discoloration which may in time fade out. In some cases the tubercular process in the glands is one of fibrosis. The glands become hard fibrous masses, containing encapsulated caseous or calcareous masses. Whole groups or chains of such dense and knotted glands may remain quiescent. In a given case not all the affected glands undergo the same process simultaneously. The different glands may be found in various stages. And the character and rate of progress and termination of the disease will vary with the vitality, the resisting power of the patient, the effect of other local irritations or infections and of intercurrent diseases, and doubtless with the virulence of the original infection. In short, the history of tubercular inflammation in the lymphatic glands is similar to that of the lungs and other tissues of like vascularity; it may end in resolution, encapsulation, calcification or suppuration. It usually presents coagulation necrosis, caseation, and liquefaction of the cheesy product. Other tubercular lesions may be found in the same patient; or if the lymphatic infection was primary it may run its course as a local disease, and terminate without extending to any other part or organ.

Symptoms and Diagnosis.—Gradual swelling, slowly but persistently increasing, is the only symptom of the beginning. Tenderness may be absent unless there is an exacerbation due to some intercurrent irritation of another kind. The swelling continues for several months, appearing behind or in front of the sterno-mastoid muscle about or a little above its middle. One or several glands may

be palpated as cherry or olive-sized movable tumors elastic or firmer in different cases. If a gland is destined to suppurate, the periglandular inflammation and adhesions form, more extensively in the deeper glands than in the superficial. These soon implicate the skin, and discharge. In time the affected glands mat together and become indistinguishable individually in the irregular swelling, and one after another they discharge, often through different openings. These openings continue to discharge for weeks or months. The presence of an open sinus with a swollen mass immediately beneath it is no proof that it may not lead to an abscess in glands beneath the deep fascia. The inflammation may at no time be very painful or tender excepting during exacerbations or the tension of abscess formation. The general health may be affected very little if any, when the disease remains local.

Childhood and youth are the periods afflicted with gland tuberculosis. It is seldom met in an active state during infancy or after puberty. The indolent swelling without apparent cause, and, if it occurs, the caseation and suppuration are characteristic. If suppuration does not take place the condition much resembles simple chronic adenitis. That, however, is more common before the third year, and although chronic or subacute, its progress is usually more rapid than the tubercular form. In case of doubt it is permissible to use the tuberculin test, by the conjunctival, the cutaneous or the subcutaneous method; or to excise a gland for examination. The possibility of syphilis should be borne in mind and an initial lesion searched for about mouth or throat; or other evidence of the disease may be found in the form of skin eruptions; general enlargement of the lymph-nodes; or in the history, or by examination of the blood.

Lymphangioma is usually though not always congenital. If it grows at all it usually grows rapidly. It has no limiting capsule, is softer, not at all tender unless inflamed, which is rare; and it presents none of that firm distinct nodulation found in lymphadenitis before suppuration.

Sarcoma may successfully invade several glands, but its growth is rapid. Sarcoma, unless removed, would probably reach a fatal termination in a few months.

Carcinoma of glands is always secondary and is very unusual in childhood.

In leukemia the hyperplasia is general, has no inflammatory symptoms, and presents the blood findings of that disease.

In pseudo-leukemia, better called Hodgkin's disease, although the swelling often begins in one gland or group of glands, it soon becomes general. The glands most affected attain large size without

tendency to suppurate or to inflame; and they remain elastic and movable.

Lymphoma is rare at any age, and belongs more to young adult life than to childhood. Lymphoma may affect more than one gland, but if so they are all affected equally from the first and grow at the same rate. There is no extension to other glands. It is movable, has no inflammatory tenderness. It has no adhesions, which is evidence that it does not extend beyond its own capsule.

Prognosis.—Dowd reported a collection of 309 cases treated by operation. Of these 65.4 per cent. were apparently cured when seen several years after operation; 18.4 per cent. were living, but presented evidence of tuberculosis, either local or general; 16.2 per cent. died of tuberculosis. The same writer quotes Fisher's table of 1273 cases, which showed 57.65 per cent. cures, and 21.84 per cent. of local recurrences, while 13.5 per cent. died, almost entirely from tuberculosis. These are but fair presentations of the general belief of the profession, that although cases of tubercular lymphadenitis, even without operation, do occasionally get well, the disease is quite serious and one should make a guarded prognosis.

Treatment.—The treatment is general and local. The general treatment will be found in the general Section on Tuberculosis in a previous chapter.

In the local treatment attention should first be directed to possible sources of infection and gates of entrance and the introduction of more of the bacilli prevented if possible. It is to be remembered that whatever irritates the glands renders them more vulnerable to infection and less able to cope with it, and that an unhealthy condition of mucous membrane or skin in the field drained into the gland is an open gateway. Any unhealthy condition of the oro-naso-pharynx, ears or scalp should be corrected; enlarged tonsils, adenoids, carious teeth, polypi, hypertrophied turbinated bones removed; catarrhs cured; disease of the eyes, of the Eustachian canals and middle ears or mastoids treated; and the scalp put in a healthy condition. As to the local application to the skin over the glands, one does not know that any of them accomplish any effect upon the tubercular process. Some of them have an influence upon other infections which sometimes complicate the tubercular disease, and one has used ointments of guiacol, of iodide of lead, and of mercury in some cases with apparent benefit. But it certainly is not advisable to apply anything that irritates or excoriates the skin. If the attention of parents and physicians could be directed away from local applications over the glands to the care of the ears, nose and throat much more good would be accomplished.

Of the treatment by injecting the glands with iodine, carbolic

acid, iodoform emulsion, acetic acid, and the like, I have no experience. Chloride of zinc I have tried and discontinued, and have seen sodium cacodylate used with temporary benefit. There is danger that attention to such treatment, even if harmless, will lead to neglect of really valuable general treatment, and to delay of radical operation until the most favorable time is past. Curetting is done by some, but it appears to me an unsurgical procedure in this ana-

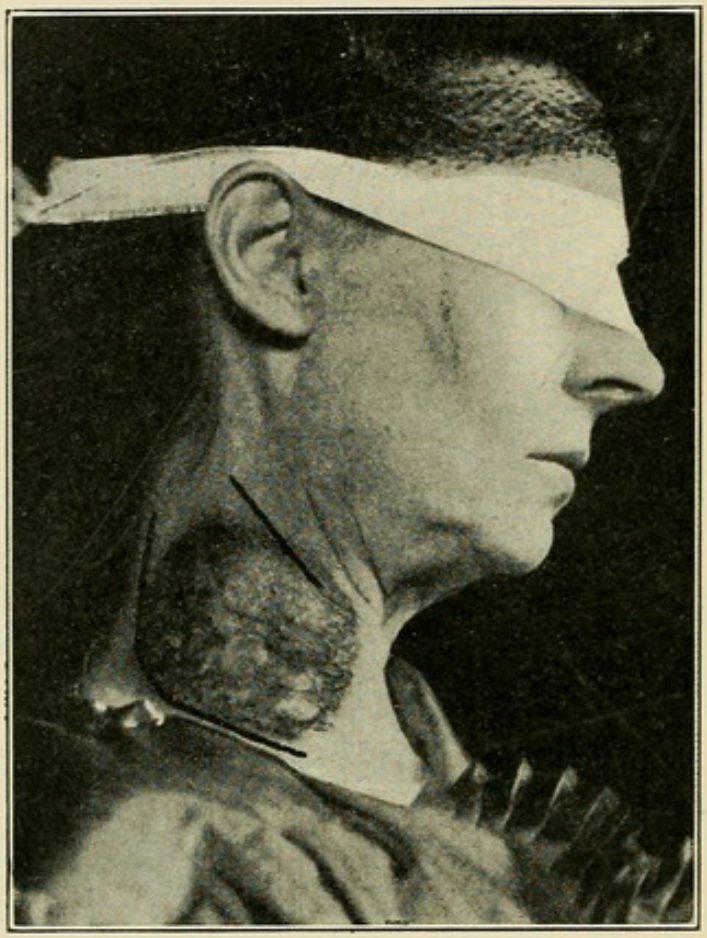


FIG. 121. SHOWING THE NATURAL CREASES OF THE SKIN UPON THE NECK; and lines of incision which will leave least conspicuous scar.

tomic region and with this disease, and unsafe both on account of favoring absorption of germs and general infection, and of possible injury to important structures. The general, and one would think sensible, opinion at present in this as in other forms of surgical tuberculosis is to avoid half-way measures, but if some operation must be done it should be clean and complete. If the constitutional treatment does not avail, but the glandular swelling continues to increase month after month, or if it tends to suppurate, or the separate glands to adhere together, operation should be advised and performed before extensive adhesions have formed and the peri-

glandular tissues become inflamed. An operation can be done, even after matting of the tissues, and in the presence of suppuration and sinuses, but it is far more difficult and dangerous, and causes a more extensive wound and more scarring than if done earlier. If done at the proper time there is more likelihood that the disease can be completely eradicated; it is a much easier and safer operation, and the comparatively small smooth scar or scars bear no resemblance to those resulting after no operation.

If the affected glands be deeply situated the operation involves a nice dissection and the surgeon should be familiar with the anatomy of the triangles of the neck. External appearances are often very deceptive in these cases; and a very innocent-looking sinus or apparently superficial gland may lead to another and another deeper and deeper and farther and farther until an entire chain of a dozen or more glands are removed, and one has been led into very interesting proximity to the arteries, veins and nerves that traverse this region. The incision should be large enough, for here, if anywhere, one should not cut where he cannot see. Scarring is to be avoided by the direction of the incision, by avoiding the tearing of tissues, by nice coaptation when it comes to suturing the wound, and by every effort to secure union by first intention. A careful dissection also avoids shock, and protects against spread of infection by the accidental opening of an infected gland. In selecting the line of incision one should avail himself of the studies of Langer and Kocher in following the natural cleavage lines of the skin. In the neck these run transversely, or obliquely, inclining backward and upward. If the incision is made in this direction the scar will not stretch; whereas, with a longitudinal incision across the tension of the skin, the wound tends to pull open and the resulting scar to stretch. This widening of the longitudinal scar, however, may be prevented, as Mayo has shown, by careful suturing of the fascia. Fig. 121 shows a case of enlarged glands in an adult, stained with iodine, selected for this illustration because the skin creases show better than in the child. The heavy line above indicates an incision which usually gives access to the ordinary case where the upper end of the chain of glands is implicated. If necessary to go after the submaxillary nodes also, the incision could be made higher, prolonged forward, keeping at least a finger breadth below the jaw to avoid the inframaxillary branch of the cervico-facial nerve. The line below is a good incision for the lower end of the chain, and this line can be prolonged at the back of the neck, if necessary. But where the whole chain is involved, as in the case here illustrated, the readiest access could be obtained by an incision just posterior or in some cases anterior to the sterno-mastoid and parallel to it. If necessary this can be prolonged by a transverse incision extending either for-

ward or backward at its base along the clavicle. By firmly uniting the fascia in closing the incision the stretching of the scar can to a great degree be avoided. The eleventh or spinal accessory nerve must be spared if possible, as it innervates the sterno-mastoid and the trapezius, and its division produces paralysis and atrophy of those muscles, one or both, and drooping of the shoulder. The phrenic and the hypoglossal may be injured, but are more easily avoided. It may be necessary to divide the sterno-mastoid muscle. If possible, this should and ordinarily can be avoided. If cut, the section should be made either above the approach or below the exit of the spinal accessory nerve. Before closing the wound the severed ends of the muscle should be reunited. Sharp dissection should be employed as much as possible; and the blunt dissector only used when tissues separate readily without tearing or dragging. Bleeding points should be promptly arrested with pressure forceps and the wound kept dry. The glands should not be seized with a volsellum, as puncture and leakage of infective material is probable. All sinuses should be followed to their termini and all diseased tissue, whether glandular or abscess walls in cellular tissue, should be removed. All diseased skin should be trimmed off, and sometimes in long-standing cases old scars can also be removed. If the entire chain is to be excised, it is usually best to begin below and work upward. On closing, drainage is necessary, as there is more than the usual discharge from a wound of this size owing to lymphorrhea from the cut lymphatic vessels, or to the interference with these absorbent channels. A strand of catgut or silkworm gut makes the best drain, coming out at the lower or back part of the wound, or through a counter-opening below the collar line. Muscle or fascia is closed with catgut; the skin usually with silkworm gut. Some use catgut subcutaneously. English surgeons often use horsehair. One has usually used subcutaneous sutures of catgut with the greatest satisfaction and almost no scar. Ample moist dressings should be used, and changed at least daily for several days, oftener if soiled, or if dried. It is well to steady the child's head with sandbags for a few days.

Dowd [1] gives an instructive showing of results of his own cases in which adults and children are compared in percentages.

Over 20 years of age, 14 cases—

Apparently cured	57.2
Filbert-sized nodes, diagnosis doubtful	7.1
Recurrent nodes	21.3
Phthisis	7.1
Tuberculosis of cranium	7.1

[1] Am. Pract. Surgery, Bryant and Buck.

Under 20 years of age, 68 cases—

Apparently cured	77.9
Filbert-sized nodes, diagnosis doubtful	4.4
Apparently well now, but have had recent operations	8.8
Recurrent nodes	1.5
Neck well, tubercular coxitis	1.5
Lupus	1.5
Died from tuberculosis of the spine	1.5

SYPHILITIC LYMPHADENITIS

Syphilitic lymphadenitis is rarely met in children and yet it should be borne in mind as a possibility. The field drained by the swollen gland should be searched for a not impossible initial lesion. Or it may be a case of lues hereditaria tarda, and Hutchinson's teeth, deafness without otorrhea, interstitial keratitis, or periostitis, or flattened nose, or the scars of rhagades may be in evidence. The history may throw some light upon the diagnosis; or failing in finding anything else decisive the suspicion may be confirmed or dissipated by the blood test or the therapeutic test.

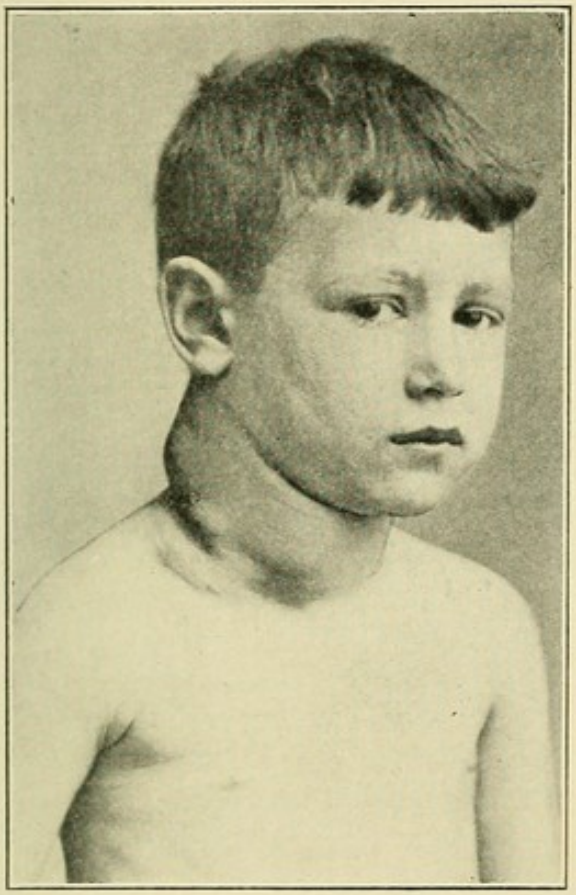


FIG. 122. HODGKIN'S DISEASE. The affected glands in the neck were removed but the disease subsequently manifested itself in the axillary glands, as seen in Fig. 123.

HODGKIN'S DISEASE

Hodgkin's Disease (*Pseudo-leukemia, Soft Lymphadenoma, Lympho-sarcoma, Lymphatic anemia, Lymphadenoma, Adénie*).—This is a rare disease in infancy or childhood. The term Hodgkin's disease, as Cotton remarks, is preferable to any of the numerous names that have been proposed as substitutes, because it is not misleading in regard to its etiology or pathology. Its etiology has not yet been determined, but its behavior leads to the belief that it is due to an infection. It is characterized by simple hyperplasia

of the lymphatic glands and the appearance of lymphoid growths in the enlarged liver and spleen, and in nearly every organ but the brain and spinal cord. The enlargement of the lymph-nodes is often first noticed upon the neck, larger upon one side, and later in the axillæ and groins, or nearly all the glands in the body. (See Figs. 122 and 123.) Of the internal glands those in the mediastinum and retroperitoneum are most affected. The nodes which first begin enlarging generally attain the greatest size, being as large as walnuts or eggs. They are soft but not fluctuating, sometimes firmer; freely movable early in the case, later being more in mass and attached to the skin, but not implicating it. They grow slowly but steadily, though sometimes stopping or receding temporarily under treatment, then increasing again. They are painless and not discolored. They often cause such symptoms as cerebral congestion, dyspnea, cough and dysphagia from pressure of either the cervical or the internal growths.

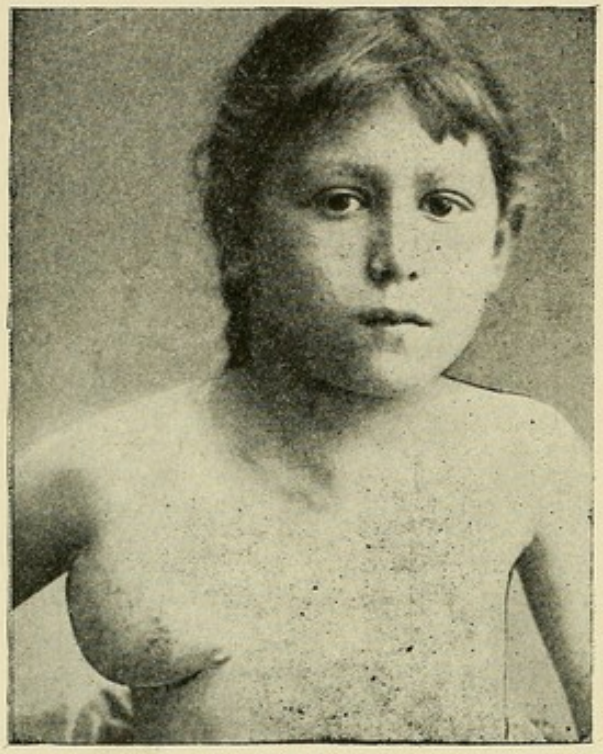


FIG. 123. HODGKIN'S DISEASE. Same case as shown in Fig. 122. The glands of the neck were removed by the author, but later those in the axilla enlarged. The case was lost sight of.

Symptoms. — The most marked general symptom is anemia. The changes in the blood are not characteristic. They are not those found in leukemia, which in some of its features the disease resembles. The number of white cells is usually thought not invariably below normal; the lymphocytes by relative count are increased; no increase in the neutrophiles; reduction in the number of the red cells and marked reduction in hemoglobin.

Diagnosis.—The diagnosis is made from the general enlargement of the glands, with anemia, in the absence of leukemia.

Treatment.—There is no treatment that has a permanent effect on all cases. Arsenic does exert a considerable control over many cases. It must be used in full doses and persistently. Cures by arsenic have been reported. The X-ray has a marked influence, though probably in the average less permanent than arsenic.

CHAPTER XIII

THE HEAD AND BRAIN

ANOMALIES AND DEFORMITIES OF THE SKULL—CONGENITAL CRANIAL MENINGOCELE AND ENCEPHALOCELE—FRACTURES OF THE SKULL—TRAUMATIC CRANIAL MENINGOCELE OR TRAUMATIC CEPHALHYDROCELE—PNEUMATOCELE CRANII—CEPHALHEMATOMA — MICROCEPHALUS — HYDROCEPHALUS — LUMBAR PUNCTURE—TAPPING THE VENTRICLE AND PERMANENT EXTERNAL DRAINAGE — INTRACRANIAL TUMORS — CRANIO-CEREBRAL TOPOGRAPHY—OPERATIONS UPON THE CRANIUM.

ANOMALIES AND DEFORMITIES OF THE SKULL

The pediatric surgeon should have a knowledge of the structural peculiarities of the head of the infant and child. This knowledge should include not only normal conditions, and the changes incident to and subsequent to birth,[1] but certain anomalies and deformities, not all of which are amenable to surgical treatment, but should be recognized and understood in diagnosis and prognosis. Plagiocephaly (asymmetrical skull), acrocephaly, pyrgocephaly (pointed, tower-shaped skull), and microcephaly, may be detected on sight, and their associated deformities and defects sought.[2]

Asymmetry may result from one-sided pressure *in utero,* constant lying on one side, defect of one hemisphere, birth injuries, premature unilateral closure of sutures (?); brain tumors, atrophy of brain; unilateral atrophy of face, torticollis; and it is frequently associated with epilepsy, rachitis and infantile cerebral palsies.

Acrocephaly is regarded as a stigma of degeneration, or possibly as a result of adenoid vegetations; and is associated with idiocy, exophthalmos, prognathos, and atrophy of optic nerves. In microcephaly the skull is small in all dimensions, with flattened forehead and occiput, protruding lower jaw, and projecting ears. It is a mark of degeneration and hypoplasia, or results from fetal disease of brain, and constitutes a type of idiocy. See section in this chapter.

[1] See Ballantyne, "Introduction to Disease of Infancy," chap. II.
[2] See Pflaundler and Schlossman, vol. I, p. 34.

Under macrocephaly may be grouped three widely different conditions having in common this one feature, the large head. Hypertrophia cerebri, which is uncommon, presents a protruding forehead and occiput, with fontanelle neither bulging nor tense; and is accompanied by severe cerebral symptoms. Hydrocephalus will be described in a separate section in this chapter. Rachitic deformity is very commonly met. For description see page 103.

The natiform skull, sometimes called the cross-shaped head or saddle-head, or bossed head, has all the tuberosities prominent with the region of the lambdoid suture depressed. This deformity is common to both hereditary lues and rickets; but the rachitic form does not present until the second year or during the second six months at the earliest, and has soft bones and a large fontanelle; while the syphilitic deformity has a small fontanelle and firmer bones, excepting in cranio-tabes, which either may have. (See pages 118, 213). Cranio-tabes may also be due to osteo-genesis imperfecta or to obstetric injury. See also Appendix (56).

CONGENITAL CRANIAL MENINGOCELE AND ENCEPHALOCELE

"MENINGOCELE is the protrusion of some part of the membranes of the brain through a gap in the skull, the result of imperfect ossification." In other words, it is a hernia of the meninges, its cavity being continuous with the subarachnoid space, covered with the dura, and with the scalp, or skin, or mucous membrane, according to the site of the hernia. The covering of the hernia may be attenuated and consist of the dura only. The protrusion is present at birth. It is most common in the occipital region, the gap being in the supra-occipital bone between its centers of ossification. Or it may protrude between the frontal and nasal bones and appear at the root of the nose, either in the middle line or in an angle of one of the orbits; or in the spheno-ethmoidal region causing a hernia projecting into the nasal fossa or the pharynx. It may come between the parietal bones or escape by way of the foramen magnum. (See Section on Congenital Tumors of the Spinal and Sacral Regions). It may be of the size of a cherry or of a nut, or it may be nearly or quite as large as the infant's head. The tumor usually contains cerebro-spinal fluid. In some cases a portion of brain is also contained in the sac, in which variety it is called encephalocele. When there is fluid between the membranes and the protruding brain substance it is termed hydro-encephalo-meningocele. Often the condition is associated with, and perhaps results from, internal hydrocephalus, and the protruding portion of brain contains a fluid-distended cavity or cavities connected with one or both lateral ventricles—hydrencephalocele.

The coverings may be thick or very thin, may be lax or dis-

tended as if ready to burst, and become more tense when the child cries. The tumor may appear translucent, in which case the contents are fluid; or opaque, when it contains brain substance. The fluid contents of the protrusion may be partly or entirely reduced into the cranium.

The swelling may increase and rupture, or ulceration may take place, leading to escape of the fluid. In either case, if the child does not die in convulsions, meningitis is likely to ensue and prove fatal. Occasionally spontaneous cure has resulted after rupture. In some cases without rupture the sac may shrink and shrivel; or ossification may close the opening in the skull.

Diagnosis.—In some instances the diagnosis is quite easy, the margins of the cranial opening and the sac containing fluid being quite characteristic. A small semi-solid or compressible meningocele may be mistaken for a nevus. Nevus, however, is usually discolored. Or it may be considered a dermoid cyst, especially if located about the orbit—a favorite situation for small dermoids. But the dermoid is not compressible. Meningocele bears some resemblance to cephalhematoma. But the latter, if subperiosteal, occupies the situation and takes the shape of the bone upon which it occurs, or if sub-aponeurotic it is more diffuse; and in either form more flattened, with no tendency to pedunculation, and impossible of reduction.

There is some resemblance to pneumatocele cranii. But that is situated over the temporal bone, where one does not look for meningocele, and contains air instead of fluid. There is also a traumatic form of cranial meningocele, or cephalhydrocele, which will be described in another section.

Treatment.—Unless the tumor is very tense and at the same time thin-walled, it is best merely to protect and keep it under observation for a time to see whether it tends to decrease or to enlarge. If the opacity and perhaps the " feel " of the tumor make it apparent that it contains a portion of the brain, active interference is contraindicated, unless the tumor is not too large and is stationary. If hydrocephalus is present with a continuous increase of fluid, operation will prove futile. If the opening in the skull is not too large, in other words, if the tumor is somewhat pedunculated and its coverings sufficiently thick and healthy to produce flaps, ablation of the protrusion may be attempted, any projecting portion of the brain being removed. An attempt should first be made to reduce the amount of fluid in the sac. Sudden opening and emptying of a tense sac may lead to convulsions and death at once. Even aspiration will sometimes cause convulsions, and may, of course, but should not if done under precautions, cause meningitis. Pressure has been advised for reducing the size of the sac. But pressure alone only

forces the fluid into the skull, and may give rise to symptoms of intracranial tension. I have found that the use of glycerine, applied upon a saturated compress over the tumor and held in place by an elastic bandage, will, by exosmosis, abstract some of the fluid and shrivel the sac without perforating it. Those thin-walled, distended sacs, threatening to burst, become thicker under the use of glycerine. Later, then, if the conditions warrant, with less tension and a smaller and flaccid sac, excision may be done. In those cases in which by later ossification the opening in the skull has closed and cut off the meningocele from the cranial cavity, there need be no hesitation about its removal.

If removal is attempted, the operation is much the same as that for spina bifida without osteoplasty. The skin is dissected from the tumor, leaving the membranes. These, if not too bulky, may be folded up within the skin flaps; or the sac may be sutured and a portion cut off and the skin flaps closed over this suture line. Or Morton's fluid may be injected in the same manner as is used for spina bifida (*q. v.*). This plan is out of favor. Or Morton's fluid or similar preparation may be injected into the walls of the sac without penetrating its interior, with a view to changing their character and causing them to thicken and contract.

FRACTURES OF THE SKULL

In no part of the anatomy does greater change take place from infancy to adult life than in the skull. At first composed of eight separate segments of partly ossified membrane and cartilage loosely held together and capable of being molded into an entirely different shape, it passes through various stages in which plasticity yields to firmness and elasticity to hardness until it finally resembles a cemented casket of one piece almost as hard and brittle as porcelain. The brain and membranes which it contains undergo quite as remarkable changes in consistency and in development of structure. It is not strange, then, that the effects of external violence both upon the skull itself and upon its contents should be widely different in the young child from similar injuries in the adult, and that these differences vary less and less from infancy on until the adult type is reached. It is obvious why, with the comparatively soft and yielding bones of the young child, force is not transmitted to more distant parts sufficiently to overcome cohesion, and both the "bursting fracture" and the "bending fracture" are comparatively rare; why extensive fissuring seldom occurs, and why the elaborated laws of "fracture by contrecoup" are set at naught. There is a tendency for the bones to bend rather than to break, and for the part receiving the force to bear the brunt of it rather than to transmit it, and for the contents of the cranium to yield to pressure rather than to resist it or

be disturbed by it; while the blood-vessels are more elastic and less friable, and the brain structure less highly organized and less affected organically by changes in its circulation. Thus one has seen a young child tumble from a second story window and perceptibly flatten its cranium upon the sidewalk, and after temporary concussion be none the worse for its experience. However, the dura mater is very closely adherent in a child, and if an area of bone be fractured and driven in, it is more apt to lacerate and carry with it this fibrous membrane, and to injure the brain, than would a similar fracture with depression in an adult. Splintering of bone is less common than in adults, and splintering of the inner table is quite rare. Depression or bending in of a large surface without fracture or with a kind of greenstick fracture is more common. Owing to softness of the skull and the loose attachment of the scalp, considerable injuries of the bone may occur with very little evidence of it upon the surface. Children not uncommonly recover from fracture of the base of the skull. One has seen this in undoubted cases. Also recovery from traumatic meningitis, from which it did not seem possible that an adult could have recovered. But as a rule, traumatic meningitis is less apt to occur in children. In punctured wounds of the skull, which are more easily made in children on account of the thinness of the cranium, no harm may result if septic matter be not introduced with the entering point.

Diagnosis and Treatment of ordinary fractures of the skull are based upon the same general principles as obtain in similar cases in adults, excepting that with children there is less call for active interference. Quietude, open bowels, bromides, with careful antisepsis, and cold to the head are the best line of treatment in most cases. A word of caution may be necessary concerning the application of cold. Serious depression may be caused by placing a child's head in cold storage, packed in icebags, as one sometimes sees done. (24)

PROLAPSUS AND HERNIA CEREBRI

Prevention is easier than cure. Compound fracture of the skull or a trephine or other surgical opening of the skull, with protrusion of a portion of the brain covered by membranes (hernia cerebri), or of the brain substance without membranous covering, (prolapsus of the brain), are very troublesome and dangerous conditions. The protrusion may be caused by hemorrhage or result from brain abscess or from imbibition of serous flow from the wound. Suppuration or gangrene or superabundant granulations may make the brain tissue unrecognizable. It may appear to be a new growth, or a sloughing tumor. Abscess should be evacuated. A gangrenous portion may separate spontaneously. Fungous granular tissue should

be removed if it is protruding and preventing closure. The protrusion should be prevented if possible, or treated if it occurs, by closing the soft parts over the gap in the skull and the use of antiseptic dressings with sufficient pressure to support the tissues. A gutta-percha plate fitted to the gap may be of assistance.

TRAUMATIC CRANIAL MENINGOCELE OR TRAUMATIC CEPHALHYDROCELE

This condition is peculiar to childhood. It results from fracture of the skull with sufficient intracranial injury to allow the escape of cerebro-spinal fluid beneath the aponeurosis of the occipito-frontalis. The condition may not appear immediately after the injury but some weeks later. Some consider the inner hernial covering to be the cerebral meninges which protrude through the fracture. The cerebro-spinal fluid is probably augmented by irritation set up by the injury. The pressure of the tumor produces partial absorption of the bones at the margins of the opening. Pulsation may or may not be present.

Diagnosis.—The diagnosis is made from the history of injury with subsequent gradual appearance of a fluctuating tumor, which tends to increase in size. A hematoma occurs promptly after injury, and having soon attained its full size, tends to diminish. If there is doubt, aseptic aspiration will discover whether the tumor is filled with blood or with cerebro-spinal fluid.

Prognosis.—Prognosis is uncertain. Many cases recover, but some die, usually of meningitis. The prognosis is best in cases having a small cranial opening.

Treatment.—The treatment should be very cautious. Active open interference is not demanded, nor, in most cases, permissible. Palliative treatment with support to the tumor offers as good a prospect as any. If tension is great and tapping is resorted to it should be done with the strictest antiseptic methods and the tumor entered through the unaffected tissues at its base.

PNEUMATOCELE CRANII

This is a rare and peculiar tumor appearing in the temporal region and occiput or over the frontal sinus or one of the orbits. The majority of the reported cases have been in adults; yet it is said to occur sometimes in children or even congenitally, although, considering the development of the sinuses and of the mastoid portion of the temporal bone, its occurrence in childhood must be extremely rare. The tumor is produced by air which dissects up the pericranium, so that one wall of the tumor is lined by the pericranium and the other is the cranial bone. The tumor is circumscribed, painless, disappears on pressure, but reappears. Forcible expiration or inflation with the Pollitzer bag renders it more tense. It is tympanitic on percussion. The air lifts the pericranium and escapes into the

space beneath, but is prevented from returning so readily by valve-like action of the pericranium over the orifice of entrance. Confined in this cavity of living tissues a part of the oxygen is absorbed from the air, while the nitrogen remains and carbonic acid gas is added; so that analysis of the gaseous contents of a pneumatocele shows 87 per cent. of nitrogen, 10 per cent. of oxygen, and 2 per cent. of carbon dioxid. This finding misled Chevance de Wassy and other earlier observers into the opinion that the contents of the tumor was not air. After the tumor continues for a week or two the pericranium begins the proliferation of new bony tissue in a ridge around the margins of the tumor similar to that found in cephalhematoma, and shreds of adherent tissue in the cavity become bony spiculæ which crush as the tumor is manipulated. In some cases there is a history of trauma, in others of inflammation of the ear or sinus, but in many no cause is assigned. (For a synopsis of the literature see article by Wallace, Jour. A. M. A., May 6, 1905.)

Treatment.—It has been recommended to obliterate the cavity by injecting tincture of iodine to excite inflammatory adhesion of its walls. A better method is to incise the tumor and pack it; or if granulations have formed to compress it so that the surfaces will adhere.

CEPHALHEMATOMA

Cephalhematoma or blood tumor of the head occurs at the time of birth from injury to blood vessels, or to this combined with the venous congestion due to asphyxia and that peculiar state of the blood of the new-born which favors hemorrhage. Cephalhematoma is sometimes divided into external and internal, the internal being defined as a blood tumor within the cranium, either sub-cranial or sub-arachnoidal. But the conditions of an external and an internal hemorrhage, although similar in origin, are so different in their clinical aspects that it seems unwise to classify them together. But it is wise to remember that where cranial injury has produced hemorrhage externally, internal hemorrhage also may have taken place, and to look for any evidence of it. It has been asserted that the edges of foramina, particularly those situated near the interparietal suture or the posterior fontanel, are instrumental in wounding the vessels they transmit; and also that intracranial and extracranial collections of blood may communicate through the foramina.

The second variety is less frequently met. In this the hemorrhage takes place between the aponeurosis of the occipito-frontalis and the pericranium, and may occur upon any part of the head covered by this aponeurosis. Very rarely indeed there may be a hemorrhage between the scalp and the pericranium. In either case the tumor is generally not present at birth, but appears perhaps a

few hours later, or may not be discovered until next day. It is often located upon the presenting part, but not invariably so. In size it varies from that of an egg to that of an apple, but hemispherical or flattened. (See Fig. 124.) The sub-periosteal variety never gets larger than the bone upon which it occurs and its outline is defined by the marginal attachment of the periosteum. The sub-aponeurotic variety is not limited in situation, size or shape by any suture lines. There is no heat, tenderness, nor discoloration. The tumor is tense, but fluctuation may usually be detected; and it is irreducible. The tumor may continue to increase in size for several hours and even for a day or two. It then becomes stationary



FIG. 124. CEPHALHEMATOMA.

and later slowly diminishes. With the sub-periosteal variety the periosteum soon attempts the formation of bone upon its under surface, so that if examined when the babe is ten days or two weeks old a crater-like margin may be felt all round the tumor. This with the fluctuating center gives much the same impression to the touch as a hiatus of the skull with the meninges protruding. When the thin layer of bone has extended over the whole surface, pressure may produce an "eggshell crackling" on palpation. In a few weeks or a month or two the tumor usually disappears. Not quite all the effused blood may be reabsorbed, but the new layer of bone formed beneath the periosteum seals it in; and, if examined years after, nothing remains but a slightly thickened portion of skull which has a thin stratum of the coloring matter of blood-cells near its outer surface, covered with a layer of bone. Occasionally a cephalhematoma may fail to absorb or may become infected and suppurate.

Diagnosis.—The diagnosis is usually easy if one remembers the possibility of this condition. The most common tumefaction upon the head of the new-born is of course the caput succedaneum.

But that is present at birth, is firm and doughy, and tends to disappear in a day or two. Meningocele bears some resemblance; but it is located at an opening or over a suture instead of upon a bone, pulsates like the brain, increases when the babe cries, and is partially reducible, giving rise usually to nervous symptoms when pressed upon.

Treatment.—Judicious letting alone is the best treatment for the great majority of these blood tumors. It is well enough to use light pressure and perhaps an evaporating lotion. Cutting down to find the bleeding point is not called for. Nor is aspiration of the effused blood, nor opening and turning out the clot. These would only add a risk of sepsis; for in all probability the blood will be taken care of in time, as before described. Symptoms of compression require exploration, probably operation. If suppuration should occur there is no choice but to incise promptly, evacuate, irrigate and drain.

MICROCEPHALUS

Microcephalus is a premature arrest of development of the brain and skull, usually accompanied by idiocy and cerebral paralysis in varying degrees. The primary cause of this arrest is unknown.

On the supposition that premature ossification of the sutures and closure of the fontanelles stopped the growth of the brain, operations were devised by Lane, Fuller, Lannelongue and others, to open the cranium in such a manner as to allow the brain to expand and have room to grow. This is generally called Lannelongue's operation or craniectomy. It consists in the removal of a strip of the skull from one or both sides, parallel with and an inch or more away from the saggital suture. The portion removed might be half an inch wide and four or five inches long; or the strips upon the two sides were connected, making the removed portion H shaped; or the opening was V or Y or inverted U or O shaped, as devised by different operators. The periosteum was also removed, to avoid or delay reproduction of bone; but the dura not opened. The hopelessness of the condition possibly justified these experimental operations, but they were based upon an unproven supposition and ended in failure. Soon after the introduction of this operation, the writer had a long conference upon the subject with the late Dr. G. A. Doren.[1] After reviewing carefully the pathology of this class of cases we concluded that the hopes held out were unfounded; there was no reasonable prospect that the operation could succeed in congenital microcephalus, and I refrained from performing it or advising it. This opinion has been amply justified by the sequel. Craniectomy is no longer used or recommended for congenital microcephalic idiocy.

[1] Superintendent of the Ohio State Institution for Feeble Minded Children.

HYDROCEPHALUS (WATER ON THE BRAIN)

Hydrocephalus consists in an abnormal accumulation of cerebrospinal or serous fluid within the cranium. There are two principal varieties—acute hydrocephalus and chronic hydrocephalus.

Acute Hydrocephalus is merely one of the symptoms of meningitis, usually of basilar meningitis, which is almost always a tubercular disease. All forms of acute meningitis are accompanied by a certain extra amount of serous exudation into the ventricles, but it is only in the basilar form of which the tubercular is the type that the quantity is large and gives prominent symptoms and characterizes the disease.

Chronic Hydrocephalus is in two distinct varieties, hydrocephalus externus or meningeus, and chronic hydrocephalus internus or ventriculorum.

Chronic Hydrocephalus Externus (*H. Meningeus*) is a rare condition, usually found in connection with malformation of the brain or prenatal disease, or resulting from pachymeningitis or hemorrhage either before or after birth. The two forms may be combined. That is, with external hydrocephalus and atrophy of both hemispheres, one of the ventricles may be somewhat dilated. Pachymeningitis may also give rise to a somewhat allied condition called hygromata of the dura, consisting of encapsulated collections of fluid. The external form seldom gives rise to the expansion of the skull, as seen in the internal variety.

Chronic Hydrocephalus Internus (*H. Ventriculorum*).—This is the commonest variety and also the one most important from the surgical standpoint. It may occur as an accompaniment of chronic basilar meningitis precisely like the acute form but running a chronic course, or it may be caused by the irritation of tumor growth. But neither meningitis, simple or tubercular, nor brain tumor may be present, and yet hydrocephalus of the internal variety may develop, either before or at some time after birth. Heredity has, of course, been considered as a cause. Although many instances have been reported of more than one case of hydrocephalus being born or developing in the same family, this does not occur with anything like the frequency of rickets, for example, and bears no comparison with syphilis, tuberculosis, or many other diseases in which either the disease or a predisposition to the disease is known to be inheritable. In my own cases I have never been able to get a history of the disease occurring in previous generations of the same family or its branches. Syphilis undoubtedly is associated with some cases, but there are others in which no luetic taint can be traced, and which will not respond to syphilitic treatment. Rickets is constantly mentioned in connection with hydrocephalus, Park

and other authors stating that it is " most common in rachitic children," and placing " rachitic curvatures of the long bones " among the symptoms. In my own experience there has never seemed to be anything more than an occasional or accidental association of these diseases in the same patient. There is no constant or even frequent association, and the two appear to me essentially different. Hydrocephalus is not more prevalent at the period when rickets is most prevalent, and the treatment of one has no curative effect upon the other. It is true that other deformities not infrequently accompany the disease when congenital, but they are usually such as show a direct relationship to the dropsical condition of the brain coverings, for instance, cranial meningocele or spina bifida, or the

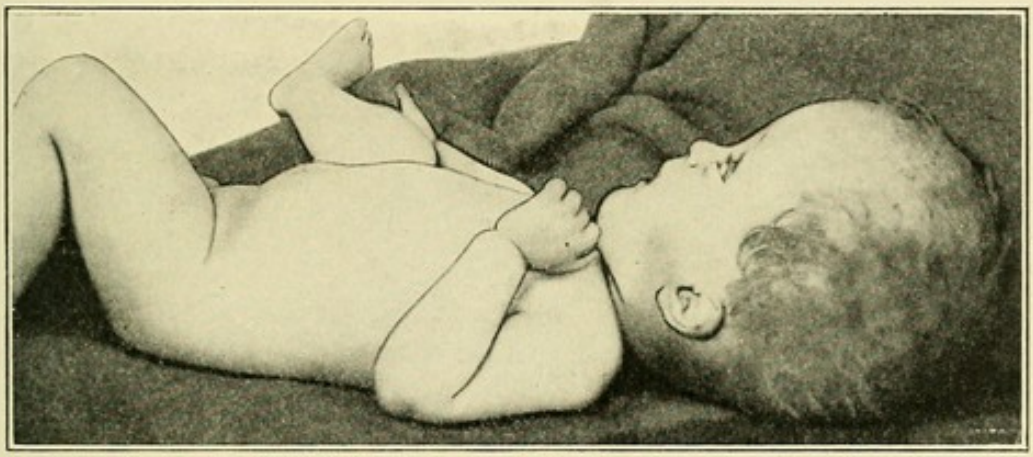


FIG. 125. HYDROCEPHALUS INTERNUS. Autopsy on same case is shown in Fig. 128.

results of maldeveloped nerve centers, producing paralysis of bladder and rectum or lower extremities, or clubfoot, and the like. One could not quite so confidently deny tuberculosis a possible causative relationship, even when tubercule is not found.

Operations for spina bifida or meningocele, or treatment of these conditions by pressure are sometimes followed by accumulation of the fluid within the cranium.

Chronic ependymitis is given as a cause, but that does not explain what inflames the ependyma. The syphilitic virus might, but what of the simple cases? In some cases it appears as though inflammatory or developmental causes had closed the foramina of Munro and the aqueduct of Sylvius or the foramen of Majendie, leading to accumulation of the fluid in the ventricles.

Pathologic Anatomy.—Chronic hydrocephalus may present a skull of ordinary or less than ordinary size. But in the great majority of cases the cranium is enlarged. In the congenital cases and those occurring in the first few months of life the sutures and fontanelles are wide and occasionally there are portions of the skull

other than the fontanelles or sutures where bone is absent. In cases that are very chronic and survive five or six years, ossification has usually taken place. On opening the skull and membranes one finds the brain showing very shallow convolutions, the cortex being thinned by the distension of the ventricles. In the case shown in Figs. 125 and 128 it was scarcely an eighth of an inch in thickness, and no convolutions were apparent, nor could one distinguish between white and gray matter. All the openings between the ventricles are enlarged. In cases dying after operation, the ependyma is found inflamed. The fluid contained in the enlarged vetricular cavities is much like cerebro-spinal fluid, excepting that in a few cases there are traces of sugar, in the infected cases pus, and following inflammation more albumin than normal. The amount of



FIG. 126. FETAL HYDROCEPHALUS. Craniotomy at term by Dr. A. J. Skeel.

fluid varies in different cases from ounces to pints. When it is removed the brain collapses like a cyst.

Symptoms and Diagnosis.—The disease may originate during fetal life and death take place in utero, or at birth the head may be so enlarged as to preclude birth alive. The obstetrician discovering the condition does craniotomy or cephalotripsy. Four times in my early practice I had this unpleasant duty to perform. Fig. 126 shows such a case. Or the condition may come on in a few months after birth or later in infancy. The head is observed to be growing too rapidly. Boas states the average head in the normal boy at birth to be 13.9 inches (35.5 cen.), at six months 17 inches (43.5 cen.), at twelve months 18 inches (45.9 cen.), at eighteen months 18.5 inches (47.1 cen.). An average example of hydrocephalic enlargement is shown in Fig. 125. At eighteen months of age the head measured 24½ inches, and 19½ inches over the vertex from ear canal to ear canal; and 18 inches from occiput to glabella.

Holt mentions one of his cases which measured at four months 24½ inches in circumference. These two cases by comparison show the well-known fact that the rate of growth of the head varies greatly in different cases, it may be from an inch to two or three inches a month. The shape of the head varies also, but is generally quite globular from the ears up, or, taken together with the small face, it is pear-shaped or pyramidal, pointed at the chin, flat at the sides and expanded above. Fig. 127, aged four months, shows the globular head. The forehead is extremely high and prominent. Thus it is very different from the rachitic head, which

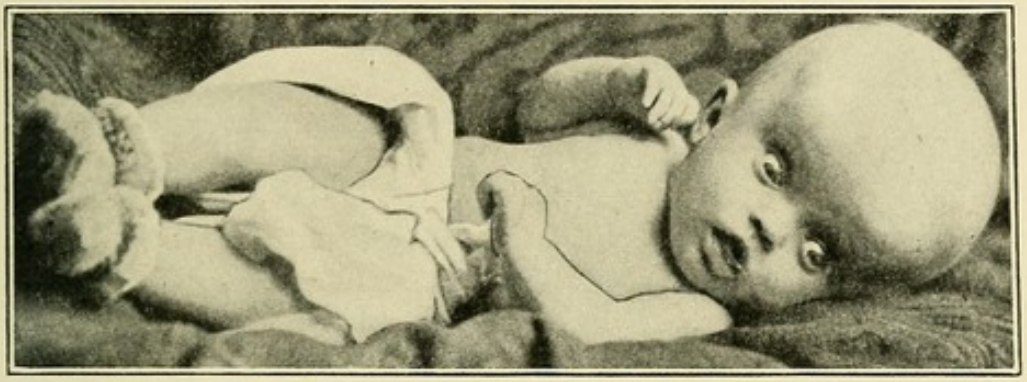


FIG. 127. TYPICAL CHRONIC HYDROCEPHALUS in infancy. Note the globular cranium. The head above the ear canals forms nearly three-quarters of a circle. The face is pointed at the chin, making the face and cranium together pear-shaped. The position of the eyeballs in their sockets is characteristic.

is cubical, flat at top and sides. The hydrocephalic case has bulging fontanelles and open sutures. Fluctuation can often be obtained. The scalp appears tightly stretched, the hair is usually scanty, and veins are large and prominent. The eyes are pushed downward and somewhat forward by the pressure of the fluid above and behind their orbits, so that the white shows plainly below the upper lid. The pupils contract evenly to light, but in some cases become insensitive and dilated. Nystagmus and squint and irregular rolling of the eyes are common. Mental development ceases or deteriorates, according to the severity of the case. The mental state, including the special senses, is dull. The motor control also is affected, producing exaggerated reflexes, partial paralysis, which is often spastic. Convulsions occur in some cases, sometimes marking intercurrent attacks of meningitis, which are repeated at intervals of weeks or months. The weak state, the incoördination of muscles, and the size and weight of the head prevent it being carried upright. Some of these babies cannot hold up the head at all. Others can by the second or third year, and can walk at five or six, but retain the mental condition of infancy. Thus there are all grades

of severity, both as regards the growth of the head, the impairment of brain and consequently mind, special senses, and motor control. There may be complete idiocy or only slight impairment. It is astonishing that the brain can perform any function while so compressed, distorted and atrophied. A fractional part of this compression, if coming suddenly, would produce coma and death, but it augments so slowly that tolerance is established. In infants, the open sutures and fontanelles and the soft bones yield more readily to the expansion and produce less actual compression.

The uniform enlargement of the head and the depressed eyes are characteristic. The globular or pyriform shape of the enlarged head should be compared with the squared head of the rachitic child. The head should be measured from time to time and its size and rate of growth compared with normal standards. Holt gives the rule that if the head grows more than an inch in a month there can be little doubt of hydrocephalus.

The disease may become arrested spontaneously at any stage and remain in that state; but in most cases it is progressive with greater or less rapidity and either steadily or with exacerbations, until, within the first year or the first few years, death comes by exhaustion through inanition, often with convulsions at the last; or the patient is carried off by some intercurrent disease.

Treatment.—Mercury and potassium iodide should be tried in in all cases. If the disease is due to syphilis these remedies will prove beneficial; and in some cases in which I could get no evidence whatever of syphilis they have stayed the progress of the disease at least for a time. I know of no other drugs that will do even that much, and they will not always. Smearing the shaved scalp with ointment of iodoform and covering it with bandages and tight strapping does no good; nor do innumerable other drugs and procedures. The mercury may be used by inunctions to the scalp, or elsewhere, or administered internally.

Very numerous operative measures have been tried—aspirations, repeated aspirations, injections of Morton's fluid, and of iodine solutions. Since Quincke's introduction of lumbar puncture this procedure has been used, not only for acute but for chronic hydrocephalus.

Lumbar Puncture.—Lumbar puncture is perhaps not too familiar to be described here. An aspirating needle or the smallest sized trocar and canula is the instrument selected and sterilized by boiling. Quincke's especially devised fine trocar and canula is the best. An ordinary hypodermic needle will perhaps do if it is long enough, but a thin needle may be broken. No syringe or suction apparatus is necessary or advisable. The skin over the lumbar region is as carefully cleansed with antiseptics as if for a capital

operation. The child's spine is bent forward with thighs tightly flexed upon abdomen, and firmly held in that position. Babies and comatose patients need no general anesthetic. Ethyl chloride spray may be used, or a single small drop of carbolic acid touched upon the skin. Quincke drew attention to the fact that while in the newly born the spinal cord reaches to the third lumbar vertebra, by the time the babe is one year old development has extended the canal so that the cord reaches only to the second; and that the nerves composing the cauda equina are grouped into two bundles, one lying upon each side of the canal and not likely to be wounded by a central puncture. The puncture is usually made in the interval between the third and fourth lumbar vertebræ. This is in very nearly a straight line between the iliac crests, and can usually be felt if not seen. The space between the fourth and fifth vertebræ will do as well. The needle is entered just at one side of the median line to avoid the spinous process, and at right angles to the surface, or pointed a little upward. It passes between the vertebral bodies, traversing the ligamentum subflavum and the theca, and enters the spinal canal at a depth of 1.5 to 2.5 centimeters, equal to three-fifths to one inch. It is not permissible to turn the needle in this or that direction in search of the canal after it is deeper than the integuments; but there is usually not the least difficulty. The fluid generally flows the instant the canal is tapped. It is very seldom that it is too thick to flow, or contains flocculi that may plug the canula and require dislodgment or a reintroduction. It is apt to spurt if there is great tension, or may only drip slowly and yet yield a considerable quantity. If the head is much retracted, straightening the neck may cause the fluid to flow; as will also raising the patient to the sitting position. The fluid should be caught in sterilized test tube or flask for measurement and examination. From a drachm or two to an ounce or sometimes more may be withdrawn. When the canula is withdrawn the puncture is sealed with collodion.

The fluid from a case of cerebro-spinal meningitis is slightly cloudy. This is better seen by comparing with filtered water. The meningococcus may be found upon microscopic examination.

In tubercular meningitis the fluid is clear. On standing in a test tube several hours a filmy white column may form in its center. Often no organisms whatever are found by the microscope.

In hydrocephalus the fluid withdrawn is clear and has the composition of cerebro-spinal fluid, sometimes slightly more albuminous, or it may contain sugar.

Tapping the Ventricle and Permanent External Drainage.—Tapping of the distended ventricles through the skull is a very old method of treating hydrocephalus, which had long been discontinued on account of its fatality, although quite a number of cures

were reported. After the introduction of Listerism it was revived and tried again, with many modifications of technique. The puncture can be made either through a fontanelle in infants or through a cranial bone, avoiding the situation of any large vessel, and usually the motor zone (Keen). Park chooses the point 3 cm. behind the external auditory meatus and the same distance above the base line of the skull. Here, after trephining, the aspirating needle or a permanent drain may be introduced. The puncturing instrument or the drainage should be introduced in a direction toward a point 6 cm. above the meatus of the opposite side. Although drainage can be effected in this manner and the wound kept aseptic for a time, it is practically impossible to maintain asepsis indefinitely with open drainage, and meningitis and death result.

Drainage into Subcutaneous Areolar Tissue.—McArthur successfully drained the lateral ventricles into the cellular tissues beneath the scalp. He inserted a silver tube with a flange at its outer end through a hole drilled above and behind the ear. A similar plan with a gold tube was used by Miculicz. Troje used glass wool as a drainage material for the lateral ventricle. I. S. Horsley attempted to drain from the vertex into the subcutaneous tissues of the neck with catgut and with silk drains. (Jour. A. M. A., July, 1906.) Kocher prefers to tap the lateral ventricle through the skull just in front of the bregma, 2 cm. to one side of the mesial line, and directing the needle downward and backward. His reason for choosing this point is that the ventricle is much deeper than it is wide, and there is some danger in puncturing transversely or injuring the inner wall; or that the tube will impinge on the inner wall as the distended ventricle collapses. (25)

Drainage into Pleural Cavity or into the Spinal Canal.—Drainage into the pleural cavity has been attempted (Sherman, So. Cal. Prac., Dec., 1907), by carrying drainage subcutaneously from an opening through the calvarium and into the lateral ventricle, down the neck and into a pleural opening between the first and second ribs; and drainage into the spinal canal by removal of one lamina is suggested by the same writer.

Permanent Drainage into the Subdural Space.—Dr. Leonard Hill found by a series of experiments [1] that "the tension of the cerebro-spinal fluid and the cerebral venous tension are normally the same," on account of the fact that fluid escapes directly into the veins from the subdural and subarachnoid spaces at any pressure above the venous pressure. He also proved experimentally that "no pathological increase of cerebral tension can be transmitted by the cerebro-spinal fluid, because this fluid can never be retained

1 "The Physiology and Pathology of the Cerebral Circulation," London, 1896.

in the meningeal spaces at a tension higher than that in the cerebral veins." One of the theories that has been advanced to explain the method of the production of chronic hydrocephalus is, that the channel through which the fluid secreted in the lateral ventricles should pass in order to escape into the arachnoid space outside of the foramen of Majendie has been closed or partly closed; thus the fluid accumulates in the ventricles and distends them and expands the cortex, compressing it against the cranium. Reasoning from this and from Dr. Hill's experimental findings, Sutherland and Cheyne [1] proceeded to relieve this intracerebral tension. If an outlet for the superabundant ventricular fluid were provided so that it might escape into the meningeal spaces, it should, according to Dr. Hill, be absorbed by the veins until the cerebral venous pressure and the cerebro-spinal pressure were equalized. Their plan consisted in making an opening through the cortex cerebri and introducing a drain which would maintain a free passage between the ventricle and the subdural or subarachnoid space. They describe the operation as follows: "A curved incision about an inch and a half long was made over the left lower angle of the anterior fontanelle, and the skin and deeper tissues were turned down from off the dura mater. A small incision about a quarter of an inch in length was then made. There was no fluid in the subdural space. Before the operation a catgut drain was made as follows: A bundle of finest catgut, containing 16 strands and about two inches long, was prepared, one end of the bundle being tied together and the other being free. As soon as the dura mater was incised, the tied end of this bundle was seized with a pair of sinus forceps and pushed downwards and slightly backwards between the brain and the dura mater for about an inch. The other end of the drain, which projected through the slit in the dura mater, was then grasped with the sinus forceps and pushed through the substance of the brain into the expanded lateral ventricle. The brain was very thin at this point and clear fluid escaped immediately. Having thus arranged one end of the drain in the subdural space and the other in the ventricle, three fine catgut stitches were employed, in completely closing the opening in the dura mater, and the skin was stitched up with a continuous silk suture." They reported three cases operated upon by this method, the first of which died three months after operation with symptoms of basilar meningitis. The third case died of measles complicated with broncho-pneumonia a fortnight after the operation. The second case presented results which may be hoped for in such cases. It was "a case of advanced hydrocephalus in an infant three months old. All the bones of the skull, vertical and basal,

[1] "The Treatment of Hydrocephalus by Intracranial Drainage," Brit. Med. Jour., Oct. 15, 1898.

were widely separated, and mental and physical development had been stationary since birth. . . . The disturbance caused by the operation was trifling and transient, there being a rise in temperature for a few days, some restlessness at night, and vomiting. The dressings were removed on the sixth day and the wound was found to be healed. The head was smaller in all its dimensions, the tension of the fontanelle was absent, the spaces between the individual bones were less and the proptosis of the eyes was not so marked. The skull appeared to be asymmetrical, as if the left side had moved backward on the right. A fortnight after the operation it was noted that the bones at the base of the skull and the parietal were overriding, while there was still a slight interval between the two parietal bones. A flannel bandage was applied to the head to keep up the external pressure and aid absorption. A few days later a slight increase of tension was noted in the fontanelle, but this soon passed off. A month after the operation the child was taking nourishment well, the cry was stronger and the head was moved freely. The bones of the cranium were all overriding, and the only unclosed space was the anterior fontanelle, which measured 3½ inches in the transverse diameter. . . . For the next two and a half months the condition remained practically stationary, and during this period the patient passed successfully through an attack of measles. . . . The head having been shaved, the following curious state of affairs was manifested: The asymmetry of the skull, which had been previously noted, was much more marked, the right side being evidently larger than the left. The right side of the fontanelle was prominent, tense and fluctuating, and on a tracing being taken was seen to cover a much larger area than the left half, which was not elevated. The left parietal was overriding the left frontal bone, while on the right side the corresponding bones were merely in contact. It was apparent that while the drainage of the left ventricle had been as complete as possible, that of the right had come to a standstill, and the fluid was again increasing. Accordingly an operation was performed on the right side of the head similar to that performed on the left four months previously. On opening the dura mater the brain bulged at once, there being no adhesions and no extra-cerebral fluid. On puncturing the brain, fluid was reached at a very short distance from the surface, and flowed at first with some force. A catgut drain was introduced in the usual manner. This operation was followed by complete disappearance of intra-cranial tension and gradual diminution in size of the right side of the head. At the present time, six months after the first operation and a month after the second, the fontanelle measures two inches transversely, and all the bones of the cranium are overriding in an extreme degree. There is

now a conjunctival reflex and the child can see. She is gaining weight, and moves the head and limbs much more freely. There are no evidences of mental development." The authors conclude that Dr. Hill's observations on the absorption of cerebro-spinal fluid by the meninges also hold good in the pathological condition of hydrocephalus. But the establishment of the drainage by a permanent opening is a matter of difficulty in some cases. "First, the brain tissue may be so thick as to close in around the catgut drain and to prevent the passage of the fluid; secondly, the inflammation set up by the wounds in the dura mater and the cerebral cortex may lead to the formation of adhesions around the artificial outlet which seal it up. This difficulty may be met by making the opening in the cortex as far as possible from that in the dura mater and allowing so much fluid to escape as will prevent the opposed surfaces from coming immediately in contact. Further experience is required both as to the best kind of drain for the purpose and the manner in which it is to be employed." Sutherland and Cheyne also note that drainage of both lateral ventricles by operation upon one side cannot in all cases be depended upon, as the usually free communication between the ventricles through the foramen of Monroe may be closed by descent of the falx cerebri as the enlargement of the head decreases. They also suggest hope of relief by intracranial drainage in other diseases than chronic hydrocephalus, in which ventricular pressure becomes a dangerous complication—such as tubercular meningitis, simple basilar meningitis, and tumor cerebri.

In hydrocephalus relief of tension may not restore cerebral function. Obviously cerebral function which never existed cannot be restored. The amount of improvement in cerebration which can be expected must depend upon development of the brain. If the brain had been considerably developed before the fluid pressure put a stop to its development, relief of that pressure may restore function. The longer the time that passes without mental development or relief of the retarding pressure the less the hope of subsequent mental improvement. This emphasizes the importance of early diagnosis and early operation in chronic progressive hydrocephalus. In discussing the work of Sutherland and Cheyne, Dr. Still presented the importance of distinguishing between cases of congenital hydrocephalus from those of simple posterior basic meningitis for the reason that the diplococcus of posterior basic meningitis might exist in the fluid in the lateral ventricles as late as the one hundred and third day (and perhaps longer, the proper date being yet undetermined) after the acute stage of the disease was over. In operation in such cases there might be risk of further infection by draining the fluid into the subdural space.

Figs. 125 and 128 are from original photographs of G. G., aged 18 months. Parents both healthy and this their first baby. No miscarriages preceded it. Normal pregnancy and delivery. When three months old parents noticed baby's eyes depressed in their sockets, and considered him a very cross-tempered baby. His head then measured 18 inches. Baby had no disease but

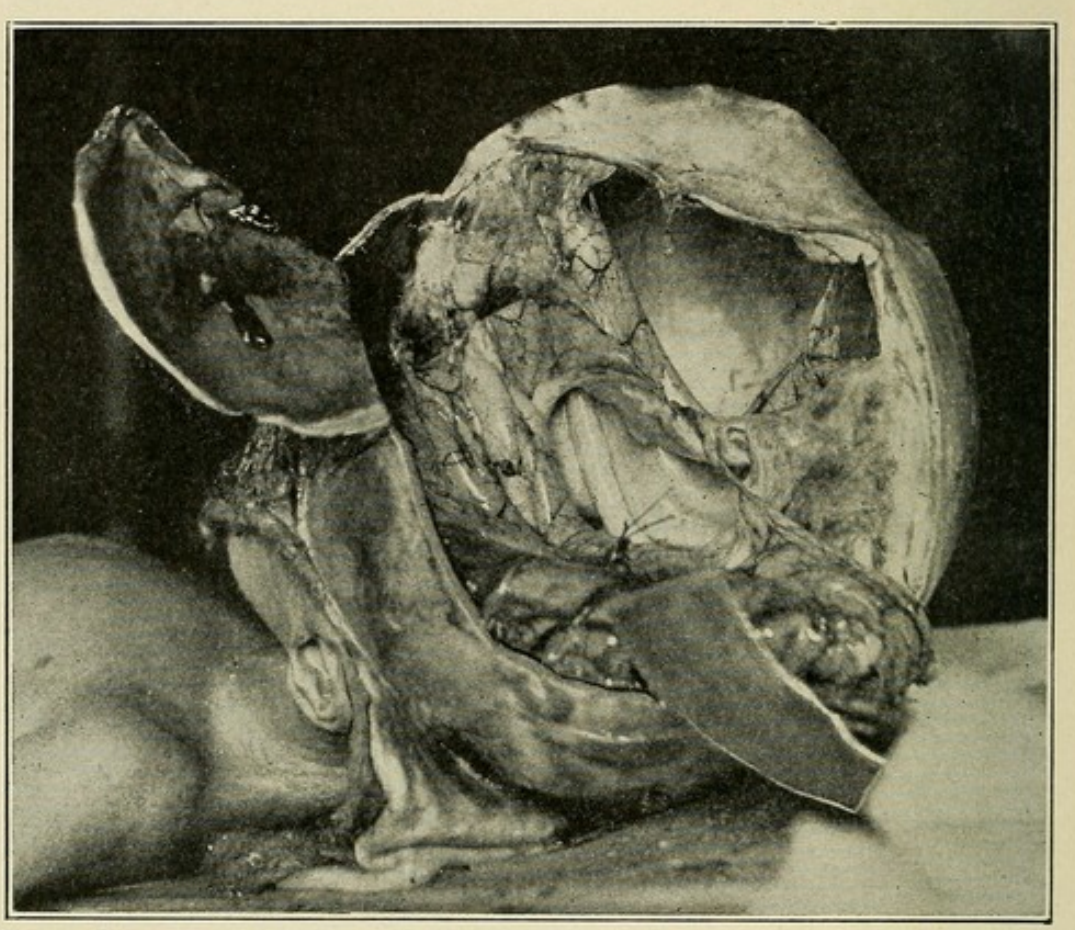


FIG. 128. AUTOPSY ON CASE OF CHRONIC INTERNAL HYDROCEPHALUS shown in Fig. 125 three weeks after operation. The thin and fragile cortex which collapsed as soon as emptied, and the distended vessels are well shown. The bundle of silkworm gut used for subdural drainage may be seen projecting into the distended left lateral ventricle.

chicken pox at twelve months, but his head gradually expanded until at eighteen months it measured 24½ inches in circumference and 19½ inches over the vertex from ear canal to ear canal, and 18 inches from occiput to glabella. Total length of the infant was 32¾ inches, of which 9 inches represented the head from chin to vertex. The anterior fontanelle measured 8 inches each way, antero-posteriorly and laterally. The cranial bones were separated and the left parietal near the fontanelle was more lacking in ossification than the right. The scalp was traced by large prominent veins and bore scanty hair. The mental development was very

low. He would cry when hungry or thirsty. If there was any vision it was slight. Hearing was present. He made no articulate sound, but when in a good humor, if spoken to would "gabble," giving several inflections and variations of tone, but no meaning. He would sometimes laugh. He could not sit up nor support the head, and was entirely helpless. Operated by the writer at St. Clair Hospital, August, 1904, by the method described by Sutherland and Cheyne, excepting that a half dozen strands of finest silkworm gut instead of catgut was used for the drain. The cerebral cortex was as thin as chamois skin. The tension in the ventricle was so great that considerable fluid escaped through the small

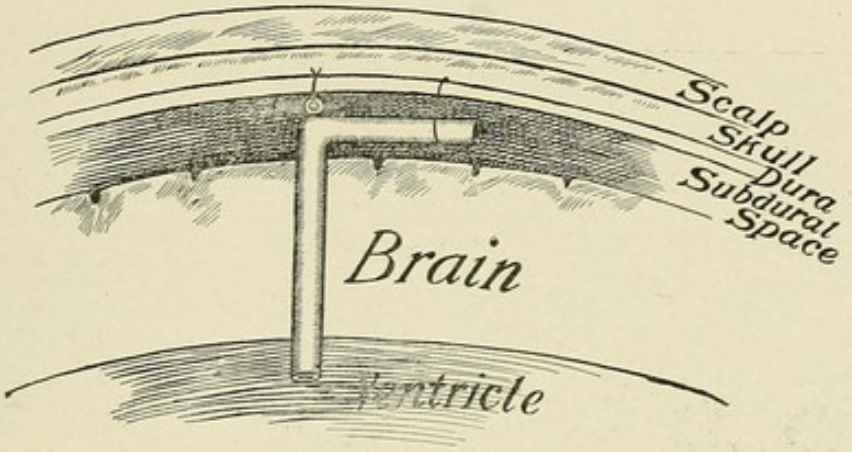


FIG. 129. BALLANCE'S OPERATION FOR HYDROCEPHALUS INTERNUS. Binnie's Operative Surgery.

incision in the dura before it could be closed. The temperature went up for a few days but subsided; the wound healed promptly, and the babe did well for 10 or 12 days, when it gradually sank and died in 3 weeks, apparently of exhaustion, the end coming with convulsions. Autopsy showed the operation wound healed with the membranes adherent at this point. At the site of the opening into the left ventricle the drain was still adhering to the cortex, surrounded by plastic lymph which peeled off. The ventricles were filled with watery, pale yellow-tinged fluid, on evacuating which the brain, being thin and soft, collapsed. The membranes were somewhat thickened and their vessels exaggerated in prominence.

On account of the difficulty of maintaining the opening free with the catgut drain, Ballance uses a very fine L-shaped tube of pure platinum or of gold and iridium (pure gold is too soft). One arm of the tube near the angle is provided with a small ring through which a suture may be passed to attach it to the dura. The other arm of the tube is made to penetrate the cortex into the ventricle, while the one with the ring lies immediately beneath the

dura, being sutured in position.[1] (See Fig. 129.) He finds that after subdural drainage it may be that the fluid continues to form and one may think his tube is blocked, when on opening the skull he finds that an internal has been converted into an external hydrocephalus, because the Pacchionian bodies have failed to absorb the fluid. Ballance has treated a number of cases of chronic hydrocephalus by ligation of both common carotids at an interval of about ten days, with recoveries in several cases. If this fails to stop the secretion of an abnormal amount of fluid, then he advises a trial of subdural drainage.

INTRACRANIAL TUMORS

Children are neither more nor less liable than adults to tumors within the cranium, but the relative frequency with which the varieties are found differs, and the location differs according to the variety. Boys are twice as liable as girls; and no age is exempt. Children under eight years are somewhat more liable than those above that age. Little has been added of late years to the essential facts of the natural history of intracranial growths. Advancement has been made in the surgical treatment of these conditions.

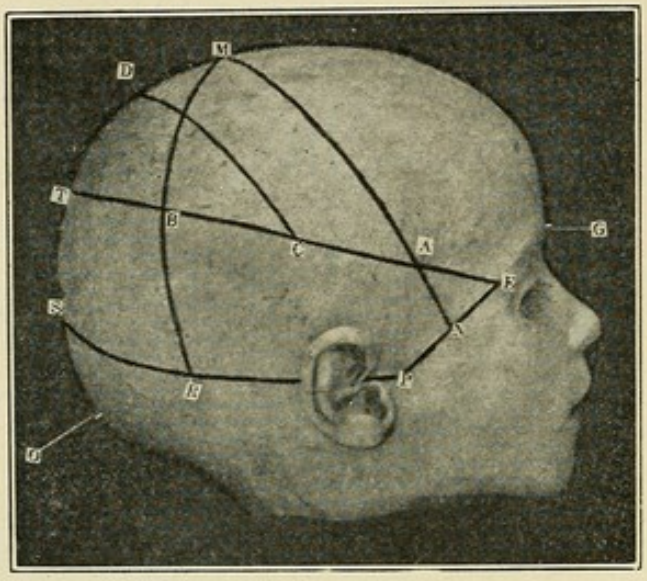


FIG. 130. CHIENE'S LINES marked upon the scalp of a child 5 years of age.—Edinburgh Stereoscopic Atlas of Anatomy.

OPERATIVE TREATMENT OF BRAIN TUMOR.—All cases of intracranial tumor as well as of abscess and chronic hydrocephalus which do not yield to medical treatment within a reasonable time should be subjected to operation if the symptoms point to disease that is accessible. Tumors upon the convexity or in the great longitudinal fissure can generally be reached. But the tumor being accessible, it does not follow that it is removable. A large infiltrated sarcoma or glioma might be reached and yet on account of its indeterminate limits and extensive implication of brain structure be impossible of removal. An encapsulated tumor or a hard, non-vascular tumor can generally be removed if it can be reached. Tumors of the cere-

[1] American Surg. Assn., May 31, 1906.

bral axis are practically out of reach; and with tumors of the cerebellum, on account of the uncertainties of diagnosis and the dangers of interference with that portion of the brain, it is only the very exceptional case that justifies an attempt.

Brain tumor may require operation not only for removal, but for the relief of pressure. Operation is justifiable if pressure symptoms, such as convulsions, coma, paralysis, choked discs, pain or other distressing symptoms, become severe.

CRANIO-CEREBRAL TOPOGRAPHY

In cases requiring operation for intracranial abscess, brain tumor, drainage of ventricles, and many other intracranial conditions, it becomes necessary to localize the different parts of the brain and its membranes and of the skull with reference to the surface of the head. In order to do this we must not only avail ourselves of the prominent landmarks of the cranium but must supplement them with certain arbitrary lines, just as lines of latitude and longitude measure the terrestrial globe. From the many ingenious systems for this purpose, such as those of Broca, Championiere, Horsley, Chipault, and numerous modifications and combinations, I have chosen to present the system introduced by Chiene, as illustrated in the Edinburgh Stereoscopic Atlas of Anatomy. The points used are the following:

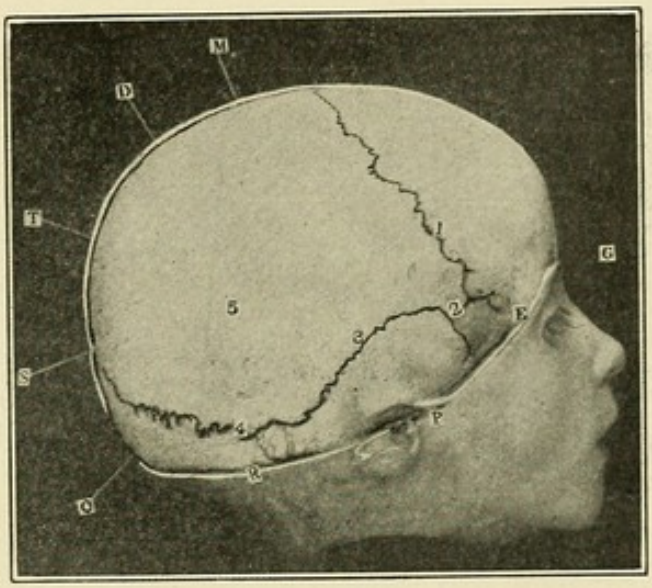


FIG. 131. The scalp has been removed from the surface of the cranium over the area marked out in Fig. 130, and the sutures are shown.—Edinburgh Stereoscopic Atlas of Anatomy.

G, the glabella, a point midway between the superciliary ridges. O, the inion or external occipital protruberance. E, the external angular process of the frontal bone, which projects at the outer angle of the orbit. P, the root of the zygoma, a point immediately above and in front of the external auditory meatus. S, seven-eighths point between glabella and inion. T, three-quarter point between glabella and inion (the lambda). M, midpoint between glabella and inion. B, parietal eminence, intersection of MR and TE.

N, midpoint of EP. C, midpoint of AB. R, midpoint of PS. CD parallels MN. A, intersection of MN and TE, pterion or in the child rather above it. Anterior division middle meningeal artery.

These points and the accessory lines are seen in Fig. 130, marked upon the head of a child five years old, for the reason that the anatomy of the child differs somewhat from that of the adult. In Fig. 131 the scalp has been removed from the cranium over the area marked out on Fig. 130, and the sutures are shown. The sutures are of limited value as landmarks for the brain, but their position must be borne in mind lest the line of suture be mistaken for fracture in injuries of the head.

The coronal suture passes transversely across the head but is in front of the midpoint M.

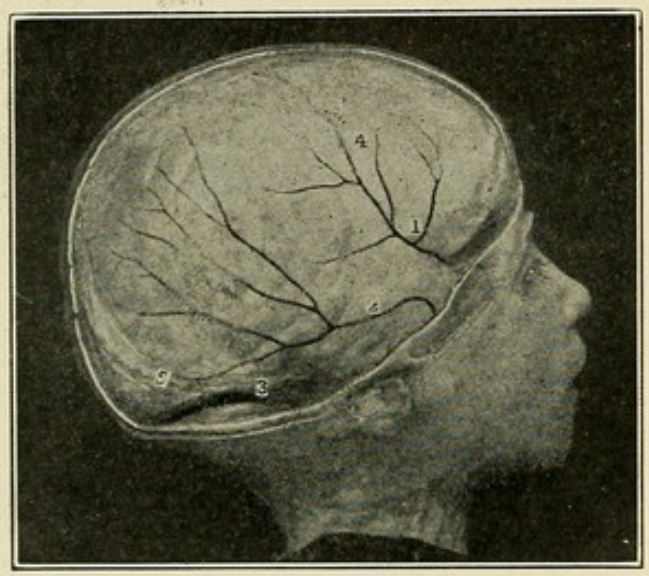


FIG. 132. The skull cap has been removed, exposing the dura mater. The meningeal arteries and a portion of the lateral sinus are well shown.—Edinburgh Stereoscopic Atlas of Anatomy.

The lambdoidal suture is between the occipital and parietal bones.

The spheno-parietal suture is between the anterior inferior angle of the parietal and the great wing of the sphenoid. It is known as the pterion, and it overlies the point of division of the Sylvian fissure into its three limbs, and the bifurcation of the middle meningeal artery, or its anterior division.

The squamous suture, between the parietal bone and the squamous part of the temporal, beginning at the pterion and arching back to the asterion or junction of the parietal, temporal, and occipital bones. The highest part of this suture reaches up to the lower end of the fissure of Rolando.

In Fig. 132 the skullcap has been removed and the outer surface of the dura mater is exposed. The outer surface of the dura mater is strongly adherent to the skull, especially along the lines of the cranial sutures. The meningeal arteries ramify between the membrane and the bone and supply both of them with blood. The largest of the meningeal arteries is the middle meningeal. A branch of the internal maxillary, which enters the skull through the foramen spinosum in the great wing of the sphenoid, and

extends outward and slightly forward on the great wing of the sphenoid. Its course and main branches are shown in Fig. 132. The lateral sinus may be divided into two parts, of which the first is seen here, passing from the region of the external occipital protuberance, to a point about three-quarters of an inch below and behind the center of the external auditory meatus, describing a curve with the convexity directed upward. The second part of the vessel occupies a deep groove on the mastoid portion of the temporal bone and on the jugular process of the occipital bone.

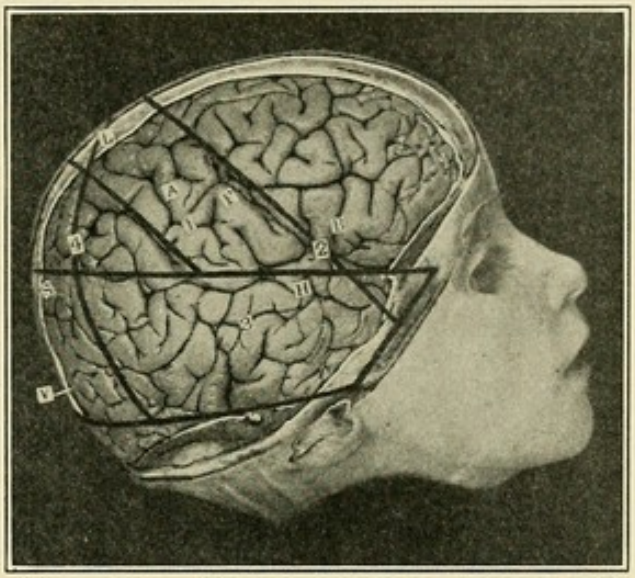


FIG. 133. CRANIO-CEREBRAL TOPOGRAPHY. The dura- and pia-mater have been removed, exposing the surface of the hemisphere. Some of the principal motor and sensory centers have been marked upon the brain as explained in the text, and Chiene's lines have been marked in the same position as they are upon the scalp in Fig. 130.—Modified from the Edinburgh Stereoscopic Atlas of Anatomy.

In Fig. 133 the dura mater has been removed, the fine membranes stripped from the surface of the brain, exposing the outer aspect of the hemisphere; and the position of some of the principal motor and sensory centers has been marked upon it. The fissures and convolutions at this age—five years—are fully developed. But it should be borne in mind that the fissures of the brain of the child do not in all cases bear the same relationship to the cranial sutures as do those of the adult. Important differences exist, associated mainly with the differences in the proportioned sizes of different lobes of the brain. At birth the Sylvian fissure lies above the squamo-parietal suture, but the fissure and the suture approach one another rapidly up to the fifth year, at which age the fissure lies about 14 mm. above the suture. In the adult the fissure may lie above, below or subjacent to the suture. Chiene's surface lines drawn upon the head of the child also place the Sylvian point above the suture, but the fissure lies at a slightly higher level even than this point. The fissure of Rolando maintains, after birth, a very constant position in relation to the surface, at both its upper and its lower ends. By comparing Fig. 133 with Fig. 130 it will be seen that the Rolandic area lies within the quadrangular figure A, C, D, M, but it must be noted that the true motor area is confined to the

pre-central area and does not extend behind the fissure of Rolando. It occupied mainly the ascending frontal convolution, extending into the depth of the fissure and occupying the anterior wall and in some places the floor. It also extends into the adjacent portions of the frontal convolutions. The upper part (at L in Fig. 133) forms the area for the lower limb and below it is the area for the body. Near the center of the fissure of Rolando, the pre-central convolution grows backwards, deflecting the course of the fissure, and the area of the cortex which occupies the indentation so formed represents the center for the upper limb of the opposite side. (See A, Fig. 133.) The center for the shoulder lies highest, and lower down are the centers for the elbow, wrist, fingers, index and thumb. The area for the face is continuous with the above (see F, Fig. 133), and the area for the tongue occupies the lowest part of the pre-central convolution. The centers for the head and eyes occupy portions of the middle and inferior frontal convolutions in front of the center for the limbs. The figure 2 is placed on the division of the Sylvian fissure, and as has been pointed out, lies at a slightly higher level than the surface mark which would indicate its position in the head of the adult. The line A, C, Fig. 130, however, overlies the posterior horizontal limb of the Sylvian fissure, and a finger's breadth below that line lies the parallel fissure (3, Fig. 133), the hinder end of which is continued upwards into the parietal lobe to the region marked S, Fig. 133, where lies the angular gyrus or center for word-seeing. The center for vision is situated at the tip of the occipital lobe. (See V, Fig. 133.) The area for hearing is found in the superior temporal convolution. The letter B, Fig. 133, overlies the area which in the left hemisphere is the motor speech center or Broca's convolution. The coronal suture can be seen to lie in front of the line AM and therefore is well in front of the fissure of Rolando.

OPERATIONS UPON THE CRANIUM

The most thorough sterilization of instruments, hands, the field of operation, and everything that comes near it, is an absolute necessity. Intracranial wound infection is an almost hopeless condition (26). The scalp should be shaved, and scrubbed with soap and water; then with alcohol to remove sebaceous or oily matters; then with bichloride or carbolic or lysol solution, and finally with sterile water. If the topography is to be mapped out, the lines may be drawn upon the shaven scalp with nitrate of silver. In all cases admitting delay for preparation this should be done on the day preceding the operation, and the head afterward enveloped in a gauze compress wet with bichloride one to three or four thousand, covered with oil silk and cotton over night, and cleansed again by the same steps

before the operation. Care should be exercised in the shaving and in every step of the preparation, that it be done thoroughly and yet without abrasion which may later become a path for infection; and without irritation of the skin which may be rendered extremely uncomfortable or inflamed by injudicious preparation. A laxative should be administered on the evening before and an enema on the morning of the operation. (See Section on Preparation for Operation.) Chloroform is usually the anesthetic of choice in operations upon head or brain. An hour previous to the operation a dose of morphine suited to the age of the child should be administered, remembering the extreme susceptibility of the young to this drug. The morphine aids by making less chloroform necessary, and, as Schaeffer and Horsley have shown, it lessens hemorrhage by contracting the arterioles of the nervous system. The careful administration of the anesthetic is a very important matter in brain surgery, as Horsley has emphasized; but inasmuch as the susceptibility to morphine differs greatly in different children it seems advisable in suitable cases to ascertain the appropriate dose by experiment a day or two previous to the operation. If the raising of the flap will obliterate the guiding lines, certain points must be marked upon the skull itself by the use of a couple of disinfected tacks driven into it, or by nicking with a drill or chisel. The head may be kept in convenient position by sandbags.

Hemorrhage during cranio-cerebral operations may be to a great extent prevented by the use of a rubber band or tubing drawn tightly round the head. Yet the oozing that follows its removal leads some surgeons to omit the Esmarch. Often it slips out of place, and after all our main reliance is in the pressure forceps, ligatures and serrefines. If there is no wound the scalp must be divided by an incision. In the mastoid operation a straight or slightly curved incision, followed by the use of retractors, gives access to the skull. If more room is needed a second incision at right angles to the first may be extended backward from it. For trephining or the raising of a bone flap, usually a horseshoe-shaped incision is made with its convexity toward the occiput or its hinge toward the blood supply. In infants and children the scalp is more movable upon and more easily detached from the skull than in the adult. The periosteum also peels easily, excepting at the sutures, where it is strongly attached.

If it is intended to make a small opening, for instance with a trephine, the scalp and periosteum constitute the flap. If the opening is to be larger for removal of a tumor, some operators prefer an osteoplastic flap composed of skull and scalp. The " trap-door " is cut through scalp and skull to the membrane on three sides, but the skull merely grooved externally on the fourth side, when it

hinges as the flap is raised outward. The skull of the child is better suited than that of the adult for making the osteoplastic "trap-door." In cutting through the skull one can choose between trephine, chisel and mallet, various saws, for instance, Hey's saw, saws or drills worked by a surgical engine, and the rongeur or biting forceps. The surgical engines and their attachments sometimes work beautifully; but frequently they are abandoned and the operation completed by hand. The chisel and mallet are preferred by some operators for opening the skull, but the jarring of the blows is an objection, and certainly may do local damage in some cases, besides adding to shock. To make a small opening, for instance to gain access to the mastoid cells, a chisel and mallet or the Russian perforator work well. In softened bone often a drill or gouge held in the hand are sufficient. For removing a portion of the cranium a good conical trephine and rongeur will be found the most satisfactory instruments. A saw works well to remove a large flap or a bridge between trephined openings; or such a bridge may be removed by the rongeur, or by passing a wire saw beneath it after opening the way by passing a grooved director between skull and dura. The skull of the child is softer than that of the adult unless it is a previously rickety skull which has become eburnated. In the young the diploë are not developed, the bone is more nearly alike in structure through the entire thickness than in the adult. The inner table is less vitreous in consistency. One should beware of thin spots in a skull, lest the trephine enter unexpectedly. The skull is thinner over the sinuses, the meningeal grooves and near the fontanelles; and it may be quite thinned over a tumor. An infant's skull may be as thin as parchment in spots. The center-pin of the trephine should be withdrawn as soon as a shallow groove is cut; and great care used as the instrument approaches the inner surface. Irrigation facilitates the work of the trephine, though it may have to be removed occasionally for clearing in carbolized water with a sterile brush. The disc of bone should be loosened and pried out without injury to the dura. This is quite closely adherent to the skull. The edges of the opening should be smoothed and all bone dust and splinters removed before the membrane is opened. Any blood clot, fresh or older, between skull and dura is easily recognizable and should be removed. The degree of intracranial tension can be judged by the bulging of the membrane and by touch. Deep discoloration beneath the dura may indicate a clot in that situation. By making a horseshoe or triangular flap in the dura the condition beneath may be ascertained.

Park's suggestion to divide the operation into two procedures, in some cases, is particularly applicable in children, for the avoidance of the shock of a prolonged operation, and also of any troublesome oozing of blood from the bone wound, which latter, however,

may give no trouble. By this plan the removal of the bone and exposure of the dura is done at the first sitting, and at the second a week or two later the membranes are opened and the remainder of the work completed. After the membranes are opened no antiseptic solutions are used for irrigation; but sterile normal salt solution may be used.

The dura is opened one-eighth or three-sixteenths of an inch from the edge of the opening in the bone, the cut being best started with a scalpel but completed with a blunt scissors, severing four-fifths of the circumference of the flap. (Nancrede.) The membranous flap being lifted the condition of the brain is noted. Tumor beneath the cortex may cause a yellowish tinge or lividity upon the surface. Yellow-white patches in the perivascular lymphatics indicate "old mischief." The motor center searched for may be located by lightly touching it with an electrode from a very weak interrupted current. Any increase in tension in the brain is noted by its bulging into the wound. If there is tumor beneath the cortex, it may be necessary to make an exploratory incision into the brain. Any necessary incision into the cortex should be vertical to the surface and in the long axis of the convolutions, and with due regard to the blood supply. Incisions should be clean cut, with Horsley's flexible knife. An endeavor should be made to leave some portion of each motor center; but if malignant growth is to be excised it must all be removed, extending the incision beyond its boundaries in the white fibers, where recurrence is most apt to take place. A cyst should be curetted and drained or preferably packed. An abscess must be cleared out.

The hemorrhage is sometimes a troublesome thing to manage. A diploic vein may be plugged with catgut or a bit of bone or decalcified bone or antiseptic wax, as suggested by Horsley; or its walls crushed in with a blunt instrument or by forceps. If dural vessels lie in the way and must be cut, they may be ligated either after or preferably before division by passing beneath them a round needle threaded with fine catgut. Wounds of sinuses may be plugged with catgut or compressed with gauze for a few days. The pia, and especially its vessels, should be wounded as little as possible. Its vessels should be ligated before division and the flaps carefully put aside, to be replaced when closing. Nancrede alludes to that common difficulty of having the vessels of the pia cut through in the tying of the ligature, and like many operators finds the small old-fashioned serrefines very handy. If bleeding recurs on removal of the serrefines and ligatures repeatedly cut off the ends of the vessels, he re-applies the serrefines with threads attached to them to facilitate removal after a few days. This also saves time, a very desirable thing in operating upon children. The brain cortex itself is not so very vascular, at least few vessels are likely to spurt.

Pressure with a gauze sponge will probably control the oozing; but if necessary fine gut ligatures should be applied. Park favors the use of a 5 per cent. solution of antipyrine sprayed upon the brain to stop oozing. Drainage is generally necessary after brain injuries and operations. If it is a pus case nothing but a tube is efficient, except possibly a cigarette drain of rolled rubber tissue. If the wound is clean and only serum or oozing blood are to be drained away the cigarette or a bundle of catgut serves for a drain. Nancrede and many other surgeons insist on draining a bullet track, especially if it has been probed. If a tumor or a portion of brain has been removed so that a cavity exists, it is usually well to pack it with gauze. Drainage should also be supplied, for gauze will not drain. But it will stop oozing and may help to prevent that frequent and dangerous condition, edema of the brain, by keeping up the usual tension upon the veins.

If packing is required flaps may be closed with secondary or temporary sutures which can be untied and the flaps partly retracted at subsequent dressings. Park uses 5 per cent. ointment of naphthalin upon tampons between the wound edges, so that they may not adhere and then bleed at subsequent dressings. The nature of the case may allow of closing the wound at once, and primary union may be secured. The buttons of bone or other pieces removed were formerly replaced in closing. But when detached from both scalp and membrane they are apt to lose their vitality. It is better (having kept such portions of bone immersed in antiseptic solution till the end of the operation) to break them into fragments like coarse sawdust and fill the gap with them. (McEwen.) If the wound is perfectly aseptic, a plate of celluloid or heavy gold foil having several perforations and cut to proper size, may be used to span the gap, resting upon its margins, covered with the periosteum and scalp. Such a plate serves to prevent protrusion of cranial contents and their adhesion in the scar. A plate or an osteo-cutaneous flap may have to be notched to allow for drainage or removal of packing. The dura is closed with fine chromicized catgut. If a portion of the dura is lacking, the vent may be partly closed by passing catgut sutures across. The scalp wound is sutured with silkworm gut or fine silk. External dressings of antiseptic absorbent gauze should be ample and well secured in place, not only with a roller bandage but with adhesive strips or basting threads. Or a starch bandage may be employed. The head may be steadied with sandbags. The child should be carefully watched and kept in perfect physiological rest, in a quiet, darkened room. The excretions should be kept active. Low diet only is allowed for the first few days. While adult patients who do well may be allowed up in perhaps ten days, a child should be kept quiet for three weeks.

CHAPTER XIV

DEFORMITIES AND DISEASES OF THE EAR AND INTRACRANIAL EXTENSION OF EAR DISEASE

Absence or Malformation of the Auricle—Over-Development and Prominence of the Auricle (Macrotia)—Fistula in Auris Congenita—The Meatus Auditorius Externus—Anatomy—Congenital Occlusion of the Meatus—Foreign Bodies in the Ear Canal—Diffused Inflammation of the External Meatus—Diphtheritic Inflammation of the Ear—Injuries of the Tympanic Membrane—Myringitis (Inflammation of the Tympanic Membrane)—Inflammation of the Middle Ear (Otitis Media; Tympanitis)—Incision of the Membrana Tympani (Myringotomy)—Mastoiditis:—Infective Thrombosis of the Lateral Sinus—Intracranial Extension of Ear Disease to the Meninges or the Brain. (27)

ABSENCE OR MALFORMATION OF THE AURICLE

The auricle may be congenitally absent or rudimentary or misshapen. The result of arrested development of the auricle is called microtia. This may be the only malformation present in the hearing apparatus, but there are usually others, to be mentioned shortly, associated with it; and not infrequently the ramus of the jaw also is stunted, as seen in Figs. 134 and 135. Malformation of the ear has been considered as a stigma of degeneration, yet ears far from the normal in shape or position are found upon normal individuals.

Treatment.—If the external ear is entirely absent or is microtic, an artificial pinna may be attached. The crumpled or distorted auricle may sometimes, but very seldom, be improved by plastic operative work planned to suit the special case.

OVER-DEVELOPMENT AND PROMINENCE OF THE AURICLE (MACROTIA)

The ears may be unduly large; and in addition they may stand out prominently from the head. This is sometimes called lop-ear. It causes conspicuous deformity and great annoyance to the patient.

Treatment.—If the deformity is one of position rather than

size of the ear and the patient an infant or quite a young child, the condition may be improved by the use of an ear truss, singly or in pairs, applied with a spring or by a bandage or a cap of thin netting. If entirely too large, the size of the pinna may be reduced by excising a portion of triangular shape, with sides of equal length with the apex toward the meatus, neatly closing the gap by suturing the cut margins together.

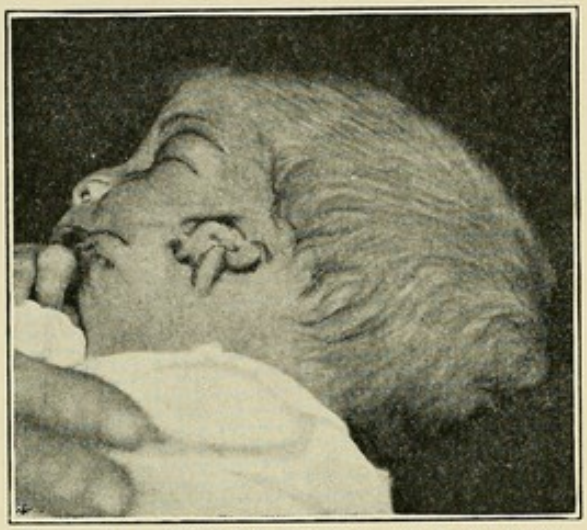


FIG. 134. MALFORMATION OF EAR, JAW, AND MOUTH. Side view. Case of Dr. J. M. Moore.

To turn the ear backward so that it will lie more closely to the head, an oval portion of skin longest vertically may be removed from the ear on its posterior surface, a vertical groove cut in the cartilage in the center of the denuded portion, the ear folded back upon itself, and cut edges of skin sutured together and the raw surfaces maintained in apposition until union takes place. Or a portion, the half of an ellipse, of skin and its underlying cartilage may be removed from the ear posteriorly, and a similar area, a half ellipse, denuded of integument over the mastoid process and the pinna sutured back in proper position with relation to the head.



FIG. 135 Same case as Fig. 134. Front view. Malformation of ear, jaw and mouth. Case of Dr. J. M. Moore.

FISTULA IN AURIS CONGENITA

This is an opening in front of or just below the tragus, which leads into a blind canal, filled with sebaceous material and sometimes pus. If the secretion accumulates it may become hardened. The canal may sometimes be obliterated by swabbing it out with a caustic to excite inflammation and adhesion of its walls; but a better method is to dissect out its epithelial lining and bring the walls together to heal by first intention.

COMMON AFFECTIONS OF THE EXTERNAL EAR

Common affections of the external ear are eczema, which most frequently attacks the crease between the ear and the head, resembling eczema intertrigo; chilblains upon the outer and upper edge of the ear; and lupus or other form of skin tuberculosis often upon the lobule. Herpes and sunburn should be mentioned. Nevus, fibroma, papilloma or sarcoma or keloid may be found upon the auricle. Traumatic hematoma may occur. These present nothing peculiar in childhood and are treated as the same affections would be upon any other part of the body.

THE MEATUS AUDITORIUS EXTERNUS

Anatomy.—It is usual to consider that the external auditory canal in the adult is two-thirds osseous, and in one-third of its length, cartilaginous. In the new-born infant the proportions are very different, for only the roof of the inner third, which is formed from the squamous part of the temporal bone, with the annulus tympanicus, are osseous. From the annulus the fibrous membrane containing several pieces of cartilage extends outward, forming the remainder of the floor of the meatus, which later, when ossified, will become the tympanic plate. The external auditory meatus is as long as, or even longer than, that of the adult, in proportion. (Symington.) Doubtless the impression of its being short was taken from examination of the skull alone, the membranous portion being absent. Ballantyne found that the upper wall of the meatus measured 19 mms. in length, and the floor, 21 mms., the difference being due to the oblique position of the membrani tympani. In infants the external canal is inclined downward as it passes inward to the tympanic membrane, which causes it to be placed quite obliquely with relation to the tympanum as compared with the adult. This has given the impression that the tympanum in the infant and young child is placed almost, if not quite, horizontally, which is not the case. It is true that it is quite oblique, and especially so with reference to the downward sloping meatus, but Ballantyne found it at an angle of 12 degrees with the floor of the meatus and of 33 degrees with the horizon. The normal angle with the meatal floor in the adult is said to be 45 degrees. This position of the canal, like its cartilaginous condition and other peculiarities of the infant, changes only gradually through infancy and childhood and will be found in any stage of development between the infantile and the adult types. The inner end of the meatus—that is, its sinus, in proximity to the tympanum—is a little larger than the rest of the canal. The narrowest portion of the canal is about the

joining of the bony and the cartilaginous portions, at the junction of the inner and middle thirds, or toward the middle of the canal.

Congenital Occlusion of the Meatus.—The external orifice of the auditory canal may be closed by a septum, or in other cases there may be no auditory canal. This deformity may exist either with or without any other abnormal development of the external, or any of the middle or internal ear. But the internal malformation is, as a rule, more marked and serious than that which appears externally.

Treatment.—Cases of this kind cause parents great anxiety, and sometimes impatience, but nothing remedial should be attempted before the child is old enough to have the hearing tested. By the tuning fork and other tests the condition of the internal mechanism of hearing can be ascertained. Earlier interference is only necessary in case a septum closes the canal, in which cerumen, or, in case of inflammation, pus, accumulates and must be released by division of the septum. If nothing of this kind occurs, an exploratory dissection may be carefully made in the direction of the canal. Or the canal may be searched for by a dissection behind the ear, and, when found, explored with a bent probe. If its external end be within reach the meatus may be opened, but it is very difficult to line such a canal with integument if it is necessary to dissect to any depth. In case of absence of auricle and canal, it is neither necessary nor possible to do anything operative for its correction. Artificial ears could be worn if desired for the sake of appearance. They would be held in place by a spring passing over the top of the head and hidden by the hair.

Foreign Bodies in the Ear Canal.—A foreign body in the ear canal is so common in children as to deserve more than mention as a possibility. The body may be inanimate or animate, and consist of anything of such size and shape that it can be introduced or can get into the canal. Beads, buttons, peas, beans, pebbles, and paper wads are usual. Insects are not so common, though sometimes found. Small beetles, bedbugs, fleas, larvæ, maggots, or woodticks may be discovered in the ear canal. One occasionally finds a piece of onion which had been heated and introduced by the mother to stop earache, as is a common practice in parts of Europe and among immigrants of that class here. Accumulations of ear wax are not so common as in adults.

Treatment.—If there is much purulent discharge this must be carefully wiped out with a cotton-wrapped probe or applicator until quite clean. In many cases, especially if there is inflammation, an anesthetic will be necessary for satisfactory examination or treatment. A head-mirror and ear specula are needed. The means for removal will depend on the shape and substance of the

foreign body. Live insects are usually readily killed with a few drops of olive oil or castor oil, after which they can be syringed out. Maggots are best attacked with chloroform vapor. Peas, beans, paper wads or any substance likely to swell by absorption of moisture should not be treated by syringing. Some objects can be readily seized with small forceps. Others are better managed by passing around them a loop of small, strong wire. A blunt hook, not too much curved, is one of the most convenient instruments that can be used in many cases. The hook is slipped over or around the foreign body, which is gradually pulled out. Beads and impervious bodies may often be forced out by directing a current of water from a syringe over and behind them. Dried ear wax is best removed in the same manner, after making a small opening between the accumulation and the upper wall of the canal, by which the water may get behind. For bodies of such shape and substance as cannot be seized or surrounded, a camel's-hair brush, dipped in glue, may be used. The brush is spread in contact with the object and left there till the glue hardens, when they may both be withdrawn.

Diffused Inflammation of the External Meatus.—This inflammation may arise in traumatism, such as a blow, or the presence of a foreign body or efforts at its removal, by the use of irritating medicaments, by excoriation of the skin lining the meatus, by infection either with or without a wound. Infection may be introduced from outside or by way of the middle ear.

Symptoms.—The symptoms are those of inflammation, confined mostly to the lining of the bony portion of the canal. Pain is present and is aggravated by movements of the jaw. There may be tinnitus or impairment of hearing, or dizziness. After a few days the inflamed skin exudes a tenacious sero-ceruminous material. Sometimes the skin itself exfoliates. The disease runs its course in three or four days, and usually results in recovery. In rare cases the inflammation may cause ulceration, or may penetrate to the periosteum and be greatly prolonged, and possibly result in partial stenosis from cicatricial contraction or hyperostosis.

Treatment.—The discharges should be carefully removed from the canal by absorbent cotton, wound upon an applicator. The canal should be disinfected with hydrogen peroxide, applied with a cotton swab. A few drops of a solution composed of glycerine, 75 per cent.; water, 20 per cent., and carbolic acid, 5 per cent., should be instilled into the ear three or four times a day. A pledget of cotton closes the canal. Leeches in front of or below or behind the ear are advised and are useful, although not very often used in children. Dry heat or cold, usually cold, are used, and usually the one most grateful to the patient is the most beneficial.

DIPHTHERITIC INFLAMMATION OF THE EAR

Diphtheria and pseudo-diphtheria may attack the ear either by infection from the outside or by way of the middle ear. For the characteristics of this disease and the treatment see Section on Diphtheria.

INJURIES OF THE TYMPANIC MEMBRANE

The tympanic membrane may be injured by accidentally thrusting any slender object, such as a pencil or wire, into the canal; or in attempts to remove ear wax or a foreign body with a hairpin, match, stick, toothpick or the like; or by accidental scalding with a hot fluid, or cauterizing by liniments or other drops injudiciously employed for earache; or by sneezing; or violent efforts at inflating the ears; or by a kiss upon the ear; by a box upon the ear with the hand or a book; by concussion produced by an explosion; by fracture of the bony canal, etc.

Symptoms and Diagnosis.—Pain may be present at the time of injury; or it may not be complained of until inflammation sets in. Hemorrhage often follows the injury. Tinnitus is usual, and loud at first, afterward subsiding. There is usually deafness in some degree; and, on the contrary, in rare instances the hearing becomes painfully acute. Shock, nausea, giddiness, and loss of equilibrium, and even convulsions occur when the labyrinth is injured.

Examination may reveal rupture of the membrane, which is most apt to be located in the posterior-inferior quadrant. The opening may be slit-like or ragged or a round perforation. The whole membrane may be ecchymotic. If there is fracture through the petrous portion of the temporal bone or the wound opens the labyrinth, cerebro-spinal fluid will escape.

Prognosis.—In ordinary cases of rupture of the membrane the prognosis is good. If the ossicles, also, are injured, permanent impairment of the hearing may result. Injury severe enough to cause discharge of cerebro-spinal fluid is very serious. If suppuration ensue the prognosis is very grave. If the labyrinth is injured it will take several weeks to determine the result to the hearing. In the meantime the nausea and giddiness may persist.

Treatment.—Usually there is little to be done locally except to prevent infection by wiping the ear out carefully, and plugging the meatus with dry sterile cotton to prevent the entrance of germs. If symptoms of inflammation ensue, leeching is in order, and the antiseptic line of treatment prescribed for diffused inflammation of the external meatus.

MYRINGITIS, INFLAMMATION OF THE TYMPANIC MEMBRANE

This may be due to any of the causes enumerated as likely to injure the membrane itself, or the inflammation may extend to the membrane from an inflamed meatus or tympanic cavity.

Symptoms and Diagnosis.—The most marked symptom is pain, but tinnitus and some deafness are usually present when swelling occurs. Deafness is only slight, unless the middle ear is involved, when it is greater. Slight fever may be present. On ocular examination the membrane is found to be congested, which gives it a reddened or yellowish-red color. The part worst affected is along the handle of the malleus and upper half of the membrane. Swelling and infiltration of the membrane extending on to the wall of the canal may render their line of junction indistinguishable. Small blisters, or blebs, may sometimes be seen upon the membrane, due to exudation of serum between the epidermic and the fibrous layers of the drum-head. The contents of these blebs may become purulent, or, more rarely, bloody. When myringitis accompanies otitis media, the mucous and fibrous layers are most affected. With otitis media there is more marked bulging of the membrane into the external canal.

Prognosis.—The prognosis depends upon the amount of alteration, destructive or degenerative, that takes place in the membrane. The acute may merge into a chronic condition. If associated with otitis media, with perforation, or if the patient is of the strumous type or has had repeated attacks, the prognosis is more serious.

Treatment.—Usually a purgative is indicated, and later, salicylates, or iodides, syrup of the iodide of iron and tonics. Dry heat, and, in obstinate cases, hot irrigation are useful. Some advise cocaine solution for the pain, but its action is uncertain, especially in children. The 2 to 5 per cent. solution of carbolic acid in glycerine is more certain and safer. The blisters which appear upon the tympanic membrane should be pricked. If there is purplish swelling the outer layer of the drum membrane should be incised or scarified. If pus is present, care should be taken not to perforate the inner layer, lest infection be introduced into the middle ear. If the Eustachian canal is closed it should be inflated to equalize the air pressure. The ear should be irrigated with a warm solution of boracic acid, dried and closed with dry cotton.

INFLAMMATION OF THE MIDDLE EAR (OTITIS MEDIA; TYMPANITIS)

The tympanic cavity of the infant differs from that of the adult in the comparatively open condition of the petrosquamosal suture.

The roof of the cavity is formed by the meeting of the squamous portion with the petrous portion of the temporal bone, a shelving outgrowth of the pars petrosa superiorly overlapping the pars squamosa inferiorly. But the suture which joins them is unossified; and there extends through it a process of connective tissue from the dura-mater which connects with the mucoperiosteal lining of the tympanic cavity and contains blood-vessels and lymphatics. This condition, as Symington long ago pointed out, increases the liability of direct extension of inflammation from the tympanic cavity to the membranes of the brain.

Inflammation of the middle ear is extremely common in infants and children. It often leads to consequences serious not only to the hearing, but to the life, and it frequently requires surgical attention. For our present purpose it is not necessary to discuss an elaborate or refined classification, for, from the standpoint of practical clinical surgery, all the inflammations of the middle ear may be considered under two groups: non-suppurative, or catarrhal inflammations, and suppurative inflammations.

The term catarrhal inflammation does not deny the presence of infective micro-organisms. In fact, the pneumococcus, the staphococcus and others are often found in the exudate, resulting from non-suppurative inflammation. In such cases either the organism is not active or the system of the patient is resistant. Again, cases of suppurative otitis occur in which no micro-organisms can be found. The differences between the two groups of cases are greater in degree than in kind. The catarrhal may readily merge into or be followed by the suppurative form of the disease.

It is best to look upon all cases of inflammation of the middle ear as due to infection by micro-organisms; although it is true that there may be an underlying or predisposing dyscrasia. The patient may be undoubtedly rheumatic or strumous, or undeniably syphilitic or tuberculous. Any disease of the Eustachian tubes which interferes with the equilibrium of the air-pressure inside of and outside of the tympanum predisposes to otitis. With occlusion of the tube, absorption of the oxygen of the imprisoned air reduces its bulk, and the diminished intra-aural pressure leads to engorgement of the blood- and lymph-vessels. The occlusion also causes retention of the secretions. In the larger number of cases the catarrhal tympanitis is associated with rhinitis, naso-pharyngitis and inflammation of the Eustachian tubes, adenoid growths, enlarged tonsils or hypertrophied turbinates, especially the middle turbinate, spurs and deflections of the septum, and may thus be said to be secondary to a pre-existing disease. A primary attack, or the onset of secondary symptoms, is usually attributed to taking cold, to cold bathing or sea bathing, cold wind or the like, and

there may be a clear history of exposure. In rarer instances it may originate in traumatism, such as a box on the ear, or accidental puncture of the ear-drum, violent sneezing from rhinitis, or the passage of vomited matters, or even worms into the middle ear through the Eustachian tube. If there be added to any of these causes active infective agents or a low state of the vital resistance, suppurative inflammation will result, either by transmission of infective material along the lumen of the Eustachian tube, or by way of the blood, or through the external ear, or, more commonly, it is thought, through lymphatic channels connecting the naso-pharynx and middle ear. The germs most apt to act as etiological factors in suppurative otitis are the pneumococcus, the streptococcus pyogenes, the staphylococcus pyogenes albus and aureus, the bacillus pneumoniæ of Friedlander, the germs of scarlatina, measles, influenza; or, less frequently, the diphtheria bacillus, the tubercle bacillus, the colon bacillus, the bacillus pyogenes fetidus, or even the gonococcus.

In acute catarrhal otitis media of the membrane lining the tympanic cavity is swollen by congestion of the blood-vessels and filling of the intercellular spaces with serum. The goblet cells of the mucosa undergo rapid mucoid degeneration, and these, with serum, are poured out in greater or less quantity, forming the characteristic mucous exudate. The surface of the mucous membrane thus becomes partially denuded of its epithelium. The process does not lead to any great destructive changes, although in rare instances the drum-head may be perforated. The morbid process runs its course in a few days. The mucous membrane is soon restored to its usual condition, excepting that it is more susceptible than before to inflammation, which may recur or become chronic.

In the presence of active infection there is proliferation of leucocytes, abscess formation, with perforation, or perhaps destruction of the drum-head, exfoliation of one or more of the ossicles; or it may be with mastoiditis, bone necrosis, thrombosis or phlebitis of the adjacent sinuses, lepto- or pachymeningitis, cerebral abscess, facial paralysis, disease of the internal ear with labyrinthine deafness, or extension to the temporo-maxillary joint, causing ankylosis.

Symptoms and Diagnosis.—It may be impossible to differentiate between acute non-suppurative and acute suppurative otitis media. In infants the symptoms may be very obscure, there being nothing objective but fever and no diagnosis made unless the ear drum-heads be examined, until rupture occurs, with discharge of mucus or mucopus, followed by fall in the temperature. But there is usually evidence of pain, such as more or less continuous crying, wakefulness and restlessness, and sometimes rolling the head or beating the head with the hands or pulling at the ears.

In older children there is fever, great restlessness, more rarely delirium or convulsions, while pain, deafness or noises in the ears are commonly complained of. Occasional symptoms are cough not otherwise accounted for, and vomiting. Examination may reveal tenderness on pressure over the tragus, and sometimes over the mastoid or the styloid processes; but pain or tenderness over the mastoid or below the ear or in the post-auricular lymphatics does not necessarily indicate suppuration of the antrum and mastoid cells. The tympanum may appear reddened or lusterless, or, after a short time has elapsed, it may bulge noticeably with the accumulated mucus or pus behind it. Bulging of the ear-drum may also be due to hemorrhage behind it, as might occur from traumatism, or in cerebro-spinal meningitis, or in hemophilia, scorbutus, Hodgkin's disease, pernicious anemia, or purpura hemorrhagica. But any of these are far more uncommon than otitis media, and usually are accompanied by a characteristic train of symptoms. Either one or both ears may be involved in the otitis, simultaneously or successively. If unrelieved in a few hours to a few days, depending on the virulence of the inflammation, rupture of the tympanic membrane may occur, with subsidence of the symptoms. The opening in the tympanic membrane is usually round or oval or elliptical, and is most frequently located in the posterior-inferior quadrant.

The continuation of fever and nervous symptoms after the tympanic membrane has ruptured, or been opened and discharged, is indicative of insufficient drainage, or possibly of farther extension of the inflammation.

Malodorous discharge usually indicates implication of the ossicles or osseous walls. Continued or irregular fever, with tenderness over the mastoid, indicates probable extension into the mastoid antrum and cells. Long continuation of a profuse discharge indicates disease of a chronic nature. The intracranial complications do not occur in the catarrhal cases of otitis, but in the suppurative; and most frequently in the suppurative cases which have become chronic. Otitis should always be thought of in the diagnosis of any fever of obscure origin, or in acute exacerbations during any of the anginas or infections or exanthemata with which it is so frequently associated, not forgetting the intestinal infections. Scarlet fever and measles are the most frequently of all associated with otitis, which becomes chronic and leads to serious intracranial disease. An acute suppurative otitis media without pain should be very carefully examined for tuberculosis, which is probably at the bottom of it.

Prognosis.—On account of the many possible complications and sequellæ, the prognosis is somewhat uncertain. Yet the great majority of cases recover, and this without even any permanent

impairment of hearing; or there may be impairment of hearing from ankylosis of the ossicles or adhesions between the ossicles or between the drum-head and the walls of the cavum tympani, and a liability to a repetition of the attack. Or the case may lead to one or more of the complications before mentioned, or it may assume a chronic form, with masses of granulation tissue, and sometimes polypi growing upon the walls of the tympanic cavity, and a persistent vile-smelling discharge. If the discharge contains only mucus the prognosis is much better than if it contains pus. Lessening of discharge, with improvement of the hearing and absence of fever, indicates favorable progress. A streptococcus infection or a mixed infection occurring during or following one of the specific fevers is apt to be more obstinate.

Treatment.—Prophylactic treatment should always be employed. It consists of careful treatment of nose and throat in all anginas and infectious diseases apt to be followed by otitis. At the outset of the disease, general and local depletion are useful—the former attained by purgation and the latter by warm baths—especially to the lower extremities, and by warmth externally over the ear. Leeches applied near the tragus or beneath the auricle, or perhaps best of all, over the mastoid antrum or at the tip of the mastoid process, are useful in sthenic children, although at present they are little employed. An effort should be made to restore the normal intratympanic air pressure by Politzerization or Eustachian catheterization or suction with the Siegel otoscope. As a preliminary step the naso-pharynx should be carefully cleansed, and any inflammatory or obstructive condition located there should be treated. Pain may be relieved by heat, either dry or moist. Dry heat is most recommended in the beginning of the attack. It is applied by a bag or coil of hot water, or a bag of hot salt, sand or hops, or an electric heater or a Japanese hot box. Moist heat may be used by filling the external canal with warm sterile water while the patient lies on the opposite side, and then applying a hot water bag over the ear to keep the column of water in the canal hot. But the best means of using heat, if the pain and inflammation persist, is by a fountain syringe and a solution of boric acid, or of mercuric bichloride, 1 to 5000. The water, as hot as can be borne and under very little pressure, should flow into and out of the ear canal for five to fifteen minutes at a time. This may be repeated every few hours, or if the pain returns. After each irrigation the canal should be dried with absorbent cotton wound upon an applicator, and then lightly stopped with a pledget of cotton to keep out infective organisms. The domestic use of oils, lotions, etc., in the ear, and of poultices and other household applications upon the outside is usually either useless or injurious. A few

drops of a 2 to 5 per cent. solution of carbolic acid in glycerine, diluted one-fifth with water, should be instilled into the ear several times a day. This has an excellent effect as an antiseptic and analgesic. It also moistens the inflamed tympanum, which is very soothing, and it relieves the engorgement of the tissues by promoting exudation. It may be necessary, also, to administer codeine or other opiate if the pain is too severe.

INCISION OF THE MEMBRANA TYMPANI (MYRINGOTOMY)

If the inflammation does not subside under this treatment, or the collection of exudate in the tympanic cavity is excessive, it is advisable to incise the drum-head. The drum-heads should always be examined with a good light, head mirror and ear speculum. If there is bulging of the membrane, showing pressure from within, an incision should be made. In fact, it is not always well to wait for bulging of the membrane, but if it is excessively inflamed, as indicated by its red color, swelling and loss of luster, it is treated as one would a cellulitis with excessive tension elsewhere; namely, by incision. Paracentesis—that is, a mere puncture—is no longer in favor. It does not afford adequate drainage to the cavity, nor relieve the tension of the membrane itself. Incision, while apparently more radical, is really conservative treatment. The incised wound heals readily, leaving very little scar and no impairment of function as a result of the incision. There is far less danger of making an unnecessary or premature incision than there is of postponing until greater damage is done. Special instruments, or myringotomes, are made for this little operation, but a fine tenotome with a long, slender shank, or a narrow bistoury will answer the purpose. A general anesthetic is usually necessary with children. A good light upon the drum-head should be obtained, and the child's head steadied by an assistant. A semi-circular incision is made in the two posterior quadrants. Beginning about half way between the tip of the handle of the malleus and the inferior margin of the drum-head, the incision curves backward and upward and passes about half way between the tip and the posterior margin, and thence more directly upward toward the margin, as shown by the black line in Fig. 136. Some surgeons carry the incision through the superior margin of the membrana tympani and into the wall of the meatus, as shown in the dotted line. The point of the knife should not be thrust deeper than necessary to penetrate

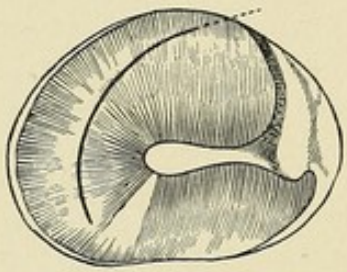


FIG. 136. LINE OF INCISION OF THE MEMBRANA TYMPANI FOR THE EVACUATION OF INFLAMMATORY PRODUCTS.

the drum-head, lest the wall of the tympanic cavity, which is not far behind it, be injured. If there is bulging confined to Shrapnel's membrane, the upper posterior quadrant, it indicates suppuration in the attic and the incision is best made where it bulges most. After incision, irrigation with warm boric acid solution or mercuric bichloride, 1 to 5000, cleanses the ear. If the discharge is very tenacious a solution of sodium bicarbonate or other sterile alkaline solution hastens the flow. Irrigation may be practical once or several times a day, according to the amount of the discharge, but enough to keep the ear thoroughly cleansed. But when thorough cleaning can be secured by dry mopping with pledgets of absorbent cotton, this method is preferable, especially when the discharge shows a tendency to diminish. It is possible to perpetuate a discharge by injudicious syringing. After each irrigation the canal should be carefully dried with pledgets of cotton on an applicator, and, if there is no tenderness, finely-powdered boracic acid should be dusted in and the meatus lightly plugged with cotton.

After the tenderness, pain, and acute inflammatory symptoms have subsided, Eustachian inflation should be used. Some surgeons now prefer suction by the Siegle otoscope as better and safer. The Eustachian tube would be very easily catheterized in a child but for the patient's fear and restlessness.

If the discharge persists for more than two or three weeks the ear may be mopped with a 2½ per cent. solution of carbolic acid, or a 10 per cent. solution of argyrol, or a 25 per cent. solution of hydrogen peroxide in water, and then carefully wiped out before insufflation with the powder. This treatment will subdue the suppuration and keep down the exuberant granulations which are apt to form. Catarrhal cases get well more promptly, but a suppurative case may require proper attention and perhaps daily inspection for five or six weeks to secure the best result and prevent its drifting into a chronic condition. Complications by mastoiditis, meningitis or implication of the sinuses will be considered in other sections.

As before stated, in the majority of acute cases in which the membrana tympani is opened with a knife, or even spontaneously, it heals again promptly. In fact, it may reunite before the cavity has drained sufficiently, and require reopening. In cases which become chronic the perforation sometimes remains permanently open and discharge continues or recurs at intervals; and the cavity may be filled with granulations. In such cases it may be necessary to scrape away the exuberant granulations, but usually they disappear under mopping with the carbolic or argyrol or peroxide solutions and dusting with boric acid. If the soft granulations persist, pure

alcohol, eight to ten drops in the ear once or twice a day or once in two days, with dry cleansing and dusting in the intervals, may be successful. Some recommend very strong solutions of silver nitrate in extremely obstinate cases. Another method of dealing with the granulations is to touch them with as much deliquesced chromic acid as will cling to the end of a bare metal probe or applicator.

When this granulating condition has become subacute or chronic, polypi are apt to form. The polypi should be twisted off at the pedicle by a probe or fine forceps, or removed with a wire snare, and the stump touched with chromic acid.

MASTOIDITIS

The cells of the mastoid portion of the temporal bone are not fully developed until after puberty. But the mastoid antrum is present even in infancy. The antrum communicates with the cavity of the tympanum, and its thin walls and very thin roof form but a slight barrier between the pneumatic cavity of the temporal bone and the membranes of the brain. With further development the walls, and especially the roof, of the antrum become thicker, and about the period of puberty they contain the vacuolations or cells known as the mastoid cells.

Mastoiditis, inflammation of the mastoid antrum and cells, one or both, is one of the most common and most serious diseases located about the head. It seldom occurs as a primary disease, but usually by extension of inflammation from adjacent tissues, in most instances spreading from the cavity of the tympanum. In rarer instances, infective inflammation in the posterior wall of the external auditory meatus penetrates to the mastoid antrum and cells, or mastoid periostitis involves the bone beneath. The invading organisms are those already mentioned as causing otitis media. The mucous membrane becomes inflamed; the bone beneath it is soon involved, softens, and breaks down; the destructive process advances rapidly in the porous osseous structure, and more slowly in that which is denser. As the shape of the bone and its degree of development and relative density, the virulence of the inflammation and the vital resistance to morbific influence vary greatly in different patients, it is very difficult to tell in which direction the inflammation will extend most quickly or in how many hours or days abscess formation or necrosis will occur. Mastoiditis does not always go on to destruction of the mastoid process, nor always extend to adjoining tissues. It may be confined to the antrum alone or destroy but a small portion of its bony wall. That most frequently involved is just in front of and below the antrum. Next in frequency are involved the cells in the tip of the process, the

posterior border of the process near the sigmoid sinus, and the portion lying above the antrum.

Symptoms and Diagnosis.—The symptoms are pain, localized tenderness, swelling, and fever. The pain varies greatly in degree. It is located about the ear or over the whole side of the head, and it has nothing characteristic that is pathognomonic of mastoiditis. Tenderness over the region of the mastoid is a more important symptom. It should not be confounded with tenderness of the auricle or cartilaginous portion of the canal. The greatest tenderness is over the antrum, but the area of tenderness does not indicate the position nor limit the area of the disease. Swelling is only present early in those unusual cases of periosteal mastoiditis. It usually does not appear until the inflammatory process has softened and penetrated the cortical layer of bone. The most frequent seat of swelling is posteriorly at the inner end of the canal. Far less frequently there is swelling and redness behind the auricle. Swelling and tenderness of the lymph nodes, near the insertion of the sterno-mastoid, is often present in mastoiditis, and not present, as a rule, in otitis media alone. It is therefore a diagnostic symptom of value.

Fever is usually present, and may vary from 101 degrees or 102 degrees to 105 degrees in acute cases. But a case may take a subacute or chronic course, with scarcely any or only a slight and irregular elevation of temperature.

Otorrhea, otitis, or a history of an otitis at some previous time should always be considered in the diagnosis.

A blood count may aid in differentiating obscure mastoiditis from typhoid fever, influenza, or malaria, since leucocytosis is indicative of the presence of a suppurative process and is not present in the diseases mentioned, which sometimes resemble mastoiditis.

Prognosis.—The prognosis in acute cases treated promptly is favorable. The inflammation may perhaps be subdued without suppuration. Even in cases which have gone on to abscess the prognosis is favorable if proper treatment is carried out while the disease is still limited to the mastoid. Danger lies in the extension of the morbid process to near-by sinuses or meninges. Before operation it is impossible to determine exactly the location or the extent of the disease process, and therefore the prognosis is always guarded.

Treatment.—So many cases of mastoiditis take their origin in neglected otitis media that prophylaxis by proper treatment of an inflammation of the tympanic cavity, whether acute or chronic, is a matter of importance.

While all cases of inflammation of the mastoid should be looked upon as infectious, it should not be regarded as inevitable that the

inflammation should go on to abscess. An attempt should be made to abort the process. Congestion, and even inflammatory infiltration, may be subdued, the infective organisms destroyed, and the products of the inflammation removed before any destruction has occurred. If the case is acute, a warm bath and a mercurial and saline purgative are in order. Following the purgative, the use of mercury in alterative doses is beneficial. Leeching, although a little out of fashion at the present time, often shows not only temporary relief, but permanently beneficial effect.

The application of cold, by means of the ice bag or the coil, is a powerful means of checking inflammatory action. The cold should not be intense in children, lest it have a depressant action, local and general. It should not be used in asthenic cases. Whenever used it should be moderated to a comfortable coldness by interposing a thickness or two of flannel between the ice-bag and the head. To do more good than harm, the cold application, once begun, should be used continuously for one to three days, and then discontinued gradually. Intermittent use of cold has an aggravating effect. Heat, as advised in otitis media, is preferred to cold by many surgeons, and is certainly better in asthenic cases. In cases involving the tympanic cavity, and this includes nearly all cases, the drum-head should be freely incised and the upper and posterior end of the incision prolonged through its margin and through the skin and periosteum to the bony wall of the canal.

If, after several days of this treatment, there is no satisfactory abatement, but the pain, fever and tenderness continue, no further time should be expended in this manner. Operation is indicated. Bulging of the canal upon its superior and posterior surface at its inner end, especially when incision through the periosteum in this region does not abate the symptoms, calls for the mastoid operation.

If, in the course of mastoiditis, chills, vertigo, nausea, or vomiting without nausea, psychic excitement, delirium, convulsions, or coma occur, the disease has invaded the lateral sinus, the brain or its coverings, and operative interference is imperative.

With fever and pain present, if tenderness and swelling develop behind the ear, independently of the external canal, either cartilaginous or bony, operation is indicated. If, in the presence of an otitis media, symptoms arise pointing toward mastoiditis, and it is found that the infection is streptococcal, the probability of mastoid invasion becomes a certainty and the case will likely require operation sooner or later.

A pronounced and persistent mastoid tenderness, even in the absence of fever or discharge, justifies an exploratory operation.

Mastoidectomy.—Although one expects to encounter pus in

this operation, he should take no chances on further infection on account of the surgical procedure. The field of operation, instruments, hands, sponges, towels, and all that comes in contact with the wound should be sterilized. The head is shaved over all space within three inches of the ear, and the skin carefully cleansed according to rules already laid down. The ear canal should be previously cleansed and rendered as nearly sterile as possible. The instruments required for the mastoid operation are one or two scalpels, hemostats, a periosteum elevator, retractors (the self-retaining retractor is convenient), a probe, a grooved director, gouges and mallet (the Russian perforator is a useful instrument, and gouge forceps or rongeurs greatly facilitate the removal of bone), scissors, and sharp-edged spoon-curettes with strong shanks and handles.

The incision through the soft parts is curvilinear, with the convexity backward. It begins at a point on a level with or above the superior border of the concha and curves downward, nearly parallel to and about half an inch behind the attachment of the auricle, to end at or below the tip of the mastoid. If it should become necessary later to secure more room, this incision can be supplemented by a second one at right angles to the first, beginning at the first incision on a level with the external auditory canal and extending backward an inch.

The soft tissues being severed down to the bone, the periosteum is elevated and the wound retracted, exposing the mastoid. The antrum is located by attention to the landmarks. It is situated just behind and above the external opening of the meatus. The meatus is marked by the supermeatal spine or the spine of Henle, which is a small triangular ridge or point of bone projecting forward at the level of the meatus. Just behind this spine will be found an area of bone perforated with numerous small blood-vessels, which ooze more than any other part on the surface of the exposed bone. The perforator or chisel, plied at this point to a depth of a half inch or perhaps less, opens into the mastoid antrum. The cortical layer of bone from this opening downward toward the tip of the mastoid and all about should be removed to a sufficient extent to expose the cells in the tip in every case, and as deeply and widely as necessary to see and remove all diseased bone. For this work of exploring and clearing out cancellous bone, no instrument is so useful as the spoon-bowl bone curettes in different sizes and shapes. The rongeur is best for the margins or the cortex, and the chisels or gouges for other dense bone. It may or may not be necessary to remove the cells or cancellous bone from the root of the zygoma, to remove a portion of the inner cortex or expose the lateral sinus. Every particle of diseased bone should

be cut and scooped away, and the cavity mopped repeatedly until it is perfectly clean.

Drainage is generally employed in the dressing. Healing by organization of blood-clot would take place in a certain percentage of cases if the wound were entirely closed. But in the majority of suppurative cases it is better and safer to introduce a small wick drain of gauze in soft rubber tubing to the bottom of the bony wound and projecting from the lower angle of the incision. The remainder of the wound is closed by suture. A small wick drain should also be used in the external auditory canal. A protective and absorbent dressing of gauze, followed by cotton and a bandage, is applied outside.

If all goes well the first dressing is made in forty-eight or seventy-two hours after the operation. The wick drain in the bony wound is removed and the cavity mopped dry and clean with cotton on an applicator. The same is done with the drain in the external canal and the outside dressings renewed. A similar dressing follows daily until discharge has ceased, when the drain is withdrawn and the wound allowed to heal from the bottom by granulation.

If there is no further complication, such as sinus thrombosis, labyrinthine inflammation, etc., the wound should be soundly healed in three to five or six weeks.

INFECTIVE THROMBOSIS OF THE LATERAL SINUS

Inflammation may extend from the mastoid or from the labyrinth and involve the wall of the lateral sinus. In the great majority of the cases it has extended from the mastoid. If the inflammatory process penetrates the wall of the sinus sufficiently to affect the intima, the latter loses its power of inhibiting coagulation of the blood. The platelets adhere to the vessel wall at this point, and soon a fibrinous mass, in which are entangled corpuscular elements of the blood, forms upon the side of the vessel and still further impedes the naturally slow current of the sinus. If this thrombotic mass does not completely occlude the vessel it is called a lateral or incomplete thrombosis. But the impeded blood current eddies in passing it and continues to deposit coagulable elements until the lumen of the channel is entirely occluded. The thrombus quickly becomes infected, and there is great danger, not merely of embolism from detachment of a portion of the clot, but of the absorption of toxins by the blood and the distribution of the infecting agents themselves by the blood stream. The result is septicemia or pyemia. Infective emboli may lodge and set up metastatic inflammation and abscess in the lungs, the liver, the kidneys, or the brain. The formation of a clot is nature's effort to erect a barrier against the advancing infection, and the thrombus

temporarily acts as such, but it is rare to have organization of clot sufficiently rapid to afford any effective protection, for the clot itself usually soon undergoes suppuration and disintegration, with disastrous general results before mentioned.

Symptoms, Diagnosis and Prognosis.—Almost invariably there is a history of otitis media, and frequently the progress of the disease can be traced in the form of a mastoiditis. The pathologic studies of Macewen and the clinical descriptions of Whiting have not been excelled, and are generally accepted as both truthful and graphic. Whiting describes the course of sigmoid sinus thrombosis in three stages, "characterized by local and systemic manifestations. First stage: The presence of a thrombus, parietal or complete, not having undergone disintegration, and accompanied by slight or moderate pyrexia, rigors usually being insignificant or absent. Second stage: The presence of a thrombus, parietal or complete, which has undergone disintegration with resulting systemic absorption, characterized by frequent rigors, and pronounced septico-pyemic fluctuation of temperature. Third stage: The presence of a thrombus, parietal or complete, which has undergone disintegration with systemic absorption, accompanied by rigors, rapid and great fluctuations of temperature, and central or peripheral embolic metastasis, terminating usually in a septic pneumonia, enteritis, or meningitis."

Going more into detail, the symptoms, diagnosis, and prognosis, corresponding to the stages in the pathologic process as described by Macewen, may be given as follows: First stage, in which the thrombus has formed either partially or completely, but disintegration has not taken place.

The symptoms are slight or moderate fever; rigors; headache, limited to the affected side and either slight or severe; slight tenderness over the region of the emissary vein; slight edema and tenderness in the posterior triangle of the neck, below the tip of the mastoid process; leucocytosis with increased polymorphonuclears.

The diagnosis is not easily made in the first stage without a mastoid operation; but the occurrence of rigors in a patient with mastoiditis should lead to a very close examination, and if tenderness be found in the upper part of the posterior triangle and over the mastoid emissary vein with edema in this region, and especially if there is leucocytosis with a relatively large polymorphonuclear count, a mastoid operation with exposure and examination of the sinus is justified. The prognosis, if diagnosis and operation are made at this time, is much more favorable than at any later period, nearly all cases ending in recovery.

In the second stage of thrombosis, whether it be partial or

complete, disintegration of the clot is in progress. Fever is continuous, but rises and falls irregularly. Rigors are frequent. Unilateral headache is marked. Tenderness over the mastoid emissary vein; tenderness and edema in the posterior triangle of the neck beneath the tip of the mastoid. There is increase in the number of leucocytes and polymorphonuclears. With these symptoms, immediate operation is imperative. The most favorable time for operation has passed by, but the prognosis only darkens with delay. With the diagnosis and operation made in the second stage, the records show 50 per cent. of recoveries.

In the third stage of thrombosis, with disintegration of the thrombus, there are excessive systemic toxemia and metastases. A chill or rigor is followed by extreme fluctuation of temperature, which may drop to subnormal and then rise to 104 degrees or 106 degrees F. The headache becomes almost unbearable. The tenderness over the region of the mastoid emissary vein and the posterior triangle is more marked and may extend to the region over the internal jugular vein. There may be symptoms of metastatic pneumonia, enteritis, hepatitis or meningitis. Unless the system be overpowered against resistance the blood examination shows a rising number of leucocytes and polymorphonuclears. The final symptom as a fatal end approaches is coma. Very few cases recover once they have reached the third stage, whether they are not operated or are operated. Yet the chance of an operation should be afforded them.

The diagnosis, as made by the condition of the sinus upon operation, will be included in the description of the operation.

Surgical Treatment of Thrombosis of Lateral Sinus.—The mastoid operation, as previously described, is first performed. If the primary otitis and mastoiditis are acute, it is probable that a simple mastoid operation as the preliminary step to exposing the lateral sinus will be sufficient. The labyrinth is more likely to be involved in a chronic case, and may possibly require exenteration. The sinus is then exposed by removing the cortex of the mastoid which covers it. This may be found dense or necrotic. Extradural abscess of the sinus may perhaps be discovered and evacuated. The sinus, being clearly exposed to view, is carefully examined. If the vein is normal it shows a dark blue color and a lustrous surface. On touching with the finger, it is easily compressible and feels soft and resilient. A probe or dissector, laid across the vessel and pressed down, causes it to flatten below the obstruction, while it remains full and convex above it. If the wall of the vessel is inflamed it has lost a part of its surface luster and deep blue color. Touch with the finger may find the wall abnormally resistant, but whether because the inflammatory thickening or from the pres-

ence of thrombus within, it may be impossible to determine by external examination. It then becomes necessary to open the vessel. It was formerly advised to aspirate it with a hypodermic needle. But it is better and safer to open it with a carefully sterilized narrow-bladed knife. The incision is made lengthwise of the vessel. If the blood flows freely there is certainly no thrombotic occlusion. But if the blood fails to flow the incision should be enlarged upward nearly but not quite to the limit of the bony opening. With a small blunt spoon curette the contents of the sinus are then examined. The clot below the opening is scooped out until the blood flows freely. Then the vein below the opening is compressed by the finger or a sponge of iodoform gauze, while the thrombus is removed from above and the vessel flushed out by bleeding. The bony canal both above and below the opening is then plugged by packing with a strip of iodoform gauze, thus compressing and occluding the vessel at both sides of its opening. The whole bony opening is then packed with idoform or cyanide gauze and a dressing applied as described after the mastoid operation. If all goes well the first change of dressing is made forty-eight hours after the operation. But if chills occur or the temperature rises the wound must be opened and investigated. A perisinous abscess may be found; or a portion of the thrombus may have been left within the sinus and have to be removed. Or the jugular bulb and vein may be thrombotic and infected and require resection.

INTRACRANIAL EXTENSION OF EAR DISEASE TO THE MENINGES OR THE BRAIN

Septic inflammation may extend from the ear to the membranes of the brain or to the brain itself through the petrosquamosal suture in the roof of the tympanic cavity, or by first invading the mastoid. From the mastoid, disease may extend through the very thin roof of the antrum of the mastoid, or by way of the covering of the lateral sinus, or at the tip of the mastoid. In infants and children inflammation is more apt to extend through the roof of the tympanic cavity than in older patients, and this can occur in acute cases; but in patients at any age extension to meninges or brain is more likely to occur as a sequence of subacute or of chronic than of acute ear disease; and in the majority the disease progresses by way of the mastoid.

The condition may be one in which a purulent collection in tympanic or antral cavities or mastoid cells is forced by its own tension through disintegrating cortical bone, and may constitute essentially a local abscess between the cranium and the dura—an extra-dural abscess. Or the dura may be penetrated by the infective

organisms, resulting in pachymeningitis. If inflammatory adhesions seal the dura to the bone in the circle surrounding the area of inflammation the condition is for the time a limited external pachymeningitis. But if the inflammation travels too fast for the erection of nature's barriers, the pachymeningitis becomes more widespread or diffuse. In other cases the piamater is infected, and to its delicate and vascular structure serious and often widespread damage usually results. The disease may be limited to the area near the point of infection, but it is prone to extend and may cover the entire surface of the brain. In leptomeningitis also the cerebrospinal fluid becomes infected; and if the patient does not succumb to general toxemia, abscess may follow in any portion of the nervous system covered by the pia. In leptomeningitis the brain itself is not so frequently involved as one might expect, though occasionally superficial infiltration, edema and softening may occur.

Again, without any visible involvement of intervening bone or membranes, infective organisms from the ear find their way into the substance of the brain adjacent, usually the white matter in the temporo-sphenoidal lobe, or less frequently the cerebellar lobe, and there produce inflammation and resultant abscess. It is a possibility for any of these inflammations to be limited in extent, although a leptomeningitis is little apt to do so, and for an abscess of membranes or of brain to become encapsulated and to remain for a time quiescent, or to find its way to the surface and to discharge itself through the ear; but such results are extremely unusual, and cannot be hoped for nor waited for without surgical intervention. A fatal termination is far more probable.

Symptoms and Diagnosis.—The great majority of cases of intracranial extension of ear disease present the symptoms of otitis media purulenta, and some of them add also the symptoms of mastoiditis, both of which have already been described. Up to this point all cases are much alike, excepting those that do not extend by continuity but by lymph or blood channels leaving intervening tissues unaffected. But the diagnosis of intracranial invasion and the differentiation between its various forms is often a matter of the greatest difficulty. Certain symptoms and symptom groups characterize the different intracranial inflammations and may be recognized when they occur alone and in typical form. But atypical cases occur, and again cases partaking of the character of more than one clinical form of disease, which it may be impossible to differentiate before operation. Lateral sinus thrombosis, besides the symptoms of mastoiditis, usually presents a chill or a series of chills, followed by a high and fluctuating temperature. The chill or chills might also indicate leptomeningitis or brain abscess; but with the leptomeningitis the temperature is more apt to be persistently

high, even if variable, and to be accompanied by symptoms of irritation, such as nausea or vomiting, vertigo, delirium, rigidity of the muscles of the neck with retraction of the head, Kernig's sign, irregular pupillary reactions, hyperæsthesia, Cheyne-Stokes respiration, paralysis, stupor, coma, and death.

Headache is common to all the intracranial inflammations. It is probably more severe in pachymeningitis than in leptomeningitis, is more apt to be localized in abscess of brain and to be occipital in location if the abscess is in the cerebellum. Percussion over the site of an abscess may increase the pain. Optic neuritis may accompany either leptomeningitis or brain abscess. In cerebral abscess, besides the symptoms of otitis or mastoiditis which may precede it, and besides the symptoms of cerebral irritation and the chill or chills which may mark its onset, there is apt to be a persistent fever of low grade—much lower degree than usually pertains to meningitis, or even a subnormal temperature, and a markedly slow pulse.

There may be localizing symptoms if any of the definite motor centers or the speech center are involved. (See Section on Cranio-Cerebral Topography.)

The rupture of a brain abscess and escape of its contents into a ventricle or into a subdural space may set up a leptomeningitis with its characteristic symptoms.

With cerebellar abscess, in addition to the headache, which may be localized in the occiput, and the vertigo and vomiting, which are apt to be severe, a typical case presents symptoms of muscular incoördination. But in abscess as in brain tumor, the localizing symptoms are often so indefinite as to make differential diagnosis between cerebral and cerebellar disease difficult or impossible.

Prognosis.—Cure of cerebral abscess without surgical intervention, at least temporary cure, is a possibility; but as a rule a fatal result is to be expected if operation is not done. On the other hand, skillful interference may save an apparently desperate case. Extradural abscess when emptied and cleaned out affords a favorable prognosis. Abscess in the brain gives a much graver prognosis. It is much harder to locate, and its situation may be inaccessible. Then its evacuation and the drainage of the cavity may be difficult to manage. However, if the abscess is in the temporal lobe, there is a fair prospect of success. With abscess in the cerebellum there is apt to be coincident septic thrombosis of the lateral sinus, complicating the case and rendering it extremely grave.

Leptomeningitis affords but little hope of recovery. Still, an effort should be made by exposure of the meninges, irrigation and drainage through the cranial wound and through lumbar punctures, as a number of successful cases have been reported.

Treatment.—In the treatment of extradural abscess following a mastoid operation, the bone covering the abscess cavity should be removed with chisel, gouge, curette or rongeur. Care should be taken in those cases in which the abscess cavity is limited by adhesion of the dura to the cranium not to remove bone beyond the adhesion nor to break through the walls of the cavity. If these walls are covered with granulations they should be cleaned by scraping and mopping with gauze sponges. The abscess cavity is drained with iodoform gauze and the mastoid wound drained and packed as usual.

For the treatment of intradural and of brain abscess it is necessary by close study of the localizing symptoms, together with the history and condition of the primary ear disease, to form a reasonable conception of the situation of the abscess. If the disease has extended by continuity it is usually best to follow it in the operation by the same route. As before stated, if in the cerebrum the abscess is most likely to be found just over the roof of the tympanum or of the antrum of the mastoid, and is best exposed by first opening and clearing out the mastoid and these cavities and then removing the cortex. The condition of the dura as to its color, its resistance to touch and the degree of tension behind it will probably make it evident whether it should be incised. If fluctuation be felt beneath the dura, or it bulge abnormally into the wound, it should be carefully opened with a small bistoury and this incision enlarged with scissors. The abscess may be found immediately beneath, or the edematous or softened condition of the brain may give evidence that it is close at hand. If not, the brain must be explored in the direction judged most promising by the localizing symptoms. For exploration a slender expanding forceps or a grooved director is better than an aspirating needle or fine trocar. When found the abscess should be evacuated through an opening large enough to introduce a drainage tube, and to permit of lavage with sterile normal salt solution at subsequent dressings. If a leptomeningitis be found the infected cavity should be irrigated with sterile normal salt solution, and if the meningitis has become general the entire cerebro-spinal serous cavity should, by means of lumbar punctures and the cranial opening, be drained and irrigated. (See also Section on Operations on the Cranium.)

CHAPTER XV

THE PARALYSES OF INFANCY AND CHILDHOOD AND OPERATIONS UPON NERVES

THE PARALYSES OF INFANCY AND CHILDHOOD—BIRTH PALSIES NON-CENTRAL IN ORIGIN—ACUTE ANTERIOR POLIOMYELITIS—CEREBRAL PARALYSES—OPERATIONS UPON NERVES.

A variety of paralyses occur in infants and children, though in widely varying degrees of frequency. See Appendix (57). I will devote space here to some of the other paralyses which occur most frequently and which have the greatest surgical interest.

BIRTH PALSIES NON-CENTRAL.

Facial paralyses.—Pressure of maternal parts or instruments upon the facial nerve, near its exit from the stylomastoid foramen or over the ramus of the jaw or upon some of its terminal branches may cause paralysis of one side of the face or some part of it. (Bell's palsy.) The great majority of these cases recover.

Paralysis of the upper extremity.—This is more likely to occur in artificial but may occur during spontaneous delivery. The injury to nerves may be caused by pressure of the blade of the forceps on the neck or pressure at the root of the neck by the fingers of the accoucheur in efforts at delivery in head-last cases; or by traction with fingers hooked into axilla or by traction upon the arm. Other damage may be inflicted at the same time, such as separation of the upper epiphysis of the humerus, fracture of clavicle or rupture of fibres of sternomastoid. The point usually injured is the fifth and sixth cervical nerves. This may lead to paralysis of the deltoid, the infra-spinatus, biceps, brachialis anticus, supinator longus and infra-spinatus, called Erb's paralysis or "upper-arm type." Only a part of these muscles may be paralyzed, not all to the same degree, varying greatly in different cases, or sometimes the serratus besides. Injury above the clavicle will not only involve the circumflex nerve, but also the musculo-spiral; and if the location of the injury is in the foramina, movements of the diaphragm will be

[1] It is probable that myotonia congenita also should be classed with the muscular dystrophies. See Batten: "Myopathies or muscular dystrophies," Quar. Jour. Med., Oxford, April, 1910.

affected through impairment of at least a part of the origin of the phrenic.

The paralysis may be noticed at once, or not observed for days, weeks or months. The attitude of the arm is characteristic. It hangs helpless, with the forearm pronated, and the arm rotated inward, so that the palm is turned outward and backward. The triceps is not affected. If the arm is flexed it can be voluntarily extended. But voluntary flexion, supination or abduction are not performed. After several weeks, atrophy of the paralyzed muscles begins. But in the infant the muscles are so small and the subcutaneous fat so abundant that the atrophy can scarcely be detected in the first year.

Diagnosis.—The diagnosis presents no difficulty if the case is typical and is seen early before there can be any question of poliomyelitis anterior acuta. When other injury, such as fractured clavicle, or humerus, or neck of the scapula, is present, the inability to use the arm may be attributed to that, and the nerve condition not discovered until later. An old traumatic deformity might mask the paralysis, but an electrical test would discover it. Syphilitic epiphysitis, or the pseudo-paralysis of infants, might superficially resemble Erb's; but in the former there is tenderness and an annular swelling at the epiphysis, no real paralysis, probably other epiphyses affected and other evidences of sphyilis. The peculiar group of muscles paralyzed is characteristic. If the surgeon has ever seen a case he is not apt to overlook one.

Prognosis.—The prognosis can only be made by judging the extent of the injury and its progress toward spontaneous recovery, together with the location of the lesion and its accessibility to surgical repair. Moderate cases recover spontaneously in a few months. But if three months have passed without improvement there is little hope of recovery by natural processes. Kennedy places the waiting time at two months. If the muscles then show response to the faradic current, recovery will probably take place without surgical intervention. If they do not respond to faradism, but respond to galvanism, an operation, if practicable, is indicated with some prospect of improvement or recovery.

Treatment.—During the first few weeks no attempt at treatment is of any use. After the first month, if the muscles respond to faradic electricity, it should be used regularly and persistently, but not too much expected from it. If the muscles do not respond to faradism, galvanism should be used. Massage also is advisable in all cases. The prospects of recovery are poor without operation.

The operative treatment for Erb's paralysis was pioneered by Robert Kennedy, whose operation is thus described:[1] The patient

[1] Brit. Med. Jour., Feb. 7, 1903.

is placed upon his back with a pad under the shoulders, so that the head is extended, and the head and face turned toward the opposite side. A long incision is made, beginning at the junction of the middle and lower thirds and at the outer margin of the sterno-mastoid and carried to the junction of the middle and outer thirds of the clavicle. The deep fascia is divided between the sterno-mastoid and the trapezius; and the omohyoid exposed below the lower edge of the wound. Above the omohyoid the scalenus anticus is exposed and under it the nerve trunks emerge. The two upper nerve trunks are traced outward to their junction, and they and their branches are freed from adhesions.

The nerve will probably be found in a cicatricial condition. If the entire nerve seems to be scar-tissue the fifth and sixth should be divided above the damaged area. The cut surface should show a healthy appearance; if it does not, more and more of the nerve must be sliced off until healthy tissue is reached. The diseased area is then pulled inward and the three peripheral divisions of the nerve, namely, the supra-scapular, the branch to the outer and that to the inner cord of the plexus, are put on the stretch. These three branches are then divided, through sound tissue. The three peripheral stumps are then sutured to the two proximal stumps with fine chromicized catgut. Before approximating the divided nerve ends and tying the sutures, the shoulder should be elevated and the head bent to the side toward the field of operation, to permit the approximation of the ends and relieve tension on the sutures.

The external wound is then closed; and after the antiseptic dressings are applied a plaster bandage is put on, holding the shoulder in an elevated position and the head inclined toward it, and immovably fixed. The fixed dressings are used two weeks. (28)

ACUTE ANTERIOR POLIOMYELITIS (INFANTILE SPINAL PARALYSIS; ACUTE ATROPHIC SPINAL PARALYSIS; MYELITIS OF THE ANTERIOR HORNS)

This is the most common form of paralysis in infancy and childhood. The real cause of the disease is unknown. (29)

Judged by the symptoms the disease attacks the entire central nervous system and also its meninges. Not only the gray matter of the anterior horns, of the cortex, bulb and brain stem are affected, but also the white matter. But with all, excepting the gray matter of the anterior columns of the cord, the affection goes no farther than an irritation. So that judged by lesions that can be found the disease is an acute myelitis with its focus in one of the anterior columns of the spinal cord, though it may extend into the adjacent antero-lateral column. It is limited also in vertical extent to a fraction of an inch or an inch. There may be more than one

focus of disease, and both sides of the cord may be attacked, usually not with the same degree of severity. The cause seems to act through the blood vessels, producing dilatation and sometimes thrombosis, and resulting in granular degeneration of the large motor cells.

The later changes are cicatricial or sclerotic. The destruction of nerve elements, both ganglionic cells and white matter, and the contraction of connective tissue, produce a narrowing or shrinking in the affected area of the cord that is readily apparent. The degeneration extends into the nerve roots, and into the nerves. Trophic changes take place also in the muscles of corresponding nervous area; they undergo atrophy with fatty and fibrous degeneration. Trophic changes also affect the bones and other structures of the paralyzed part which fail to grow at the normal rate in length and thickness.

Symptoms.—As a rule there is sudden fever, 100 to 104; with vomiting, pains in the extremities and nervous excitement, crying or insomnia. The paralysis may appear on the second day or be discovered after a few days as the illness subsides. In some cases the symptoms are much more severe, with higher fever, 104, 105 or even more, pains in back and extremities, retraction of the head, rigidity of the neck, convulsions, starting and screaming, coma, opisthotonos, sometimes death, or an illness prolonged a few days or a week. On the other hand, every practitioner has seen cases in which a child without apparent illness was found one morning to be paralyzed. The history of one of my cases reads: "His parents say, 'When he was one year old he was taken sick and a doctor gave him some medicine which made him go to sleep, and when he woke up he was paralyzed.'" Such a history is not uncommon. But the paralysis is not due, as the parents allege, to the doctor's medicine.

The extent and distribution of the paralysis vary greatly within certain limits. The paralysis may appear widespread during the illness or upon its cessation, but in a week or two it begins to disappear, excepting in one limb or two which remain permanently paralyzed. But even in the primary paralysis the respiratory muscles are seldom seriously affected and the sphincters usually escape. In a study of 500 cases occurring in the epidemics of 1906 and 1907 Collins and Romeiser tabulate the distribution of the paralyses as follows: Leg, 216, both, 134; arm, 36, both, 5; triplegia, 27; quadriplegia, 32; homolateral, 20; crossed, 13; "other," 136; cranial, 35.

Distribution of the "other" paralyses was as follows: Abdomen and diaphragm, 29; lumbar and gluteal, 65; back, 20; chest, 9; neck, 29; sphincters, 6.

Distribution of the cranial (nuclear) paralyses: Rectus colli,

15; facial, 9; larynx and tongue (aphonia and anarthria), 14; pharynx, 3.

The relative frequency is indicated in the following order: 1, leg; 2, legs only; 3, arm; 4, quadriplegia; 5, triplegia; 6, hemiplegia; 7, contralateral; 8, both arms only.

The residual paralysis usually affects only certain muscles or muscle groups, and not the entire musculature of the affected member. The most common form is paralysis of the lower extremity; it may be the anterior tibial group, or the peroneals, or these with the posterior tibial and the quadriceps. The extensors are more often or more severely affected than the flexors. The hamstring muscles and the glutei are apt to escape; but sometimes the paralysis of an extremity, for instance a leg, is so complete that it dangles, a mere useless appendage. Paralysis of both lower extremities may occur, partial or more severe. Paralysis of an upper extremity may occur, but usually in association with paralysis of one or both lower extremities; if only one, it is upon the opposite side. Of the muscles of the upper extremity the deltoid is frequently affected, and it may be singly, or together with the biceps, the brachialis anticus and the supinator longus. This is the so-called "upper arm type." In the "lower arm type" the extensors or the flexors of the wrist or fingers are paralyzed. In the forearm type the triceps is paralyzed. Thus it is seen that the muscles which are associated in function, rather than in anatomical relation, are paralyzed together. Some of the muscles of the trunk may be paralyzed. Those of the face are seldom affected at any stage. Faradic excitability is lost or lessened in the primary illness. It may be entirely gone in the most severely affected areas at the end of a week, and the reaction of degeneration is demonstrable. After a time, as the muscles themselves atrophy, galvanic excitability lessens. In partially paralyzed muscles, which are capable of improvement by electricity, the faradic response is present in a slight degree although feeble. The paralyzed limb is cold and relaxed. The cutaneous sensibility is not lost. The reflexes are absent.

Deformities result from the paralysis, the contraction of unopposed muscles, and trophic changes. Wryneck may occur if a sterno-mastoid is paralyzed. Paralysis of the deltoid may allow subluxation of the head of the humerus. The hip may become dislocated upon the dorsum ilii in old cases of paralysis of the muscles connecting pelvis and femur. Paralysis of the erector spinæ or shortening of one lower extremity may cause spinal curvature. The thigh may become flexed and contractured, causing lordosis on attempting to straighten the limb. Flexion of the knee with subluxation of the head of the tibia may occur, or hyperextension of the knee, or knock-knee. Or the whole limb may become rotated

outward by paralysis of the adductors and extensors of the thigh; or the leg from the knee, or the foot from the ankle, may hang flail-like. Various forms of paralytic talipes occur—equino-varus, calcaneo-valgus, equinus, calcaneus, and cavus.

Diagnosis.—The symptoms of the acute stage are common to so many diseases that usually no diagnosis can be made until the paralysis is observed. Then there should be no difficulty. (30)

Cerebral paralysis may begin suddenly and with convulsions. But there are usually more cerebral symptoms, and the reflexes are exaggerated. The paralysis is usually hemiplegic, and the face also affected. There is rigidity with the paralysis and the atrophy is not marked nor rapid. There is no reaction of degeneration.

Acute transverse myelitis is rare in childhood. It affects both legs and usually involves sensation as well as motion, and often the sphincters; it has exaggerated knee-jerk and ankle-clonus; no reaction of degeneration, slight atrophy, but a proneness to bedsores.

Spinal paralysis, due to hemorrhage into the cord, involves sensation, motion and the sphincters, and soon shows a proneness to form bedsores.

The pseudo-paralysis of scurvy has been mistaken for poliomyelitis; but the condition is very different if one has the typical symptoms of tenderness over the epiphyses and the long bones, especially of the lower extremities, the pain on motion, the spongy gums and ecchymoses. However, one has seen scurvy with considerable pseudo-paralysis and without either spongy gums or ecchymoses.

Diphtheritic paralysis might be mistaken for infantile paralysis. But the former most often affects the throat and respiratory muscles, which are less often affected in infantile paralysis. And one has the aid of the history of a preceding diphtheria. If there is still doubt, a few weeks' time will tell the truth.

There is some resemblance between poliomyelitis and what Fothergill called "the muscular listlessness of malnutrition." But careful examination will show that in the latter there is no real paralysis and that the weakness is general, and often accompanied with definite signs of rickets. Failing in these points, the electrical reactions should be tested.

Congenital dislocation of the hip has been mistaken for paralysis. But there is no paralysis nor wasting.

Hip-joint disease, too, is one that it would not be necessary to mention in this connection, but that mistakes still occur. Although hip-joint disease has lameness and wasting, there the resemblance ends. The limb is not cold nor flaccid. There is usually muscular contraction about the joint and limitation of motion, and a history of a chronic inflammation instead of an acute disease which passed by and left only the result.

Prognosis.—There is said to be very little danger of death from this disease. I have sometimes queried whether a few of the deaths charged to "convulsions," "teething," "meningitis," "acute gastritis," and so on, were not due to poliomyelitis in the acute stage. However, the prevailing opinion is that death is rare from this disease. As to permanency of the paralysis—it is only the very slight case that completely recovers. When the paralysis is demonstrated it has probably reached its worst as far as motion is concerned. Wasting will follow. Improvement is sure to come to some extent. When the febrile stage is passed the muscles should be tested with the faradic current. Such as entirely fail to respond may be expected to waste. If faradic reaction improves, improvement in motion and nutrition may be expected. If no response is shown in six months, no improvement is to be expected. Improvement usually begins during the second week and continues for perhaps two months. After that progress is slower for a few months. The period when improvement will cease depends a great deal upon the treatment employed. Failure of growth in a severely affected limb is increasingly noticed as time goes on. The other deformities can for the most part be prevented if care is taken. Almost all cases coming to the surgeon after paralysis and deformity are established can be improved in some way, either by mechanical or operative means.

Treatment.—Drug treatment apparently avails little in this disease, and the subject is sufficiently discussed in works on medical pediatrics. Massage, gymnastics and faradic electricity will do much to prevent wasting of the muscles, and failure in growth; and to maintain them in condition and position to prevent deformity, and to take advantage of the aid that can be rendered by mechanical and operative treatment. (31)

Mechanical and Operative Treatment.—No sooner is paralysis discovered than means should be employed to prevent the deformity that will surely occur to some degree if the case is neglected. The point is to keep the paralyzed extremities in a natural position, not allowing unopposd unparalyzed muscles by their constant contraction to maintain a position of deformity until permanent contracture on the one side and overstretching on the other side results. Moreover, maintaining a natural position gives partially paralyzed muscles an opportunity to act so far as they are able, and this improves their nutrition and their innervation. With a patient in bed, very slight mechanical support with pillows or sandbags or light splints is all that is necessary to hold the joint half-way between flexion and extension or between pronation and supination, or between outward and inward rotation. As soon as the patient is able to be up or to get about, some apparatus should be devised, whether of leather, of

gypsum or felt, tin or steel, according to the needs of the case, to maintain the proper position, prevent stretching or contracture, and to allow the parts to be used. This apparatus is to be removable so that the systematic massage, electricity and exercise can be kept up daily. This plan of treatment should be pursued for months, or as long as improvement can be observed. A suitable brace for a lower extremity is made of steel covered with leather. It consists of a steel pelvic band having an upright extending from the pelvic band to the sole of the shoe on the outside, and jointed at hip, knee and ankle. On the inside of the limb there is an upright, extending from the perineum to the sole, and jointed at knee and ankle. The two uprights are connected by encircling bands, half of steel, upon thigh and leg. The knee-joint has a sliding ring or other device which locks the hinge in extension when the patient stands. On sitting he unlocks it.

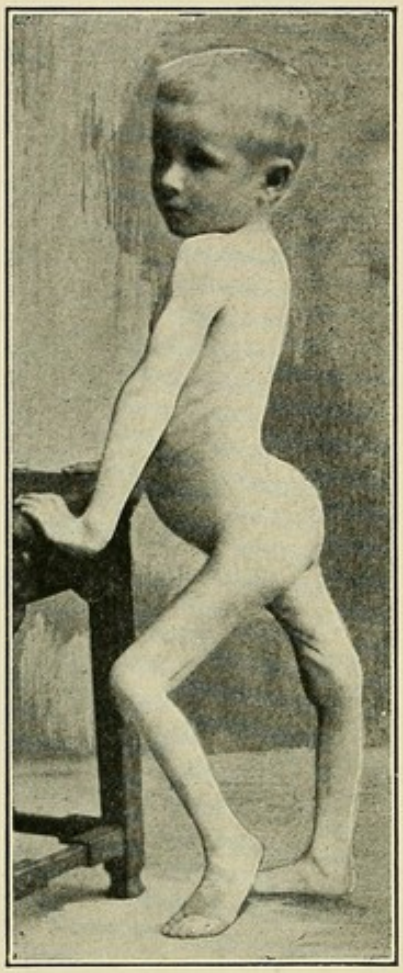


FIG. 137. PARALYSIS FROM POLIOMYELITIS in the second year. He could not walk nor stand without support and contractures held his left limb flexed as shown. Attempts to straighten the limb caused lordosis.

With most cases coming to the surgeon, there is not merely paralysis, but deformity has been allowed to develop. It is the deformity which must first be dealt with. Fig. 137 will serve to illustrate the bad results of infantile paralysis when neglected. The boy was five years old, but had never walked, the disease having attacked him early in his second year. His lower extremities had, as usual, suffered the worst. They were wasted, cold, and weak. In this case it was both limbs, which is not usual. He could crawl, dragging the paralyzed limbs. Fig. 137 shows his best effort at standing by putting the strain on the ligaments of the right knee in over-extension, and leaning on the arms. The left thigh could not be more than half extended because of contraction of the flexors. The left sole could not be placed on the floor, but it was held in the position of equinus or equino-varus by the shortening of the unparalyzed or less paralyzed foot-extensors at the back of the leg. Sub-luxation backward of the left tibia upon the femur had taken place. Attempts to stand upright

caused lordosis by the pull of the contracted thigh muscles upon the pelvis.

Obviously it would be impossible in such a case to overcome the deformity by mechanical appliances of any kind. Months of time and the expenditure of measureless patience would result in nothing but failure, and perhaps add pressure ulceration to the trouble. The deformity must be overcome before a brace is applied.

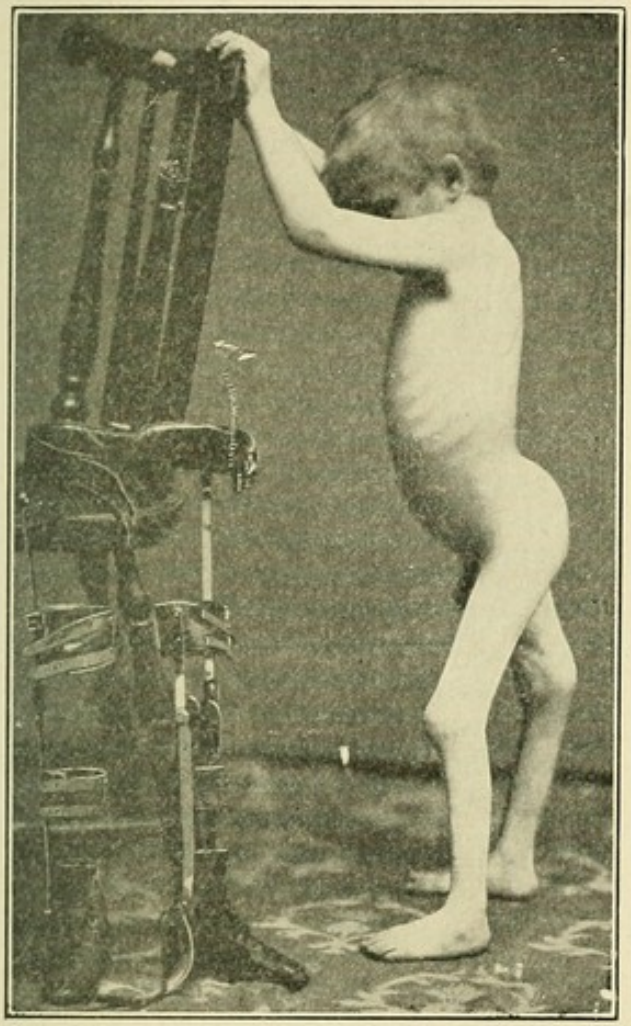


FIG. 138. Same case as Fig. 137 after tenotomies had enabled him to bring the left limb down and to place the sole upon the floor. Suitable braces are shown.



FIG. 139. Same case as shown in Figs. 137 and 138, with braces applied. Boy able to walk.

The contracted tendons of the thigh, and also the tendo Achillis, were released by tenotomies, so that the boy could take the position shown in Fig. 138, with both soles on the floor, the thigh much better extended, and the lordosis improved. But the muscles needed aid to support the weight and control position, and so braces were supplied. The limbs being now in position for locomotion, active exercise, supplemented by hot bathing and massage, began to improve them so that he soon walked very well. Almost every case

of infantile paralysis can be improved and the patient be made to walk or to use the arm if deformity be overcome and the part be maintained in a position to be used. If it is the lower extremity that is paralyzed, the brace has two functions to perform: to put the joints in such position that the muscles are balanced, and to support weight. For instance, in the case shown in Fig. 138 the left knee must be held in extension, for the extensor is paralyzed; and the right must be prevented from over-extension and maintained in extension, for both flexors and extensors are almost entirely paralyzed. But there is sufficient power to maintain the pelvis balanced upon the femurs and to swing forward the limbs in walking, provided they are maintained in the extended position and enabled to bear the weight. Suitable braces are shown in Figs. 138 and 139. There are numerous modifications. Fig. 140 applies this principle to ankles in which the muscles of the leg are paralyzed, and allow the sole of the foot to turn when weight is put upon it. (See Fig. 141.) A flat-foot plate under the sole with a brace to reach up the leg to an encircling band below the knee holds the foot squarely under the leg, where it bears the weight of the body in walking. Sometimes a strong, well-fitting laced shoe may have a brace attached, with a joint that does not allow extension of the foot beyond a right angle, but allows flexion in walking. A toe lift in the shape of a spring or a rubber muscle may be added if the anterior muscles are paralyzed so that there is a tendency to drag the toe. In other cases it is necessary to have an upright at each side of the foot instead of only upon one side, reaching up to the leg-band, of which half its circle is of steel, leather covered. Such a brace with the artificial muscle in front, is useful not only in weak ankle, but in all deformities in which there is a tendency to equinus. In club-foot from paralytic contractions the contracted tendons should be released in the same manner as for congenital club-foot. In equinus the tendo Achillis is at fault and must be severed or lengthened or part of it transplanted, unless nerve transference can be planned and performed. (See Fig. 142.) In cases of equino-varus the tendo Achillis and sometimes the tibiales, and it may be also the plantar fascia, will require division. In the less common form, calcaneo-valgus, the peroneals will need tenotomy. In calcaneus the tendo Achillis should be shortened. (See Club-foot.)

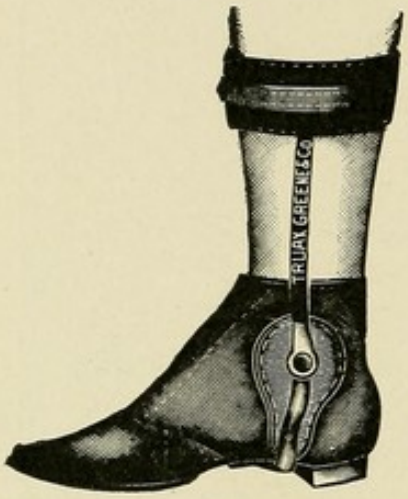


FIG. 140. WEAK-ANKLE BRACE.

The technique of tenotomy, and tendon shortening and lengthening, will be found in the section on the tendons.

It is useless to perform either tendon shortening or lengthening if the muscle connected with the tendon is completely paralyzed. If the muscle has but slight power, putting it to use will improve it. Otherwise a simple tenotomy will relieve the contracture as well as a tendon lengthening; and a shortened completely paralyzed tendon will require also arthrodesis to show any appreciable result.

Arthrodesis.—In complete paralysis of muscles controlling foot or leg or thigh, causing " flail-joint " at the ankle, at the knee or at

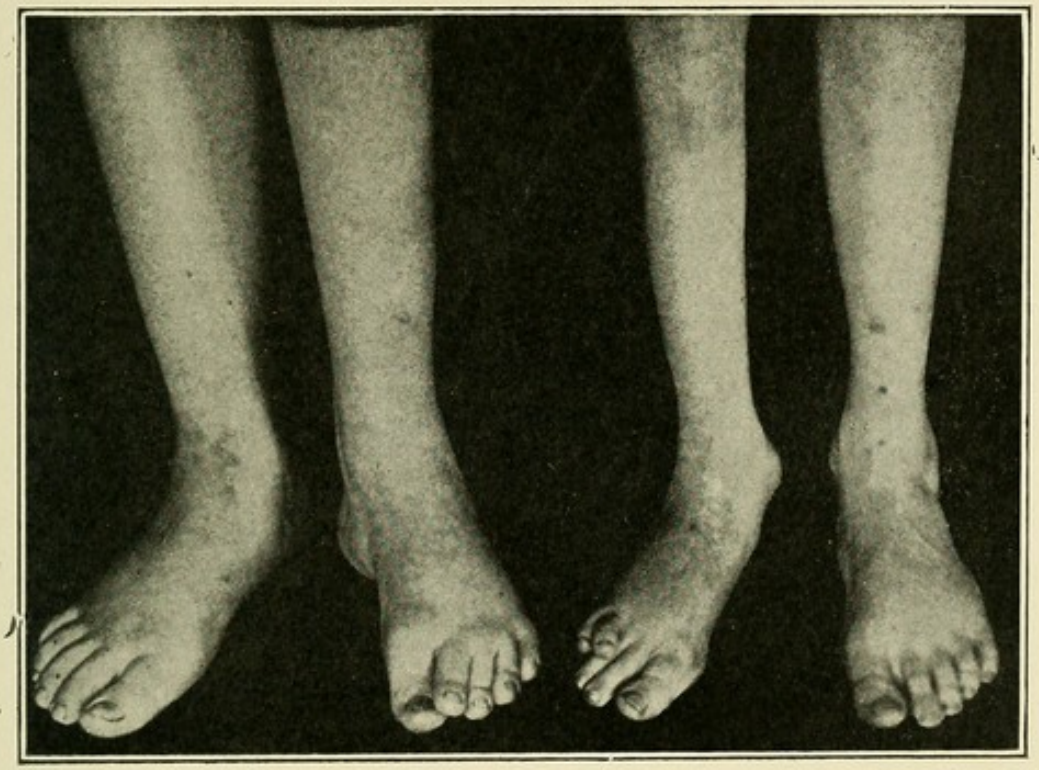


FIG. 141. POLIOMYELITIS IN INFANCY. One left and one right leg paralyzed, so that the ankle yields laterally. Children now in twelfth year.

the hip, the operation of arthrodesis is sometimes performed with the object of causing ankylosis of the joint, in such position as will support the weight of the body and permit walking. It has also been occasionally, although far less frequently, performed at the elbow or wrist than at the ankle. The operation is very similar to erasion or atypical resection, but more easily done, for there is no diseased tissue to look for and remove. For each joint the mode of opening is selected which seems best suited to the individual case. If tendons or ligaments are better upon one side, that side is spared, and the over-stretched tendons or ligaments upon the side opened are shortened in the closing. In the ankle this operation finds its most useful application. The usual incision is anterior. Some oper-

ators prefer the posterior, or one or the other lateral, according to conditions. In the knee the incision is anterior, through the patella. After the joint is opened, with a knife, gouge or Volkmann spoon, the cartilage, or a portion of it, is removed. It is not necessary to remove all of the cartilage nor synovial membrane. In closing, the severed tendons and ligaments are carefully replaced and united, and no drainage unless a strand of catgut is employed. After the antiseptic dressing, a plaster case is applied and the joint immobilized for one or two months. Fibrous ankylosis is expected. If both knee and ankle in the same limb are flail-like, both will require the operation, or an apparatus can be worn for the knee. Children do better under this operation than those past puberty. In many such cases it is a question whether amputation is not preferable.

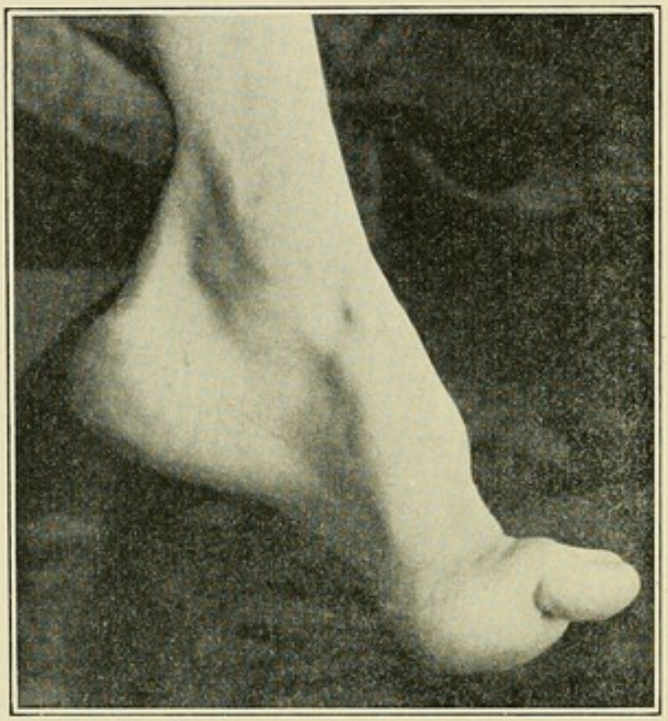


FIG. 142. HAMMERTOE, approximating pes cavus, with equinus. Result of poliomyelitis. Case of Dr. Stewart L. McCurdy.

The condition of the psoas and iliacus should always be considered. If the limb cannot be swung forward it is not of much use even if the joints are stiffened to support the weight. The circulation and the condition of the skin as to ulceration and tendency to sores and chilblains, should be taken into account. Some patients would prefer to wear apparatus rather than have an ankylosed knee-joint, which cannot be bent on sitting down.

Arthrodesis of the hip is not to be thought of unless the joint is so readily luxed spontaneously as to be useless. Even then strong ankylosis is not always obtained.

Contraction deformities of the hip-joint resulting from poliomyelitis are a difficult class of cases to treat. Some cases will yield to the weight and pulley, or to this if preceded with a few tenotomies. But when the deep-seated tendons and the fasciæ and the ligaments are all permanently contracted it requires extensive operative work to release them. Under these conditions osteotomy of the femur close below the lesser trochanter is preferable. The tech-

nique of osteotomy is described in the chapter on rickety deformities. In the thigh the incision would be upon the outer side.

In the knee the most common deformity is flexion, or this with sub-luxation backward. If flexion only, it may frequently be overcome by the use of a Thomas knee splint, applying an elastic bandage or even a flannelette roller over the knee, tightening it a little every day. Traction with weight and pulley will also often succeed. In other cases it is necessary to tenotomize. If there is also sub-luxation these methods will not answer. Weight and pulley to the leg may be used if a second one be applied to the upper end of the tibia to pull forward the head of the bone. Or a splint resembling the Thomas knee splint, with a band to press forward on the tibial head and another to press backward upon the lower end of the femur, may be used. Or forcible straightening may be performed, either by manual force or the aid of a Peters or Goldthwaite or other pattern of genuclast.

Tendon Transplantation.—Modern surgeons have not been contented with mechanical aids to locomotion, with arthrodesis, correction of deformities by tenotomy, with tendon lengthening or shortening. They have attempted, successfully, to substitute healthy muscles for paralyzed by the procedure known as tendon transplantation. The principles and the technique of this procedure are discussed in a general section on the subject in a previous chapter. Tendon transplantation often finds application in poliomyelitis, in which often a single muscle or group of muscles may be paralyzed, and sound or nearly sound muscles have their tendinous attachments within reach. Each case must be carefully studied and the work planned to suit it. A few examples will be cited by way of illustration. With paralysis of both tibiales the foot is everted and flattened and the patient treads upon its inner border. If the extensor proprius hallucis is healthy its tendon can be cut and transplanted to the periosteum of the inner side of the scaphoid. To supplement its action the tendon of the peroneus longus may be cut at the outer border of the foot, drawn out through an incision behind and above the outer malcolus and drawn through a tunneled opening beneath the tendo Achillis, and attached to a groove beneath the periosteum of the scaphoid. Or with the same condition of valgus or equinovalgus from paralysis of both tibiales, the peroneus brevis may be transplanted as just described for the peroneus longus, and the peroneus tertius be carried under the tendons in front of the ankle and also inserted into the scaphoid. Or, with paralysis of the tibialis anticus the tendon of the extensor pollicis may be divided and so transplanted as to take the work of the paralyzed muscle.

With paralysis of the gastrocnemius and soleus we get calcaneus; the peronei remaining healthy, the latter may be transplanted and made to do the duty of the former. The tendo Achillis should

be shortened. If pes cavus also exists with over-action of the anterior tibial group, this deformity should be forcibly corrected at the same time. Conversely, with paralysis of the peronei, the gastrocnemius remaining unparalyzed, the tendo Achillis may spare its outer half, which is detached from its insertion, split upward a distance of two or more inches, and by having its length augmented with strands of heavy silk, be inserted into the outer side of the cuboid, and be made to abduct and evert the foot.

Likewise the inner half of the tendo Achillis may be carried around the inner side of the joint and sutured to the tendon of the paralyzed tibialis anticus; or a better procedure, the transplanted sound tendon may be lengthened by silk and inserted into the periosteum on the inner border of the foot.

Of the muscles which move the leg upon the thigh, that most frequently paralyzed is the quadriceps extensor. This has been successfully treated by transplanting the hamstring tendons forward to the tendon of the extensor, or with silk grafts extending them to the anterior surface of the head of the tibia. Before resorting to this procedure it should be ascertained whether the gastrocnemius is sufficiently strong to accomplish flexion. If it is not thought best to spare the hamstrings from their normal situations, the tensor vaginæ femoris and the sartorius, being transplanted to the quadriceps, can be utilized as extensors of the leg. It should be mentioned that after transplantation of the hamstrings over-extension of the knee has occurred in some instances.

The foregoing are but examples of the application of tendon transplantation. The variations that are resorted to are as numerous as the varying distribution of the paralysis, and more so. There are scores of them.

In all cases the technique as described in the general section must be observed. The joint must be held in over-correction and the transplanted tendon must be taut when it is attached to its insertion. In operations near either knee or foot both joints should always be included in the plaster bandage. Otherwise immobility is not assured.

Nerve Transference.—The general subject of nerve transference and nerve suture has been discussed in another section. It has an application in the treatment of paralysis following poliomyelitis. An example is one of Murphy's cases.[1] The paralysis, of five years' standing, was limited to the anterior tibial and extensor communis digitorum muscles. An anastomosis was made between the external and internal popliteal nerves. A tendo-plastic operation also was performed, the flexors being elongated and the extensors shortened. The result was great improvement. Electrical response returned to the extensors and the patient was able to walk and to run.

[1] Magazine of Surg., Gynec. and Obst., April, 1907.

Another example is implantation of two-thirds of the peroneal branch of the musculo-cutaneous into the anterior tibial. Conversely, an anastomosis may be formed between the anterior tibial and the musculo-cutaneous. (Spiller and Frazier.[1]) There are many difficulties in the way of nerve transference in paralysis in the same quarter of the body. But many of them will be overcome by further study and experiment. Murphy draws attention to the cauda as a zone wherein the lower sacral and lumbar nerves are in close proximity, and could be joined to neighboring fibers, or to roots on the opposite side of the cord.

CEREBRAL PARALYSES

Infantile Cerebral Paralysis (*Spastic Paralysis, Spastic Diplegia, Paraplegia or Hemiplegia*).—The accumulated literature upon this subject is voluminous and still augmenting, and I can only present here a brief outline which has a bearing upon the practical surgery of the condition. There is much confusion in the earlier descriptions, and more recent studies have not yet solved all the problems pertaining to the subject.

There are a number of causes connected with malformation of the brain, and fetal disease of the brain so early in fetal life and so obscure as to be in many instances untraceable.

In another class of cases the brain was originally normal in development and health up to the hour of birth, when accidental injury resulted in changes accompanied by spastic paralysis.

In a third class of cases the brain was normal in development and escaped the dangers incident to birth, but later, from accident or disease, became disabled in its motor and probably in other areas. Now it is the second and third class of cases, and particularly the second, the birth palsies, that present the greatest surgical interest,—an interest which I believe will increase with further surgical study of the subject,—and yet it is necessary for us to consider somewhat all three groups of cases. None of them are to be looked upon as an active disease, but rather as a result of developmental fault, or of injury, or of disease, which has already at some time in the past done its worst, since which time nature has endeavored to deal with the consequences. It should be understood that it is only one prominent symptom that has given the name to the disease, and that there are often other symptoms, such as idiocy or epilepsy in connection; and that no classification is at the present time scientific either from an etiological or clinical standpoint.

Paralysis from Pre-Natal Causes.—In these cases there is defective formation of brain tissue, microcephalus, porencephalus, or the results of fetal intracranial hemorrhage or thrombosis. Some

[1] Jour. Am. Med. Assn.

cases have been attributed to lowering disease of the mother, or to injury of the mother during pregnancy. In some cases there is no gross lesion of brain, but a failure of development of the cells of the cortex. The results vary according to the stage of the development of the fetus when the arrest took place and to the location and extent of hemorrhage or thrombosis.

Symptoms.—These cases usually present a variety of symptoms more prominent than the motor paralysis. There is usually feeble-mindedness or idiocy in some degree. There is sometimes, but not always, abnormally small or asymmetrical cranium. And there is frequently some other malformation besides that of the brain. The paralysis is usually widely distributed and either diplegic or paraplegic. When the cortical portion generally has failed of development the spastic feature does not accompany the paralysis. The muscles are flaccid. In other cases there is rigidity and apt to be convulsions.

Paralysis from Birth Injuries (Birth Palsies; Little's Disease).—In this important and interesting class of cases, the condition results from meningeal or intra-cerebral hemorrhage in an infant at or about full term or in the act of birth. There may be present only that predisposition to hemorrhage which seems normal to the fetus at term, or a distinct hemorrhagic blood dyscrasia which is thought to be due in some cases to an unknown infection, in others undoubtedly to syphilis. The exciting cause is injury before or more frequently during labor. This may arise in cases of undue or prolonged pressure upon the head, premature, precipitate, or delayed delivery, or forceps delivery, delay in head-last cases, and asphyxia livida from any cause. In many cases there is cephalhematoma and in a few demonstrable cranial fracture. The hemorrhage varies greatly, both in amount and in location. There may be only a drachm or two, or several ounces. This may be diffuse or all in one mass. It frequently comes from the vessels of the pia-mater, or a cerebral vein, or more rarely a sinus, or a vessel traversing a cranial foramen. Therefore it may be beneath the pia or between pia and dura, or between dura and skull. The blood is more frequently found at the base and posteriorly, but it may occur over the convexity, especially over the occipital lobes of the cerebrum.

Hemorrhage may lead to softening, or set up a meningitis, or gradually, by pressure, after months or years lead to atrophy of the brain, sclerotic changes, and sometimes cystic degeneration. The sclerosis consists in proliferation of the neuroglia, thickening of the walls of the vessels, and hypertrophy of the connective tissues all about them, while the nervous elements diminish or disappear. The sclerosis may be localized in tuberous shaped portions or diffused over one of the cerebral hemispheres. But it may be impos-

sible in making an autopsy upon a case of spastic paralysis to state whether the original cause was a cerebral hemorrhage or meningo-encephalitis or embolism. Nor is it always possible to say whether it was secondary to any of these or was an arrest of development. What Sachs calls agnesia corticalis, considering it a failure of development of the cells of the cortex, Oppenheim attributes in many instances to changes secondary to meningeal hemorrhage. Porencephalia may occur in connection with the sclerosis or independently of it; and like it may be looked upon as an error of development or as secondary to intra-uterine disease or to an injury or disease acquired at or after birth. The cysts are usually about the size of a walnut, and are apt to be located in the central and temporal convolutions, but may occupy nearly as much of a hemisphere as is supplied by the middle cerebral artery and the artery of the Sylvian fissure. Degenerations also of the internal capsule and the lateral columns of the cord are frequently found.

Symptoms.—An extensive hemorrhage taking place either before or during labor may cause death. Or the infant may be born alive but asphyxiated, and even when resuscitated remain lethargic, with shallow or irregular respiration, and feeble and slow pulse. He can scarcely be induced to nurse. He may sink gradually and die after a few hours; or may rally and develop rigidities of the muscles of the extremities, retraction of the head with contracted pupils and nystagmus, increased patellar reflex, sometimes general convulsions. It is probable in such a case that the hemorrhage is over the cortex. It is after hemorrhage at the base that coma with paralysis of respiration causes death without convulsions or other motor disturbances. In many cases it is difficult to acertain whether paralysis is present, or will follow. In some it may be observed that a leg or an arm or the face is paralyzed; or the convulsions or automatic movements may be confined to one part, showing irritation at the corresponding cortical center, to be followed later by paralysis. Occasionally definite hemiplegia, diplegia or monoplegia can be demonstrated. Many cases are undetected until the child is old enough to make voluntary movements.

Diagnosis.—The main diagnostic symptoms of the recent case are succinctly listed by Holt as " stupor, rigidity, increased reflexes, convulsions, paralysis, and opisthotonos." The nystagmus, contracted, dilated or unequal pupils, sighing, irregular respiration, a bulging fontanel, may also be present. Often there is corroborative evidence in a cephalhematoma, a fractured skull, a history of breech presentation, tedious labor, asphyxia at birth and other probable causes. The presence of a group of the symptoms detailed, in a new-born infant or one apparently normal and of full term development, justifies the diagnosis of intracranial hemorrhage. But

with a small and cachectic babe, or one evidently premature, or syphilitic, or with a microcephalic or hydrocephalic or asymmetrical cranium, or spina bifida, or other deformity, one would hesitate even in the presence of several of these symptoms to make a diagnosis of hemorrhage. The cases which survive four or five days will probably live to develop the secondary changes and exhibit symptoms according to the extent and location of the lesion. The paralysis may be hemiplegic, diplegic, paraplegic, or, very rarely, monoplegic. Of 150 cases reported by Osler, 120 were hemiplegic, 19 diplegic, and 11 paraplegic. Holt believes that the original cases of diplegias and paraplegias outnumber the cases of hemiplegia more than four to one; but that many of the former die during the first two years, while the hemiplegics live to develop the results of the lesions and come under the observation of neurologists and surgeons. During infancy there may be more or less rigidity of the muscles of the extremities, particularly of the lower extremities, and sometimes of the neck and trunk, with occasional attacks of convulsions. There may be noticeable backwardness in growth and development, physical and mental, the babe not learning to hold up his head or to sit up or to grasp objects or to make attempts to stand at the age when normal infants do. Or the condition may be so slight as to pass unnoticed or considered mere backwardness until the child is two or four or five years old. Then the condition varies greatly in degree. A severe case may be bilateral—a bilateral hemiplegia—with spastic rigidity of the extremities, probably much less marked in the upper than in the lower. The legs may be crossed and so rigid as to prevent the patient from walking. If he does walk it is with a stiff and jerking gait. He drags the limb and circumducts it in advancing the foot. The feet may be rigidly held in equinus or equino-varus. The hands, especially, are liable to athetoid or irregular choreic movements, often with the fingers closed over the thumb. These movements affect also the neck or the muscles of middle and lower parts of the face. The rigidities yield gradually to steady pressure. The cranium may be small or misshapen. Frequently the mouth is large and kept open, with the saliva dribbling. The teeth are large and irregular. There is mental impairment often amounting to partial idiocy; but it often is of a higher grade than one would expect from appearances. The tendon reflexes are exaggerated. Electrical reactions are normal. Epilepsy develops in nearly half of the cases.

Acute or Subacute Acquired Cerebral Paralysis.—This class of cases occurs in children originally normal and born without accident. As a result of whooping-cough, or of one of the exanthemata, or diphtheria, or pneumonia, or more rarely of traumatism, and sometimes without discoverable cause, hemiplegia appears. More rarely it is diplegia or paraplegia.

Lesions.—The lesions may be found in the blood-vessels, or in the membranes of the brain. But if a hemorrhage it is more apt to occur over the convexity than in hemorrhage at birth. Hemorrhage may initiate or may result from meningitis. Sinus thrombosis and, more rarely, embolus, may be associated with it. Whether the primary lesion is of blood-vessels or of the meninges, the effect upon the brain substance is much the same as has been described in birth palsy, namely, atrophy and sclerosis, with secondary degeneration in the cord.

Symptoms.—A typical primary case is ushered in by fever, convulsions, often with vomiting, and followed by coma or delirium. These symptoms continue for several days, when paralysis is discovered, usually hemiplegic. In secondary cases there may be only convulsions, and perhaps coma, in addition to the symptoms of the primary disease. Occasionally the coma or general paralysis results in death. The cases that recover present spastic paralysis with increased reflexes on the affected extremities. The paralysis may improve considerably in the course of a few weeks. The speech center may be affected, and, curiously, this occasionally occurs in right-sided brain lesions as well as left-sided in infants. After a few years, atrophy of affected muscles and contractures may result. As in birth-palsy, epilepsy and irregular choreiform or athetoid movements are common sequellæ. The mental condition is very much less likely to be affected than in birth-palsy.

Prognosis in All Forms of Infantile Cerebral Paralysis.—Three factors enter into the prognosis. The stage of development of the brain when the lesion occurs, and the extent, and the location of the lesion. Those injured or diseased in fetal life are apt to be seriously damaged, and many of them do not survive infancy. Those in whom the lesion is so extensive as to produce diplegia or paraplegia may be placed in the same class as regards prognosis. If any of them survive they are seriously defective mentally and practically helpless physically on account of spastic paralysis of the extremities. When the lesion has been of less extent and resulted only in hemiplegia there is prospect not only of life but of a degree of usefulness. The older the child, and therefore the more advanced the cerebral development at the time of the paralytic attack, the less serious is the resulting damage to mind and motor centers. In an infant it is possible for speech to be restored after having been destroyed by a lesion in the left side of the brain, the right side apparently acting as a speech center. The probability of the development of epilepsy should be borne in mind. It is impossible to predict in infancy what the degree of mental development will be. Ordinarily there is a tendency toward improvement. Much can be done by education and training, both for the mind and for the body, and an improvement of the physical condition and the motor control by

surgical means seems to react very favorably on the mental state. The less the mental deficiency the greater will be the practical benefit from surgical interference for the improvement of the deformity.

Diagnosis.—In the acute stage of the acquired form, it may be impossible to distinguish between hemorrhage and meningitis secondary to another disease. If hemorrhage follows trauma it would likely supervene earlier than a meningitis would have time to develop. Early loss of consciousness and early and permanent paralysis point toward hemorrhage rather than meningitis. Characteristic symptoms of cerebral paralysis are its distribution, being diplegic or hemiplegic, the presence of rigidity which slowly yields to pressure, exaggerated reflexes, slow atrophy, and finally the unaltered electrical reactions. Corroborative evidence may be found in the psychic symptoms and the paralysis of the facial and motor oculi, and in the history. Paralysis of poliomyelitis is confined to certain muscle groups, or even a single muscle; has the reflexes absent; rigidity if present is permanent, and will not yield to pressure in a short time; the paralyzed extremity is cold, reaction of degeneration is present, and there are no head symptoms. In pressure paralysis, for instance, that accompanying spinal caries, there are pain and usually deformity, spinal rigidity, and no cerebral symptoms. In beginning pseudo-hypertrophic paralysis if the past history does not make the diagnosis clear, the future will do so.

Treatment.—The treatment of the ante-natal cases can only be prophylactic, and resolves itself into treatment of syphilis if that disease is present, and hygienic care and safeguarding of the pregnant woman in all cases. The prophylaxis of hemorrhage during birth rests with the obstetrician, in shortening labor and avoiding undue or prolonged pressure upon the head. Intracranial hemorrhage in the new-born has never received the attention from the profession that it deserves. Many cases, doubtless, with hemorrhages at the base or in inaccessible locations, are beyond the aid of surgery. But those not resulting fatally within a few days, among which are a large number with the hemorrhage over the convexity, should, if the diagnosis can be made and the situation of the clot localized with reasonable certainty, have an effort made for their relief by trephining and removal of the clot. (See Section on Operations upon the Cranium.) There is no denying the danger of such a procedure, and yet without relief the result is distressing and sometimes worse than death. The diagnosis and accurate localization are often difficult; and yet I think with care and attention these could both be accomplished in a large number of cases. Otherwise nothing can be done immediately after the hemorrhage but to keep the babe quiet and await developments. Convulsions,

meningitis, fever, or vomiting supervening are to be treated symptomatically. The same may be said of the acute stage of acquired paralysis. But later the treatment of the resulting conditions is by educational methods, massage, passive and active movements, gymnastics and electricity. Faradic electricity is recommended to be used daily. When the spastic contractions prevent placing the parts in position for proper use they should be relieved by tenotomies, myotomies and fasciotomies in the same manner as described for spinal paralysis. It is usually useless to attempt correction by the use of braces without operation. Pain and ulceration would ensue and no permanent correction of the spasm be accomplished. Tenotomy, besides allowing correction of the deformity, relieves the spasm. But when, after operating, the extremities can be held in position for use without undue tension, it is surprising how much more good is apparently accomplished by the massage and the gymnastics. Successful use of the muscles often stimulates the child mentally, and all the distressing features of the case may be alleviated in a very satisfactory manner.

The tendo Achillis and the hamstring tendons are those most frequently requiring section. These may be divided by the subcutaneous or open methods. When the fascia also requires division in the popliteal region it is better to use the open method, closing the skin wound afterward with sutures. The operations and the braces are exactly the same, as are more fully described in sections on tenotomies, on correction of deformities in poliomyelitis, and on correction of club-foot. But in tenotomy for cerebral paralysis the deformity is merely corrected,—not over-corrected,—before putting it up in plaster. After the plaster bandages are dispensed with, a proper brace is applied and used for months, and not laid aside until there is no tendency to relapse.

In epilepsy following trauma if the lesion can be localized, operation is to be considered; but if there is evidence of secondary changes in the brain, operation would probably be useless.

OPERATIONS UPON NERVES

Nerve Transference and Suture of Nerves in the Paralyses of Childhood.—By combining the studies of anatomists, histologists, physiologists, neurologists, and experimental and clinical surgeons, an immense number of data have been accumulated concerning the structure and functions of nerves and their behavior under injury or disease and under operations. Many of these facts are applicable in pediatric surgery. In briefly presenting this subject I shall make use of the excellent monograph of Murphy especially, and of the papers of Harris and Low, Kennedy, Keen, and others, without attempting to credit each observation to its original source.

The controversy as to whether a peripheral nerve which has been a long time severed from its connection with the cord, or

whose ganglionic cells have been destroyed, is permanently degenerated, is not yet quite settled in the minds of all. But it is held by those who have been foremost in recent studies upon the subject, that if the connection between the severed nerve and a central ganglion is properly restored, that new nerve fibers will regenerate even if the disconnection had been long continued and degenerative changes had taken place. The new fibers will not be anatomically or physiologically perfect at first, but under the stimulus of impulses from the center they will develop to normal structure and function. The length of time that may elapse and the exact degree of degenerative change that may make such restoration impossible have not been definitely determined, but restoration to function has been secured in nerves which had been severed many years before. However, the sooner the severed peripheral segment is united to its own proximal segment or to another sound nerve the sooner and the more complete will be the functional result. All nerves provided with a neurilemma are capable of this regeneration. Nerves without a neurilemma, the aneurilemmic axones, are incapable of regeneration.

It interests pediatric surgeons, especially in connection with the subjects of peripheral paralysis and poliomyelitis, to know that ganglionic cells and aneurilemmic axones when destroyed never regenerate; and that all the extra-spinal nerves, peripheral nerves, cranial and spinal, that is, all peripheral nerves excepting those of special sense, are medulated and neurilemmic, and are therefore capable of regeneration under suitable surgical conditions.

The fundamental principle of uniting nerves so that regeneration shall take place and function be secured lies in the fact that the peripheral axones in the nerves are insulated, and that to secure axonal contact the axis-cylinders should be brought together end to end, or else freed from their insulation if joined laterally.

Nerve transference is applicable both in cases of peripheral paralysis due to a contusion or division of a nerve trunk, resulting in a separation of the divided ends, or in the presence of scar tissue which will not transmit impulses; and in peripheral degeneration due to destruction of the ganglion cells. The operative treatment consists in the re-establishment of the continuity of the divided nerve or the anastomosis of the peripheral end of the divided nerve, or of the nerve whose center is destroyed, into a potent nerve, that is, one receiving impulses from ganglionic cells. This plan of treatment has not as yet been carried out in many cases. But a large amount of experimental work has been done, and tested in practice sufficiently at least to justify Murphy's statement that " the treatment of the various palsies by nerve anastomosis is destined to a broader

application, we firmly believe, as the principle underlying this treatment is physiologically and histologically established."[1]

In all operations upon nerve trunks an important step is the identification of the nerve. The operator should not depend only upon his anatomical knowledge, for the tissues at the seat of an old injury may be so changed in structure and color and so confused in a mass of connective tissue as to be unrecognizable. To meet this

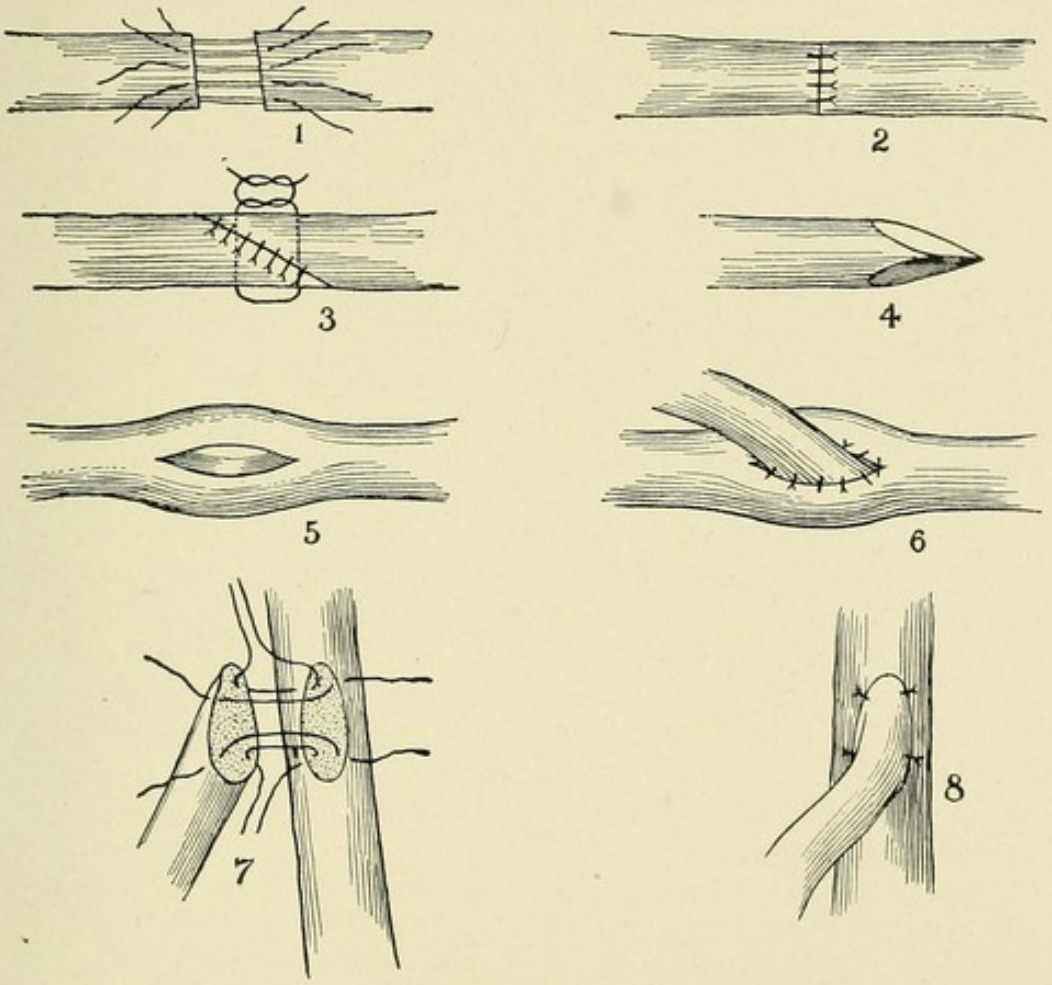


FIG. 143. Diagrams 1 to 8 showing various methods of nerve suture.

difficulty a nerve excitor is used. This consists in a metallic electrode having at one end two platinum needles or tips three centimetres long, with their points five millimetres apart. At the other end the needles are connected with a faradic battery having a weak current. The metallic handle and needles are sterilized and can be used by the operator during his dissection. Upon touching a motor nerve with the needles, the muscles in its area of distribution contract, and many mistakes are thus avoided.

[1] Magazine of Surg., Gynec., and Obstet., April, 1907.

Nerve suture may be primary, that is, within twenty-four hours after division; or secondary, when months or years have intervened between the injury and the attempt at restoration. In secondary suture connective tissue should be removed from nerve endings that are to be joined. Axis cylinders or nerve fibers will extend their growth a considerable distance under favorable circumstances, but they cannot penetrate cicatricial tissue. If the nerve ends can be brought to face each other with only slight traction, they are easily sutured in position. Even a little stretching is permissible. Fig. 143, Diagrams 1 to 8, show different methods of joining the nerves.

The needle should be a round intestinal needle and the suture fine silk, or chromicized catgut, linen, or kangaroo tendon. The suture should be passed through the perineurium and through the surrounding connective tissue, and (this is an important point) not through the nerve itself. If there is a considerable gap between the two ends, a flap method is resorted to; or a segment of nerve or of spinal cord, or a piece of artery from small animals, or a bundle of catgut, or a tube of a decalcified bone, is interposed to fill the gap and afford a bridgework for the construction of the new nerve tissue. Sometimes the peripheral end of the severed nerve is united to the side of a sound nerve, or to a portion of it detached for that purpose. In order to prevent the encroachment of new connective tissue at the seat of union, various procedures are resorted to. Sterilized tubes of decalcified bone, of gelatine, of magnesium, of the arteries of animals, Cargile membrane, membrane lining an egg-shell, wax or paraffine are used. When available at the seat of operation the fascia, or muscle or fatty tissue adjacent should be drawn around the point of suture as a protection. Primary union is absolutely necessary for success. If union takes place, restoration of function comes in a certain order, first trophic, then sensory, and finally motor. The time necessary for restoration of function varies much in different cases, and as yet no definite knowledge has accumulated; but, approximately, sensation does not return sooner than six weeks nor motion sooner than twelve weeks. (32)

CHAPTER XVI

THE SPINE

Malformation of the Sacrum—The Normal Curves of the Spine—Lateral Curvature or Rotary-Lateral Curvature (Scoliosis)—Tuberculosis of the Spine (Pott's Disease; Caries of the Spine; Spondylitis).

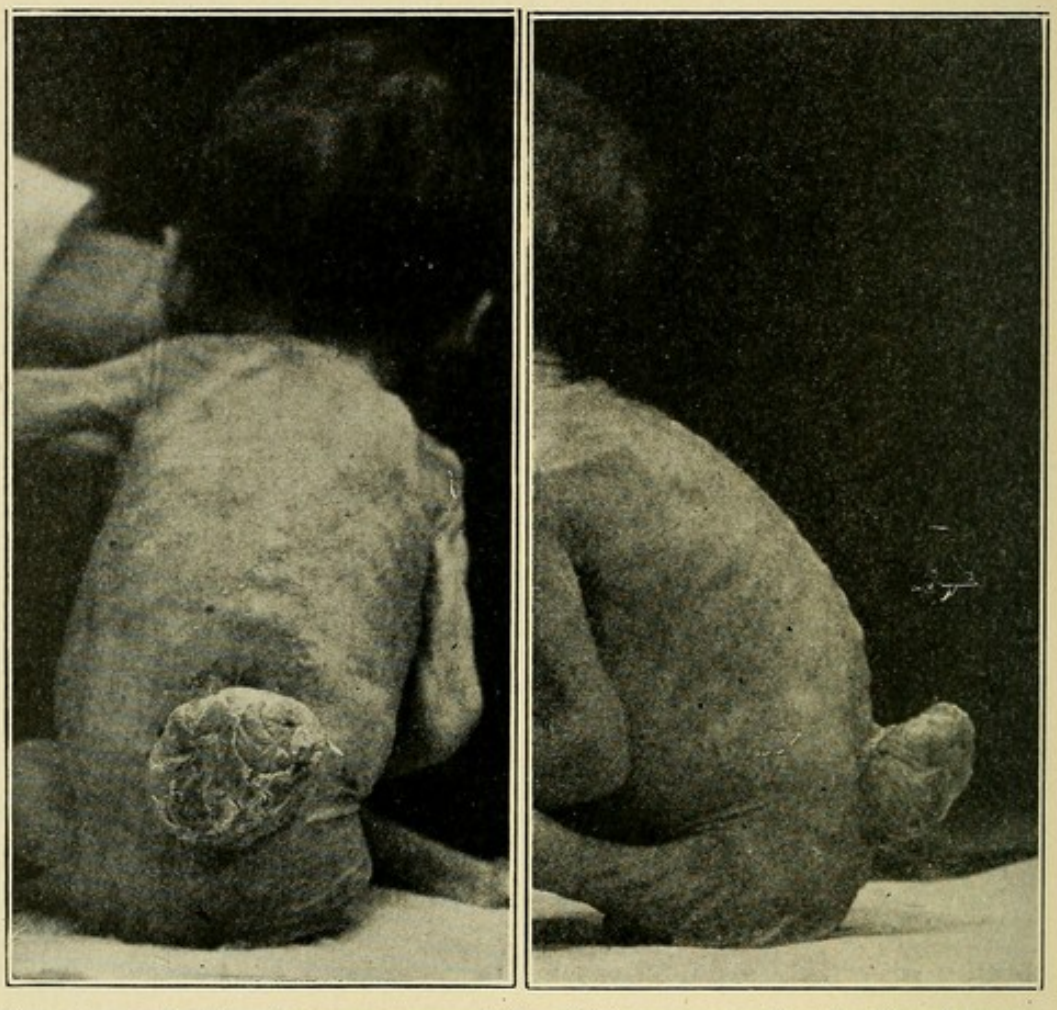
The conditions of the spine with which the children's surgeon should be acquainted are the malformations, tumors, curvatures, including the rickety deformities, spondylitis, Pott's disease or caries, the typhoid spine, the hysterical spine and cases of injury.

Sarcoma of the spine, aneurism of the abdominal aorta, syphilis, actinomycosis, and hydatids of the spine, are infrequent or so extremely rare as only to be mentioned as possible.

SPINA BIFIDA

The nerve elements of the spinal cord are derived from the epiblast. At first a mere furrow forms in the outer layer of the blastoderm. The furrow deepens into a groove, and by the closing of the margins of this groove a tube is formed—the neural canal. The mesoblast furnishes serous and fibrous elements which take their places around the neural canal. And from the mesoblast also are derived masses of cells at each side of the canal. These cells are destined to form the vertebræ. They extend around in front and form the vertebral bodies, and they also extend backward, forming the medullary or dorsal plates; and they arch over the neural canal, enclosing it in what will become the vertebral canal with its column of bodies, and arches and spinous processes. But if the dorsal plates fail to meet and close at a certain point, there will be a lack of vertebral arches and spinous processes, and through this cleft the spinal meninges, or the cord with the meninges will protrude posteriorly. There may be a failure of formation in one or more vertebral bodies and allow protrusion of the canal contents anteriorly. Or it may protrude through one of the foramina. Such protrusions, whether anterior, or, as is far more frequently the case, posterior, constitute spina bifida. (See Figs. 144 and 145.) This peculiar pathological condition is usually classed with the malformations, and yet it often bears a relationship to the tumors. Its surgery is closely associated with that of the spinal cord and nerves. It could also be well classed with cranial meningocele and

encephalocele; and it often enters into a discussion of syringomyelia and of hydrocephalus. Spina bifida is always congenital, never acquired. It is either "true" or "false." True spina bifida consists in a protrusion of the spinal meninges or elements of the spinal cord, or both, through an opening in the spinal canal, making



FIGS. 144 and 145. SPINA BIFIDA. This child was one of a family of twelve children, three of whom had a malformation. Its mother had nine children by first husband. The second child had webbed toes on the left foot. By the second husband there were three children, the first of whom had its mouth one inch too wide on the left side. This babe is the third.

a soft tumor external to the canal. Whether an abnormal increase of the fluid in the spinal canal has led to this hernia of the meninges and prevented a closure of the vertebral canal, or whether the failure of the vertebral canal to close is primary, are yet unsettled points. Certain it is that true spina bifida is sometimes associated with hydrocephalus and with cranial meningocele, or encephalocele. It is also true that it occurs occasionally in connection with hiatus of the bladder, a developmental failure, and that it is associated with congenital tumors of the spinal canal, such as lipomata, fibromata,

angiomata, chondromata, sarco-coccygeal cysts, and teratomata. Other pathological conditions accompany spina bifida, such as club-foot, paralysis of the lower extremities and of the bladder and rectum, doubtless resulting from the involvement of the cord at the seat of the tumor. Children with spina bifida are often but not always defective mentally. The condition is also frequently accompanied by general feebleness and poor nutrition.

The tumor is in or near the median line, most commonly projecting posteriorly in the lumbo-sacral region (where the canal normally is last to close), but may be in the sacral, high lumbar, dorsal or even in the cervical regions. (See also Chapter on Tumors.)

The tumor may be red, translucent, or oozing the contained fluid; or partly covered with skin, the skin becoming thinner and thinner toward the center of the protrusion, leaving only the membranous arachnoid. In the usual type of spina bifida the size of the protrusion may cover an inch or two, or rarely be as large as the child's head. It may become distended when the child cries, or in an infant the fontanelle may be distended by pressing upon the tumor. It may be constantly distended as if about to burst or be quite compressible, or wrinkled or shrunken. Sometimes the bony margins of the opening in the vertebral canal can be felt. This opening may involve only one or two or several vertebral arches. In extremely rare instances all the vertebral arches from the cervical to the sacral regions may be lacking. This is called rachischisis totalis. The tumor may have burst at the birth, or have ulcerated through. Where there is tumor growth in connection with spina bifida more solid tissues will be felt in the walls of the sac and there may be a hairy growth upon the skin of the covering.

True spina bifida may be divided into three varieties: First, spinal meningocele which consists merely in a protrusion of the membranes of the cord containing cerebro-spinal fluid. It corresponds to the meningocele occurring upon the cranium. The lining of the sac is the arachnoid, and the outer coverings vary in their representation in different cases. The tumor is apt to be translucent, in the middle line, and higher in the spine than the majority of spina bifida, and may protrude through a comparatively small opening in the spinal canal.

The second variety is meningomyelocele, so named because it contains, besides the meninges, some elements of the spinal cord. In the fetus at the fourth month the cord occupies the entire vertebral canal. But from that time on the canal exceeds the cord in its rate of growth, so that at birth it terminates at the level of the first lumbar vertebra in the cauda-equina and filum terminale which occupy the remainder of the spinal canal. If, then, the cord

itself has not suffered too seriously in its development, some portion of it or its terminal elements may sometimes be seen by the aid of properly transmitted light, fused with the membranous covering of the meningomyelocele or drawing it into folds. These cases of implication of the cord or cauda-equina are apt to be associated with clubbed-feet or paralytic lower extremities and defective innervation of the pelvic viscera. The vertebral defect is apt to be large and the tumor wide at its base.

The third variety, called syringomyelocele, has the dilatation producing the tumor in the central canal of the cord. It does not produce great distension, so that the covering is not thinned, often appearing quite like normal skin. Being often a small tumor and not always quite in the median line, it is apt to be mistaken for spina bifida occulta, or one of the other congenital tumors.

Spina bifida occulta, or false spina bifida, resembles spina bifida in its location and also in that it does come from within the spinal canal through a defect in its bony arches; but it has no cavity containing cerebro-spinal fluid, and is said to contain none of the constituents of the spinal cord. In those cases presenting some degree of anesthesia and perforating ulcers, doubtless the cord is implicated, whether within the canal or outside in the projecting tumor it may be impossible to determine. It may have been a true spina bifida which underwent spontaneous cure.

Differential Diagnosis.—The possibility of anterior spina bifida should not be forgotten when examining for abdominal and pelvic tumors. Several cases have been reported in children and in adults in which anterior spina bifida was discovered—sometimes after it had been dealt with upon a mistaken diagnosis. The presence of club-feet or paralysis of lower extremities with an obscure abdominal enlargement would arouse suspicion at once. But diagnosis might be impossible in many cases without an exploratory laparotomy. It will not do to pronounce every external congenital tumefaction along the spine a spina bifida. It should be differentiated from the congenital sacral tumors, from dermoids, teratomata, lipomata, lymphangiomata, fibromata and tumors compounded of more than one of these varieties. (See chapter on Tumors.) Also an attempt should be made by careful examination to distinguish which variety of spina bifida is presented, as this influences the prognosis and the treatment.

Prognosis.—The prognosis in most cases is unfavorable and in all doubtful. Infection of the sac may extend to its interior and result in meningitis, myelitis, destruction of the cord, and death. (See Fig. 146.) Or pressure or irritation of the sac may set up ulceration, and the sac opening and fluid escaping, convulsions and death rapidly follow.

The smaller the defect in the spinal arches, the smaller the tumor, the thicker and more natural its coverings, the less the other deformities or paralyses, the better are the prospects of either a spontaneous obliteration, which sometimes occurs, or of a successful operation. The meningomyelocele, with its extensive base connecting through a large opening with the interior of the spinal canal; with its thin membranous covering in which are involved portions of the cord, compels a very doubtful prognosis. The meningocele, even if it be rather large, having its communication with the spinal canal small and easily shut off, and skin flaps obtainable, offers a

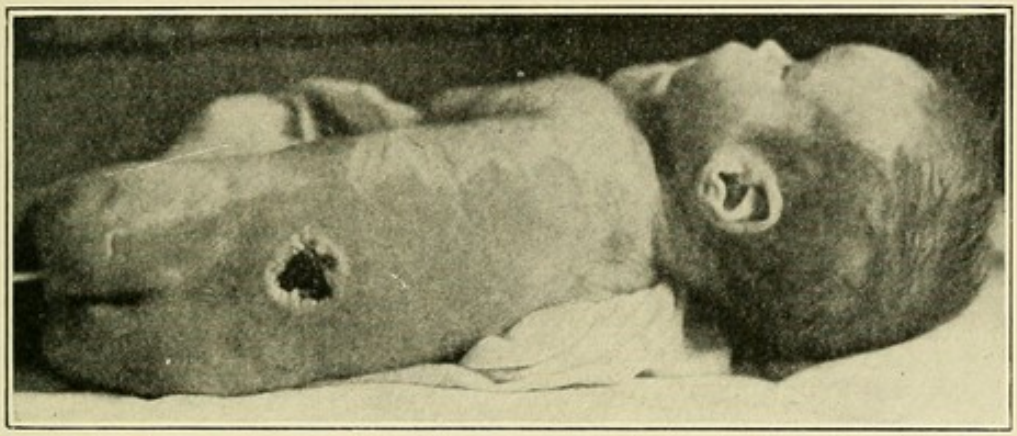


FIG. 146. SPINA BIFIDA. Infection occurred through the ulcerating membranous covering of the spinal meningocele, and the infant died of meningitis.

fair chance for operative success, if hydrocephalus does not interfere with ultimate recovery.

The syringomyelocele, which is apt to be small and well covered in, is a rather hopeful case as to life; although neither in this nor in meningomyelocele can improvement in sensory or motor defects of the parts below the cord lesion be expected. Cases ulcerating or inflamed at birth or when first seen are likely to die of meningitis in a few days. Cases of spontaneous cure by cicatrization after emptying of the sac by oozing, have been reported, but this result is not to be expected.

Treatment.—Several methods of treatment are open to the choice of the surgeon, and these have been variously modified. First, the spina bifida may simply be protected from pressure and irritation. This may be done by means of a cup-shaped appliance made of sole leather or metal with round edge, or a wire frame with its edge covered by india rubber tubing or otherwise rounded, or similar contrivance. The cup should not press upon the tumor at any part and should rest upon sound skin. To simply pile a few layers of gauze and cotton upon a spina bifida, as one sometimes sees done, is no protection from pressure, but the reverse. The

surface, if moist, should be dusted antiseptically. This treatment is applicable to small tumors in which spontaneous obliteration may be hoped for, or cases in which immediate consent to operation cannot be obtained, or may be of doubtful utility.

Secondly, the injection method, or Morton's method. Morton used a preparation of ten grains of iodine and thirty grains of iodide of potassium in an ounce of glycerine. With the child lying upon its side, and under antiseptic precautions, a fine aspirating needle is made to enter the cavity through healthy skin at a little distance to one side of the tumor, and a part of its contents allowed to escape, in quantity according to the amount of tension. But it is not desired to collapse the sac completely. Then about a drachm of the glycerine mixture is injected through the needle, while the opening into the spinal canal is shut off from the sac if possible. The needle is withdrawn and the puncture sealed with collodion. A protective dressing is applied and the child kept lying upon its side for a few hours. The glycerine being heavy, does not rapidly mix with the cerebro-spinal fluid in the spinal canal, but remains for the most part in the sac and excites alteration in its tissues. The injection is generally repeated at intervals of a week or a week and a half. Morton advised that this method be begun when the infant is from three to six weeks old.

A third method is radical operation by removal of the sac or a portion of it and closing the meningeal and cutaneous flaps separately by careful suturing. A muscular cutaneous flap may be utilized to fill the hiatus. (Bayer.) A further elaboration of the radical plan is a closure or partial closure of the vertebral opening by chiseling an osteo-plastic flap from the rudimentary laminæ on each side. (Selenko-Boborof.)

The vertebræ (excepting the atlas and axis) have each three centers of ossification, one for the body and one for each of the laminæ which, uniting posteriorly, form the arch and extend into the spinous process. At birth the ossification of the laminæ generally has not united them posteriorly, although Ballantyne found them united in several specimens. The formation of the arches and their ossification takes place last in the lumbar or lumbo-sacral region. In cases of spina bifida there is no uniformity in the degree of the hiatus in the spinal canal, and there may be rudimentary arches which have made an attempt at ossification, and being divided at their base laterally are brought to the middle line and sutured together. Portions of the sacrum chiseled off, but still retaining their muscular attachment, have been used in the flap formation.

Radical operation promises best in those cases in which the opening into the spinal canal is small, or in which if it is larger there

are adequate skin flaps available. If nerves be found fused with the membranous covering of the tumor, perhaps portions of the sac between the nerve strands may be sacrificed, and the remainder, after suturing, be folded in to fill the cavity in the canal, and covered with the skin flaps.

The nerve strands are apt to be connected with the middle portion of the posterior wall of the tumor. In this case the dissection is best begun at the side. If pedunculated the sac may be isolated and temporarily compressed while it is opened and examined. If free from nerve structures it may be ligated at its base. If it contain the expanded cord itself the latter should be replaced within the canal and retained by closing the sac with sutures. If the sac contain the nerves of the cauda the atrophied portions should be excised and the severed ends united end to end. (Murphy.) The cauda-equina, although within the dura, is a collection of extramedullary spinal axones with a medullary sheath and neurilemma, and capable of regeneration the same as the axones of peripheral nerves. (See Section on Nerve Transference and Suture of Nerves.) Careful suturing of the flaps is necessary. The meninges should be sutured with fine chromicized catgut or kangaroo tendon in continuous suture; and the skin with silkworm gut. The meninges and skin are best not united in the same line. Immediate union is sought and may be obtained, but meningitis is liable to ensue upon any operative procedure upon spina bifida, unless the most rigid aseptic technique is carried out.

MALFORMATION OF THE SACRUM

In the infant and young child the sacrum and coccyx are more in direct line with the rest of the vertebral column, and present less concavity on the pelvic surface than in the adult. However, there is at birth normally an anterior sacro-coccygeal concavity, extending from the promontory of the sacrum to the tip of the cartilaginous coccyx. In some cases the infantile straightness of the sacrum and coccyx is exaggerated, and there appears externally in the region of the coccyx a so-called "post-anal dimple." These cases may have the line of the sacrum extended farther backward than normal from the line of the lumbar spine.

THE NORMAL CURVES OF THE SPINE

Early in the development of the fetus the spinal column has but one curve, its concavity forward. Later the promontory of the sacrum appears and divides this into two, a shorter curve below and a longer above, each concave anteriorly. At birth there still persists a tendency to anterior concavity in the dorsal spine. But for practical purposes it may be stated that the normal infant's

spine, with the exception of the projection of the promontory of the sacrum, is straight, up to the time that he assumes the upright position. At any rate it has no curves which are made constant either by bony or cartilaginous formation, by the binding of ligaments or the tension of muscles, but is a perfectly flexible column which will change its curves according to the position in which the infant is placed.[1] But as the infant begins to hold its head, and later its body in the upright position, the cervical and then the dorsal curves are formed. Still later, when standing and walking are essayed, and the spine and pelvis with the body on the anterior side of its center of gravity must be balanced upright upon the femurs, the action and counter action between weight and muscular tension produce the lumbar curve. The sacrum retains its anterior concavity, and even increases it in the course of the development of the pelvis and pelvic contents. When normal growth is attained the cervical and lumbar portions of the spine have their convexity anteriorly. In the dorsal spine the main curve has its convexity posteriorly. Some anatomists describe also as normal a very slight lateral curve of the whole length of the dorsal region with its convexity to the right. These curves, when not exaggerated, do not appreciably diminish the weight-supporting strength of the spine, while they greatly increase its flexibility, and especially add to its elasticity, relieving the spinal cord and brain of the shock of concussion. As stated, in the infant the normal curves can be obliterated by laying it on its back upon a plane surface; but gradually, as age and development advance, they become more fixed in the dorsal and lumbar regions, although in the latter the consolidation of the curve does not take place till adult life. According to Symington's observations, the cervical curve is never consolidated, but can even in the adult be obliterated by strong flexion of the head upon the thorax. This is doubtless true. It is within the observation of all that the degree of the normal curves as well as the flexibility of the vertebral column vary considerably in different individuals of the same age and can be varied greatly at will by practice. Flexibility diminishes and the curves become more fixed with age and development, the advance of ossification of the bony skeleton, and increased density of cartilage, ligament and muscle.

LATERAL CURVATURE OR ROTARY-LATERAL CURVATURE (SCOLIOSIS)

This variety of abnormal curvature of the spine is not due to any disease of the spine itself, but there may be congenital malformation of the bodies of the vertebræ, producing a curve. It may be due to general weakness of the muscles which should hold

[1] Ballantyne's Introduction to the Diseases of Infancy.

the spine in its normal position. The weakness may be but one manifestation of the general enfeeblement of rickets, or that following a fever or other severe illness, or that which accompanies too rapid growth in height without corresponding increase in strength and stamina, often combined with habitual faulty attitude. Scoliosis may be due to muscular weakness from paralysis, for instance hemiplegia or poliomyelitis. It may be compensatory to some inequality in the length of the lower extremities, such as a con-

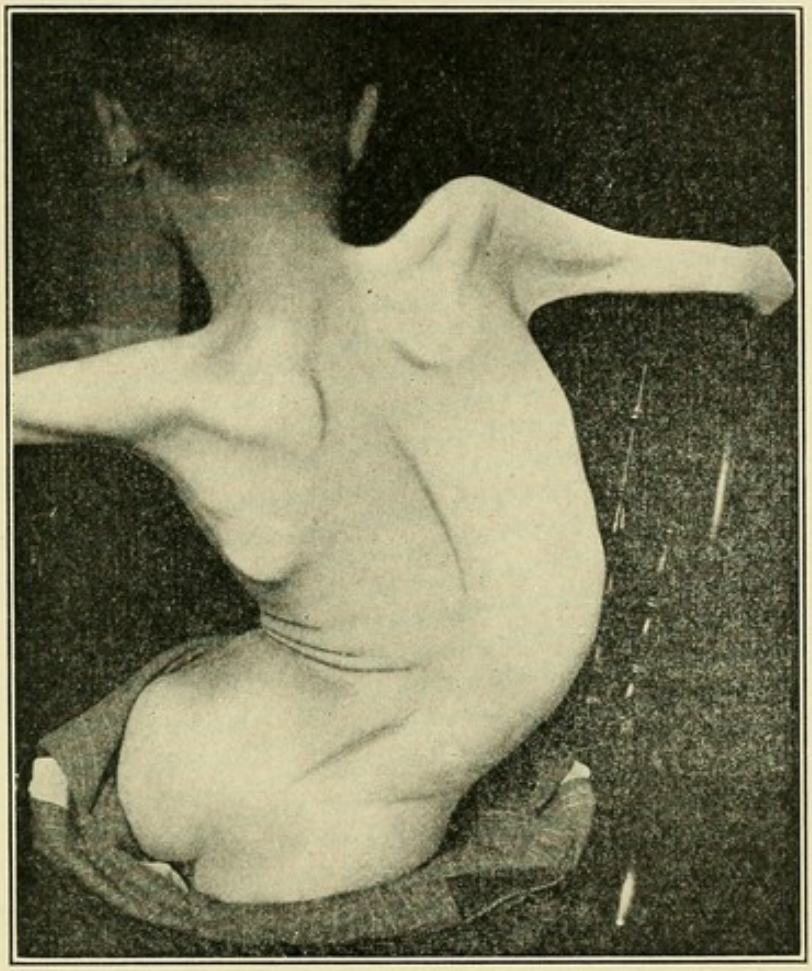


FIG. 147. SPINAL CURVATURE FROM PSEUDO-HYPERTROPHIC PARALYSIS. Same case as Fig. 37 taken two years later. Note the atrophy of the muscles of the shoulders and trunk.

genital shortness of one limb, or to a fracture with shortening, or joint disease of hip, knee or ankle, or congenital hip dislocation unilateral, or to flat-foot. Scoliosis may be caused by atelectasis pulmonum, or empyema, with or without thoracoplasty, or to pseudo-hypertrophic muscular paralysis, as in Fig. 147. It is occasionally produced by tuberculosis of the spine, affecting one side only of the vertebral body, or by torticollis or cicatrices. Scoliosis is sometimes said to belong to the period of young adult life, but it

may occur in infancy and is common enough in childhood and frequent in youth approaching puberty. Those cases due to malformation of the spinal column itself are of course manifest early in life; likewise those due to congenital shortening of one limb. The rickety cases make their appearance in infancy and early childhood, (see Figs. 24 and 148), and those due to paralysis are also apt to appear in childhood. Those from empyema in childhood or youth. (See Fig. 189.) These forms of course continue into the subsequent periods, while youth, puberty and adolescence are especially productive of the very common class of cases due to general feebleness, muscular and ligamentous relaxation with habitual faulty attitudes.

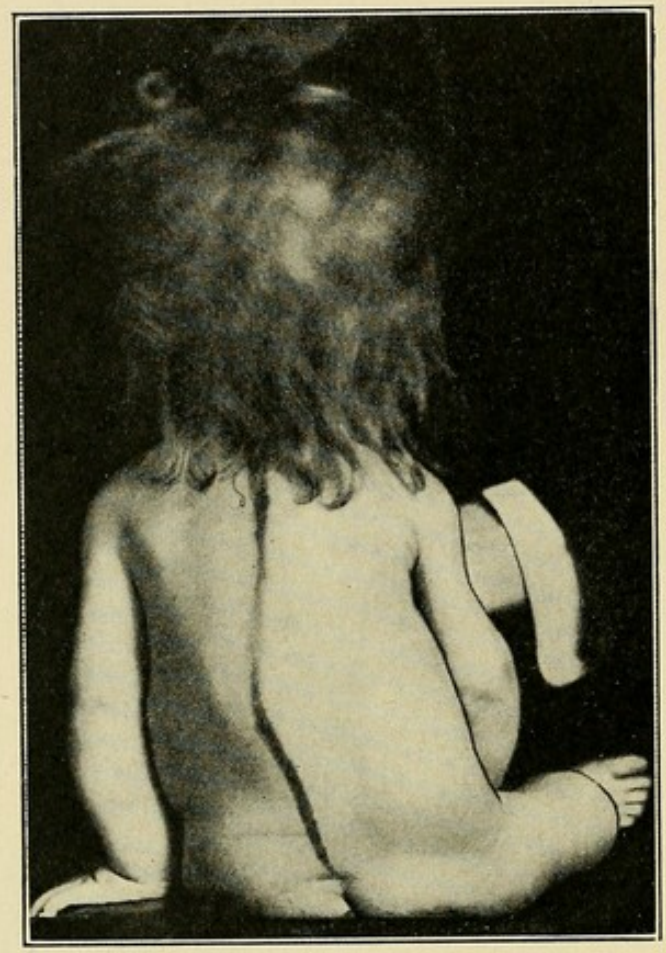


FIG. 148. RACHITIC SPINE. Rickety curvature of the spine is usually simply a convex bowing; but this shows there may be also a lateral curvature. This habitual position of sitting bearing weight upon arm has also bowed the left forearm in the same curve.

The principles involved in the production of scoliosis are the same in all cases, although the initiation of the trouble varies according to the cause. For example, if the left lower extremity is shorter than the right, as in congenital malformation, or from injury or disease, the left side of the pelvis will drop to a lower level and the lumbar spine must make a primary curve to the right to maintain the equilibrium. The body thus leaning toward the right, if the shoulders and head are to be held upright the dorsal spine must make a secondary curve to the left.

In the case of general muscular feebleness suppose the child sit on a level seat with the right side toward a desk, the right elbow resting upon the desk and raising the right shoulder, while

the left elbow hangs at its side. Here the dorsal spine describes a primary lateral curve with its convexity to the right, while the lumbar spine must make a secondary or compensatory curve, with its convexity to the left. The thorax overhangs the pelvis on the right side, while the right lower ribs approach the iliac crest. On the left side the hip bone projects far outward from its normal line and its crest is separated widely from the lower ribs. The muscles project in a ridge along the convex sides of the curvature. A primary dorsal curvature convex to the right is the variety most frequently met, but a curvature to either left or right may take place in any region of the spine, and may have its compensatory curvature in other regions. If there is a secondary curve it is of course in the direction opposite from the primary, and if there are three they alternate in direction.

These lateral curvatures are not simple inclinations of the spine to one or the other side, but involve a rotary deviation or twist in the column of vertebræ, those vertebræ involved in the curvature turning their bodies to face its convex side. This rotation of the vertebræ upon a vertical axis, of course, causes the transverse processes to point farther backward and to separate on the convex side of the curve, while on the concave side they point farther forward and are crowded together. In the dorsal curvature the ribs necessarily follow the same course, in time producing deformity of the thorax, which shows a projection and has its cavity increased upon the convex side, while it recedes and has a lessened capacity on the side of the concavity of the spinal curvature. (See Figs. 149 and 150.) The scapula upon the convex side cannot lie flat upon such a rounding surface, but its lower angle projects backward and outward. On the concave side the scapula is on a lower level than its fellow and its angle approaches the spine. The vertical length of the body is shortened.

In the early stages of scoliosis, excepting in congenital malformation, the curvature can be corrected by changing the position, shifting or removing the superimposed weight. But if a faulty position be habitually maintained for a considerable length of time, and the muscles be too weak or inactive to correct it entirely in the intervals, the overstretched ligaments become lengthened, cartilage, and even bone, by compression upon one side greater than upon the other, grow correspondingly misshapen, and the deformity at first temporarily permitted by the muscles is permanently fixed in the bony skeleton, in its cartilaginous cushions and its fibrous supports. (33)

More than one cause may take part in the formation of a curvature. For example, an infant with torticollis may become rickety, or a rickety child be paralyzed. The same cause may act both

directly and indirectly; for example, a bowed leg from rickets may tilt the pelvis in conjunction with a rickety spine and produce a

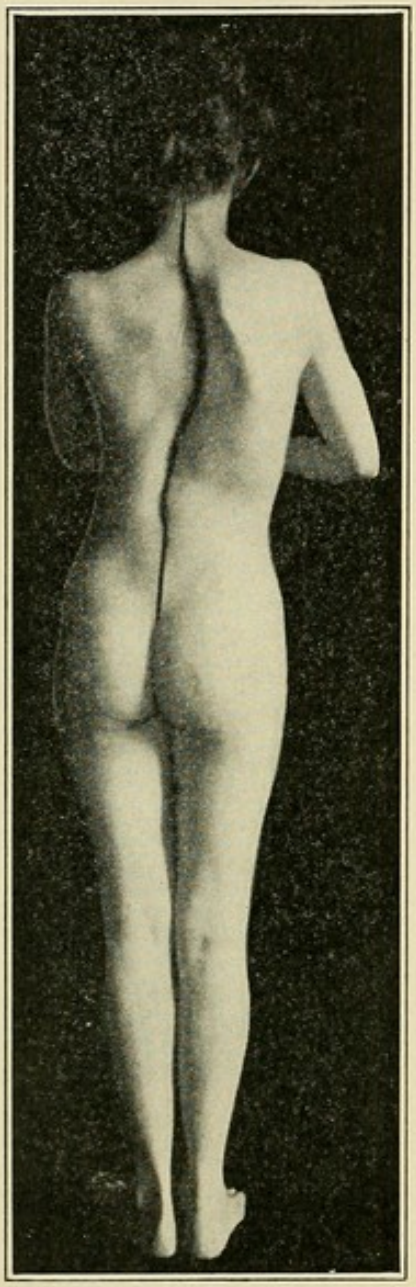


FIG. 149. RIGHT DORSAL ROTARY-LATERAL CURVATURE. The dark line shows the position of the spinous processes, demonstrating that the rotation is greater than the curvature would seem to indicate.

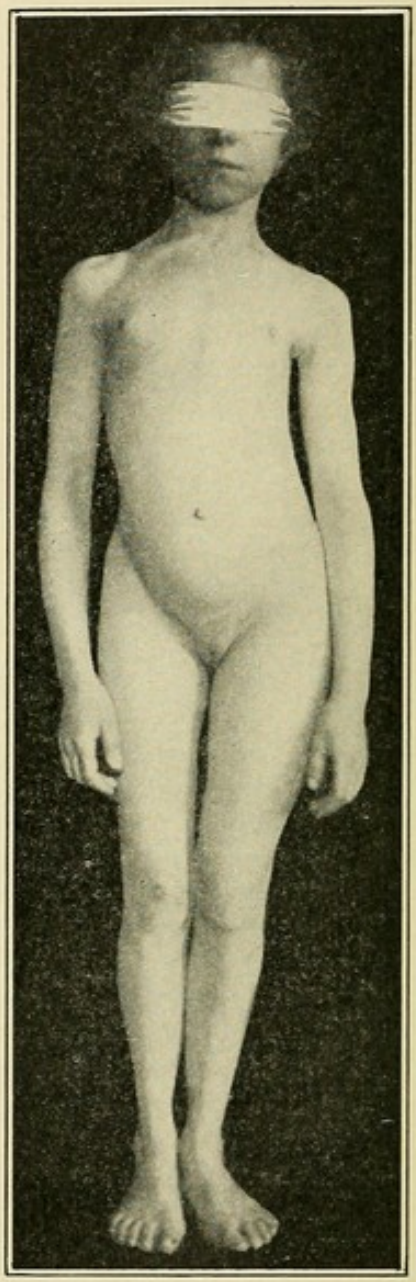


FIG. 150. Same case as Fig. 149, showing thoracic deformity from spinal curvature in an otherwise well-formed girl of 13 years. Chest capacity increased on convex side; decreased by compression on concave side.

lateral curvature. Or a lateral tubercular spondylitis may be coexistent with morbus coxæ and a shortened limb.

Scoliosis is very unequally divided between the sexes, a very large share going to the girls. This is explained by their inferior physical vigor, and their customary indoor and sedentary occupations.

Rickets is apt to produce a general bowing of the whole spine with the convexity backwards. This kyphosis, as it is called, even if it involve less than the entire spine, is larger and rounder than the angular curvature or kyphosis of spinal caries. Rickets may also less frequently produce a lateral curvature of the spine, as shown in Fig. 148.

Lordosis is a concavity posteriorly in the lumbar or cervical regions. In the lumbar region it may result from congenital dislocation of the hip, or morbus coxæ, or accompany a kyphosis from Pott's disease of the dorsal spine, or be due to paralysis of the muscles of the back, or to carrying too heavy a weight in front of the body. It may be alone or more frequently combined with lateral curvature; occasionaly it accompanies congenitally an abnormally straight sacrum which projects downward and backward from the sacro-lumbar joint. Lordosis in the cervical region is occasionally seen in feeble children compensatory to a rickety kyphosis of the dorsal region. (34)

Examination and Diagnosis.—The case may come to the surgeon with the diagnosis of spinal curvature already made by the mother; but more often she only complains that the child's "hip is growing out" or that she is "round shouldered on one side." Or the condition may be found upon routine examination, or after suspicion is excited by the shape of the thorax observed during examination of the lungs.

To examine for spinal curvature it is best to have the patient, if an infant or young child, entirely stripped of its clothing. A girl or older child should at least be stripped to the level of the trochanters and the shoes removed. The patient should then be directed to sit, to stand, to walk, and to bend over forward and to lie down. The sitting and standing should be prolonged sufficiently for the child to relax the muscles and unconsciously assume the habitual attitude. In bending over forward a curvature due merely to muscular weakness without rotation disappears; whereas, if changes in the skeleton have taken place they cannot be thus obliterated. One should compare the height of the two shoulders, which often serve as an index to the spinal deviation, and also of the two iliac crests, to see whether the pelvis is tilted. When the child is lying level on his back on a plane surface one raises the lower extremities to the vertical line to detect any difference in the length of the limbs. A suspicion of a curvature may sometimes be confirmed by correcting it by placing a book or like object under the

short limb as the patient stands, or under one buttock as the patient sits. Slight deviations can be shown by marking with crayon the position of the spinous processes, one by one, until the line is evident. As the child lies prone, by raising his legs slowly from the table, a rickety kyphosis will be obliterated or almost obliterated; but an angular curvature due to spinal caries will remain. Changing the patient's attitude will demonstrate how nearly the deformity may be obliterated by muscular action. Suspension by head and arms will show what could be accomplished by relief from weight-bearing and by weightextension. Subjective symptoms, as aching or tired feelings in the side are sometimes complained of, with general lassitude. There may be sharper pain. But the ache or pain is usually not in neck, chest or abdomen as is apt to be the case in spinal caries, but in the side. The scoliosometer is a complicated instrument and, after all, hardly as accurate as the practiced eye. Photographs and skiagraphs are very useful for study, for demonstration, and for record.

Prognosis.—Prognosis is good in the functional or postural cases. In structural or fixed deformity little can be expected without exceptional opportunities for treatment and unlimited time, unless the Abbott method shall prove to be what it is hoped and appears to be.

Treatment.—The treatment in scoliosis should be planned according to the individual case and with regard to the cause. A very slight curvature compensatory to a shortened limb, unless it is increasing, may need no treatment at all. Or it may be remedied by raising the shoe so that the limbs are equal. In curvature from empyema, breathing exercises and corrective gymnastics are in order; when from lateral caries, its treatment should be for caries. If a constitutional disease, as rachitis, is present that must be treated in addition to the corrective posturings, rest, exercise, massage and corrective manual pressure several times daily.

If the general cause be feebleness, inherent or due to illness or too rapid growth, our attention must be directed to a more hygienic plan of living and to tonic treatment. Mechanical supports have no part in the treatment of the great majority of functional and rickety curvatures in children. Often they would be positively harmful. Soft beds and high pillows should be abolished. Rest on a firm mattress with a plane surface or with a spine hammock or sandbags so disposed as to maintain symmetry, while other treatment for the feebleness or the rickets is in progress, may be useful. Tiresome or sedentary tasks may need abatement and outdoor life and games be substituted. In short, the treatment of functional spinal curvature is comprised in removing the cause, improving the

strength and tone of the muscles, and in correction by gymnastics. Until recently the same methods have been applied to fixed curvatures, with the addition of braces, jackets or corsets, and of complicated and powerful machines, calculated to forcibly correct the deformity. Exercises must be carefully graduated to the strength of each patient and should not fatigue. After each stint there should be a few minutes rest in a correct position; and when the work is done shampooing the muscles.[1]

Among the corrective exercises recommended, I have found the few which follow very useful:

(1) Breathing and Shoulder Exercise.—The patient stands erect; arms at side, palms forward, and takes two or three deep breaths, then having filled the lungs full, he raises the arms over his head and still further expands them. With the lungs filled to the utmost, he brings the extended arms from the vertical to the horizontal position in front of him, with palms forward, as though pushing the air before him, and when they are horizontal, he sweeps them back of him, as though in the act of swimming. Repeat five to ten times.

(2) Setting up Shoulders.—Breathing deeply meanwhile, the patient extends the arms outward horizontally and circumducts them, keeping them backward to the limit—the only joint-motion being at the shoulder. Repeat fifteen or twenty circles.

(3) Spine Extension with Exercise of Antero-posterior Muscles.—Hanging from a horizontal bar, the patient swings himself by throwing his thighs into hyper-extension, that is, backward, allowing gravity to give the forward swing. Five to fifteen times. The swinging bar may be used at times for variety.

(4) Spine Extension with Exercise of Lateral Spinal Muscles.—With his hands as far apart as comfortable, grasping the bar, he swings himself from side to side like a pendulum. Five to fifteen times.

(5) This last exercise is better done with parallel bars, which support the patient by passing under the axillæ, while he swings from side to side as far as his body will bend.

(6) Untwisting the Rotation Actively while Suspended.—Hanging in this position on the parallel bars, which fix his shoulders, the patient rotates his pelvis as far as possible toward the convex side, thus untwisting the rotation. Five to ten times.

(7) Correcting Rotation Passively while Suspended.—Likewise the surgeon may grasp the patient's body suspended with both hands and gently turn it in the direction to correct the rotation.

(8) Correcting the Convexity.—As the patient hangs suspended either from the horizontal bar or the parallel bars, the surgeon with his hands pushes against the convexity, using as much pressure for a moment or two as is comfortable to the patient.

(9) Thigh Extension.—The patient lying prone upon table, couch or

[1] Many exercises and combinations of exercises will be found described in the writings of Busch, Roth, Gibney, Alexander, Shaw, and many others. Wands, dumbbells, head extension appliance, the reclining board, the quarter circle, the rowing machine, the horizontal bar and many other apparatuses may be used if convenient, but very little apparatus is absolutely essential in the ordinary run of children's cases of functional curvature.

floor, hyper-extends his thigh while the limb is fully extended, lowers it to his level and raises it again five to ten times. The hand of the surgeon on the patient's ankle may make resistance.

(10) Trunk Extension.—The patient lies upon a table or couch with his body extending over the end while the surgeon holds the legs down to his level. The patient then lowers his shoulders slowly toward the floor and returns to the horizontal again. Repeating three to ten times according to his strength.

(11) Correcting the Rotation Actively while Standing.—The patient standing, extends his hands, palms forward, above his head in the horizontal plane of the body. With pelvis fixed, he then turns his shoulders, face and palms as far as possible toward the concave side, pauses, returns to position, facing forward, then drops hands at side. Five to ten times.

(12) Correcting the Concavity.—The patient extends the upper extremity of the convex side toward the horizontal. The upper of the concave side is extended high above the head and circumducted ten or twenty times.[1]

Abbott's method.—Abbott has devised a method by which he is able to correct the deformity of fixed lateral curvature of the spine.[2]

The method has two principles: (1) overcorrection; (2) fixation in the overcorrected position until the structures are so thoroughly changed that they will not resume the deformed position. Abbott maintains that the usual deformity develops with the spine flexed and bent to one side (either right or left), together with elevation of one shoulder (convex side) and depression of the other shoulder (concave side) allowing of rotation of the bodies of the vertebræ toward the convex side. To correct this deformity the integral parts involved must be made to pass through the same route as that which produced the deformity but in the reverse order and direction. Therefore, with the patient bent strongly forward, the low shoulder must be elevated, the high shoulder depressed; the bulging ribs must be drawn downward and forward; and lateral traction must be made against the lateral curve; and while in this position a plaster of Paris corset must be applied. A special apparatus is necessary. This is best understood by referring to the illustrations. Nine of the rails are windlasses with rachets. The hammock of light duck is taut at one edge and slack at the other. The patient is prepared by placing upon him two seamless woven undershirts. Saddler's felt is used over all bony prominences, heavy padding back of the low shoulder, over the sacrum, over the spinous processes of the ilium, over the prominent ribs at the front of the thorax, under both arms and over the convexity of the ribs

[1] See also Klapp's method of creeping gymnastics (Jour. Am. Med. Assn., Feb. 24, 1906) in Scoliasis and its secondary heart disturbances.

[2] E. G. Abbott: New York Med. Jour., June 24, 1911. Ibid. Apr. 27, 1912.

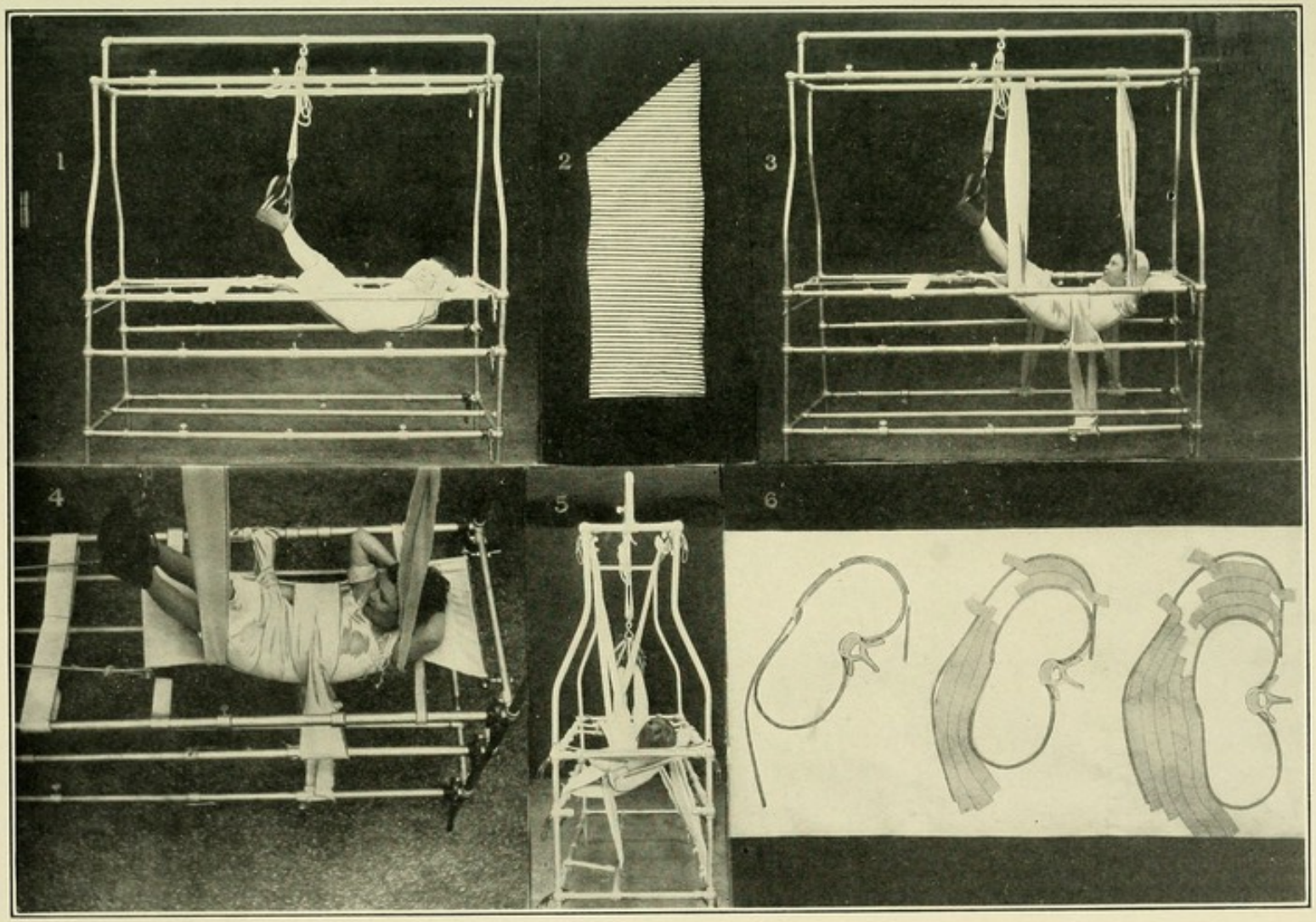


Plate I.—Illustrating Dr. Abbott's Method in Scoliosis. Fig. 1. Patient on frame with feet suspended to increase flexion. Fig. 2. Hammock. Fig. 3. Patient on frame with all straps applied—side view. Fig. 4. Patient on frame all straps applied—overhead view. Fig. 5. Patient on frame with all straps applied—end view—showing over-correction. Fig. 6. Shows diagramatically cross section of skeleton in cast with the changes when felt pads are inserted.



Plate II. – Illustrating Dr. Abbott's Method in Scoliosis, (*continued*). Figs. 7. 8. 9. Show windows in corset and amount of flexion. Figs. 10. 11. 12. Show patients in corset with rotation sufficiently over-corrected but lateral curve not, so hip and shoulder are cut out and pads inserted under opposite arm and hip to further over-correct lateral curve.

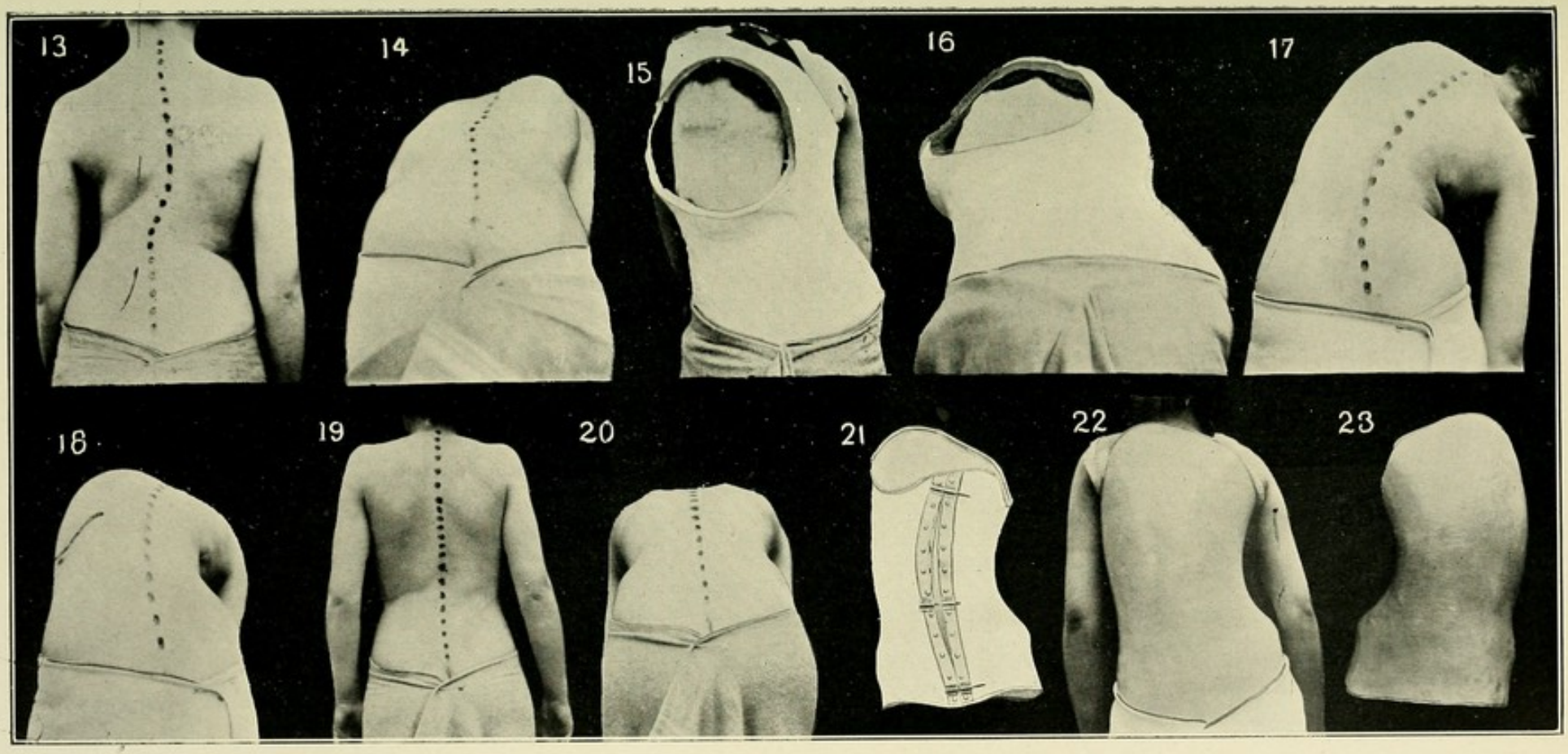


Plate III.—Illustrating Dr. Abbot's Method in Scoliosis, (*continued*). Fig. 13. Shows a case of lateral curvature, standing, before treatment. Fig. 14. Shows same case bending. Fig. 15. Same case over-corrected in plaster, standing. Fig. 16. Same in plaster, stooped, showing bulging of ribs through window on side opposite to deformity. Fig. 17. Same case taken from plaster after full over-correction—standing. Fig. 18. Same, bending, showing over-correction of ribs or rotation. Fig. 19. Same case finished, standing. Fig. 20. Same case finished, stooped. Figs. 21. 22. 23. Show views of celluloid cast, in which the patient is held in an over-corrected position after it is obtained in the plaster cast, and from which the patient is taken daily for exercises. Usually worn for a year. From photographs furnished by Dr. Abbott.

where the band is to be applied in making lateral traction. The pads are applied by slipping them into position between the two shirts. If the patient is lean, the body is then covered also by winding with sheet-wadding. The patient is now placed face upward, on the hammock with the convex ribs pressing next to the taut side of it. The head rests upon the end of the hammock, between the end rod and a strap which supports the hammock beneath the neck, the buttocks rest upon the adjustable crosspiece toward the center of the frame. The slack side of the hammock gives room for the depressed ribs to be pushed backward (i.e. toward the floor). The patient's lower limbs are now hoisted upward and toward his head, so that the spine is strongly flexed. Straps of muslin are now applied around the body and fastened to the bars of the frame which can be made to wind them and so pull the body in any desired direction. One strap is passed under the low axilla and the ends carried laterally and obliquely upward to the opposite side. A second is passed around the buttocks and draws them toward the same side as the first. The third strap is passed around the body at the most convex portion of the curvature and wound upon the upper rail of the main frame. Traction upon this strap obliterates the curvature or produces a curve in the opposite direction. A fourth strap is used only if the curvature is very rigid and very rapid reduction is desired. It should be at least four inches in width and is used by first fastening it to the upper rail of the main frame, on the side to which the axilla and buttock-straps are fastened, then passing it across the body and hanging weights upon its lower end. Its object is to exert force against the anterior protruding ribs to press them backward (downward) against the slack side of the hammock. It may be wound on a lower rail or its pull changed by guys. The arm of the low shoulder is elevated as far as possible and held by an assistant. The other arm rests on the frame rail, at a little less than right angle with the body. The frame may be tilted or the lower limbs further elevated to exaggerate the position. If now the overcorrection is deemed sufficient, or if this is not to be the only corset, but the first of a series, the patient is ready for the plaster. But if it is preferred to use a single corset and yet make still further correction, it is necessary now to apply a thick oval-shaped pad of felt over the concave side and back of the body, so that when, subsequently, the window is cut in the corset and this pad removed it leaves room for the ribs to be pushed farther backward and the spine to be more overcorrected by pads placed in the front and sides. The plaster of Paris is applied as in any corset, excepting that, over the shoulder that has been elevated, it is extended posteriorly as high as the acromion process. In trimming, the bot-

tom of the corset is cut shorter in front and longer behind than ordinary. The upper edge is trimmed very high beneath the elevated arm, but cut away in front, so that the shoulder may come forward. Beneath the other arm it is cut low, but high in front so that this shoulder cannot drop forward, and cut out behind so that the shoulder may come backward. A large window is cut in the back of the corset over that part where the ribs were depressed, so that they may push backward, and extending toward the side to allow further overcorrection laterally. A second window is cut on the opposite side in front, allowing the ribs which were bulging posteriorly to push forward. Patients are able to be dressed and walk about with the corset. Further overcorrection may be obtained if desired, by the use of felt pads, at intervals of a few days or a week, as the body yields to the pressure. These pads are slipped in through the windows, especially in front to push the ribs backward through the window cut behind; and sometimes (but less effectively), they are placed in at the side over the convexity of the lateral curve. Pads are used only as yielding allows and then only of such thickness as will not cause too painful a pressure. Bromides may be used as a sedative. This padding process is repeated, with the same corset until satisfactory overcorrection is attained; or new corsets may be applied. Overcorrection may require three to six weeks time, more or less. The corset is then worn until the structures have had time to adapt themselves permanently to the new position, which may require two or three months or more. A course of exercises and massage follows, generally with a light brace in overcorrection, until complete restoration to normal.

TUBERCULOSIS OF THE SPINE (POTT'S DISEASE; CARIES OF THE SPINE; SPONDYLITIS)

Etiology and Pathology.—Hereditary vulnerability, diseases which lower vitality, notably the infections like measles, scarlet fever and whooping-cough, prepare the way for vertebral tubercular caries. Traumatism undoubtedly frequently locates the point of attack. Yet cases occur where there has been no known hereditary tendency, no previous illness, and no possible injury. Neither sex enjoys greater immunity than the other, and no age is exempt. (See Section on Tuberculosis.) The lesion consists in a tubercular inflammation, running the slow but persistent course of years characteristic of this disease, softening the bone by a process of rarefying osteitis, absorbing the cancellous tissue or changing it to granulation tissue which breaks down into cheesy semifluid material resembling pus, making a " spinal abscess." There may or may not be sequestra. Or the softened material may be reabsorbed and carried away by lymph or blood channels—so-called " dry caries." Or

after abscess has formed it may be absorbed, as sometimes occurs elsewhere, leaving a dry, cheesy or cretaceous mass. If injury occur or the patient's vitality be lowered by illness, or the cheesy deposit become infected with pyogenic organisms, it may break down and become a "residual abscess." If the original infection be a mixed infection, that is, not only by the bacillus tuberculosis but by pyogenic organisms as well, or they later gain access to the focus of disease, the destruction is much larger and more rapid, being an affair of months instead of years. The disease process generally affects the bodies of the vertebræ, beginning near the epiphyseal line. One or several contiguous vertebræ may be diseased, with destruction also of the intervertebral discs, or there may be more than one focus, with sound vertebræ intervening. There may be coexistent tubercular disease of other bones or joints, lymphatic glands or viscera remote from the spinal disease. The disease being in the bodies of the vertebræ and very rarely extending to transverse or spinous processes, it follows that when softening of the bodies takes place the column collapses on its anterior side, being supported by the arches and spinous processes posteriorly. This produces the deformity of the disease, namely, angular curvature or kyphosis, small if only one vertebra has collapsed, larger in proportion if more than one, but always pointed posteriorly more acutely than curvature from any other cause. As the disease continues, nature endeavors to protect herself by building up osseous walls around the seat of the disease; so that if recovery follows one finds what remained of the distorted vertebræ cemented together in their new position by masses of newly formed bone. The "abscess" of tubercular spondylitis is not strictly speaking an abscess. The material it contains is not true pus unless pyogenic organisms have gained access. The content of the so-called spinal abscess may be quite liquid or semi-solid, and vary in color from pale straw color to dark yellow. It may hold also spiculæ of bone or sequestræ of considerable size. The collection may be small or large, may be confined by the inflammatory thickening of surrounding tissues, or as it accumulates and tension increases, it may find its way in the direction of least resistance between surrounding structures, often burrowing along fascial planes until it finds exit upon the surface of the body, or into some cavity or viscus perhaps far distant from its source. Caries may be located in any vertebra or in a number of them. A resultant abscess will present clinical features according to its location. Cervical caries may form an abscess appearing in the post-pharyngeal region (see Section on Chronic Retro-pharyngeal Abscess) or at the side of the neck before or behind the sterno-mastoid muscle, or it may burrow into the mediastinum or pleural cavity,

or into the esophagus, trachea, or a bronchus. Dorsal abscess may open into any part of the intestine, or into the bladder; or more commonly it will be retained by the sheath of the psoas, following it down beneath Poupart's ligament and there protruding beneath the skin, which, if left to itself, it would finally burst through, or track farther down the thigh. (See Fig. 156.) Lumbar spinal abscess may follow the same course, or may appear in the gluteal region, or upon the back just outside of the quadratus lumborum.

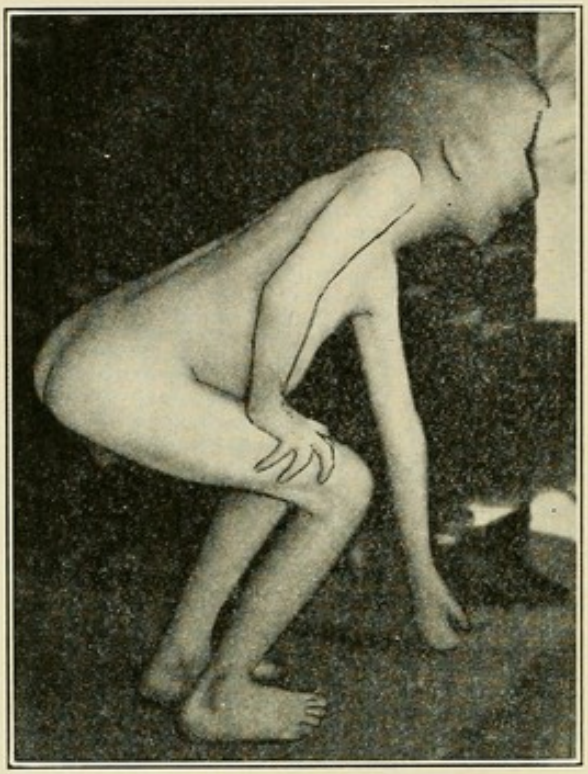


FIG. 151. BOY WITH SPINAL CARIES in the act of stooping to touch the floor. The spine is held rigidly straight and supported by a hand upon the thigh.

It would seem hardly possible that a process destructive of bone and resulting in abscess could take place without obvious symptoms. And yet cases occur unsuspected until a swelling, perhaps in Scarpa's triangle, betrays the presence of spinal abscess tracked down from the dorsal or lumbar region.

Symptoms and Diagnosis.—The symptoms and signs by which the disease may be diagnosed, in the majority of cases, begin early in the disease but are often so obscure as to pass unaccounted for at the time. The prominent ones are lassitude and peevishness, tenderness, pain, attitude and movements, rigidity, psoas spasm, deformity, abscess, nervous symptoms. The child shows disinclination to play as usual, or, after beginning an active game, desists and chooses a sedentary one, or grows fretful and lies down. This may continue for several days or weeks, and if by any good fortune the child be carefully examined during this time it is not probable that anything farther could be discovered except that he does not like to jump or receive any jar in the long axis of the spine. The tenderness is not evident to external pressure or percussion, but unconsciously the child avoids jarring. Pain may be complained of in the head, neck, throat, or chest, and be accompanied with difficulty in swallowing or choking sensations if the trouble is cervical; it may be in the chest if high dorsal, in the belly if low dorsal, and down

the thighs if lumbo-sacral. The pain is intermittent and is hard for the child to locate. The pain persists. It will not be banished like an ordinary "belly-ache," but returns day after day. It may get worse in the early part of the night. The pain of malignant disease of the spine is severe and constant, not relieved by rest in bed, and the patient is cachectic in appearance. Paralysis appears early with malignant disease as compared with caries. In some cases one must await developments before deciding between malignant disease and caries. The pain of rheumatic spine is apt to be more diffused, or, if localized, to be more severe on motion, there are rheumatic symptoms in other joints, and the whole course of the disease is more acute. Rickety curvature causes no pain. If lateral curvature causes pain it seldom occurs until the deformity is so marked that there need be no difficulty in the diagnosis. The pain in hysterical spine is produced by light touch which has little effect in causing pain in spinal caries.

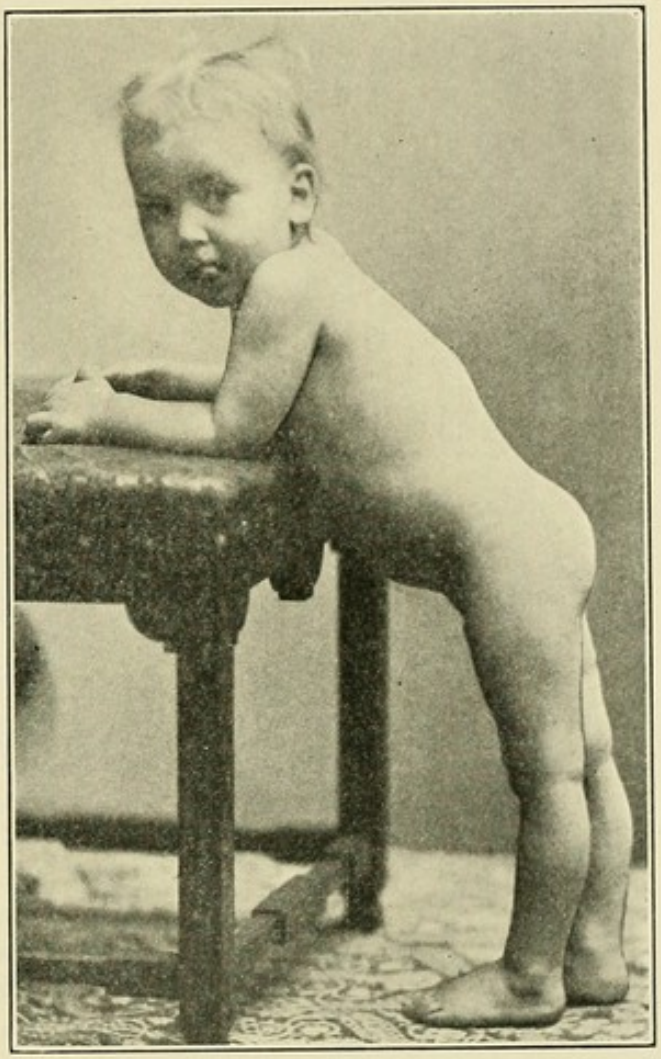


FIG. 152. CHILD WITH LOWER DORSAL CARIES. Showing characteristic attitude, seeking support for the spine.

Probably by this time, if not before, muscular rigidity has become evident by attitude and restricted motion. The child walks as if he were afraid of the slight jar of each step. He carries his feet low and moves cautiously as if he were balancing a weight upon his head. With disease in the dorsal or lumbar region, if he is asked to pick up an object from the floor, he will not bend over to reach it, but will squat down by flexing knees and thighs, without arching the spine. (See Figs. 151 and 155.) Perhaps he will support the spine by resting the hands upon knees or thighs, or will raise himself in the same

manner. Or he will support himself by holding on to a table or a chair or by leaning over a chair. (See Figs. 152 and 154.)

If the child is laid prone on the table and the spine be hyper-extended by lifting his feet, the rigidity of the diseased portion of the column will contrast clearly with the flexibility of a normal spine. This muscular fixation is a most important sign. (See Fig. 153.) There is no such rigidity in lateral curvature, nor in hysteri-

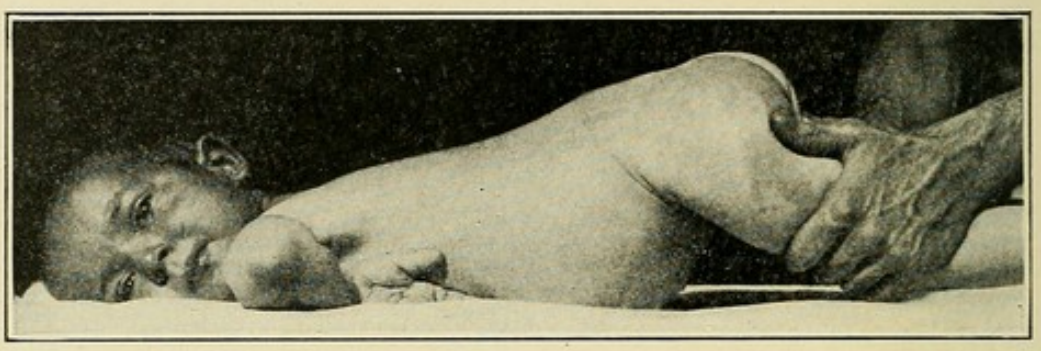


FIG. 153. CARIES OF THE SPINE. Showing muscular rigidity upon attempting flexion of the lumbo-sacral region, which is diseased.

cal spine. With the child still lying prone the thighs should be hyper-extended, one at a time, by flexing the leg to a right angle with the thigh and then lifting it vertically from the table. If spondylitis be present in the lower dorsal or lumbar regions, this over-extension of the psoas muscle will cause its reflex rigidity to yield with a characteristic tremulous spasmodic twitching known as psoas spasm. This may be present upon one or both sides. These cases with psoas spasm should be carefully differentiated from hip-joint disease, and from sacro-iliac disease.

Peculiar attitude, restricted movements, rigidity of the muscles of the affected region are equally marked in cervical caries. The child is apt, while sitting, to rest the elbows on the knees and support the head with the hands. Normally the head of the young child can be rotated at the atlanto-axial articulation through a quarter of a circle, and by employing also the other cervical articulations it can be turned through nearly a half circle. It can be fully flexed and extended. In cervical caries the head is not willingly rotated at all, this motion being most strictly limited in occipito-atloid or atlanto-axial disease. Flexion and extension also are inhibited by the reflex muscular spasm, this being especially marked if the cervical disease is below the axis. The child draws up the shoulders and settles the head between them as if by that means to prevent motion. If asked to look to either side, he turns the shoulders with the head. The attitude sometimes much resembles at first glance that of torticollis. But the shoulders are not so elevated in torticollis, and the face is

turned away from the contracted muscles. Whereas with caries the face is turned toward the contraction. In the majority of cases of cervical tuberculosis it is the flexor and extensor muscles that are reflexly contracted; while in wry-neck it is most often the sterno-mastoid that is fixed.

Deformity is an early and characteristic sign of caries. Typically it is a sharp antero-posterior curvature, one or more vertebræ being involved in the formation of the angle, thus making it smaller or larger, but is always more pointed posteriorly than a curvature produced by any other condition can be. A rickety spinal curvature usually involves quite a number of vertebræ, making a much longer, rounded projection posteriorly, which can almost if not quite be obliterated by the flexibility test. Moreover, with the rickety spine, there are almost always other evidences in the skeleton—the cranial bosses, beaded ribs, enlarged radial epiphyses, bowed arms or legs. The prominence of the carious kyphos varies somewhat also with the region of spine affected. In the dorsal region, which is normally convexed posteriorly, it projects more than in the lumbar or cervical, which is concave posteriorly. In the lumbar region particularly a deformity seems to appear late, and is harder to detect, its first evidence being an abnormal straightness of the affected region rather than a projection, which comes later. (See Fig. 155.)

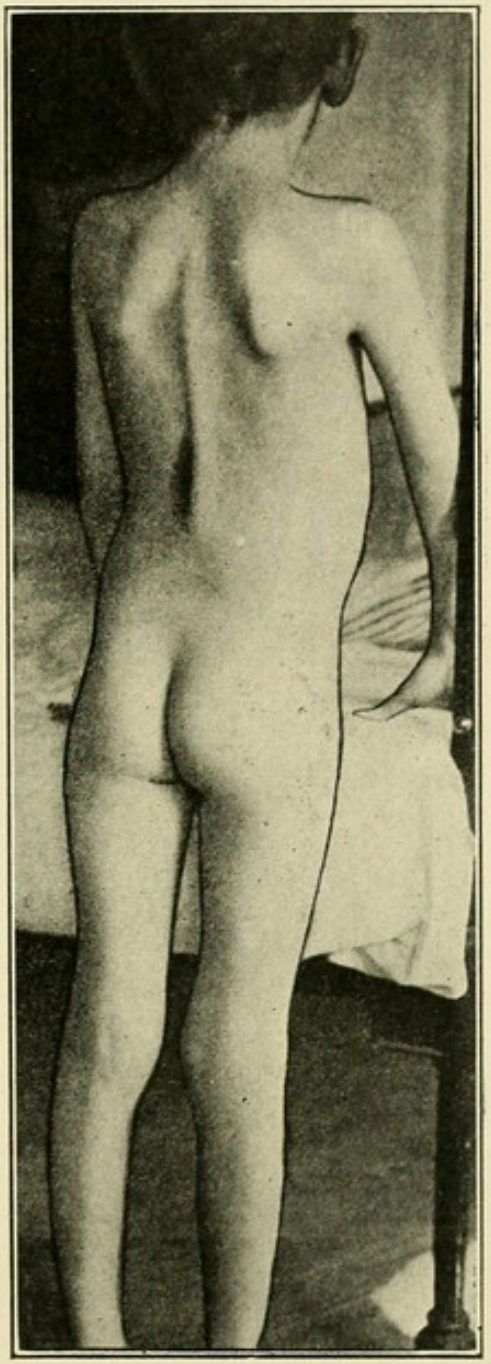


FIG. 154. DORSO-LUMBAR CARIES. Boy of 7 years. Kyphos beginning to show.

The nervous symptoms accompanying spinal caries are sensory, motor or trophic. Pain (and its regional distribution) has been referred to as one of the earlier symptoms. Later the skin in certain

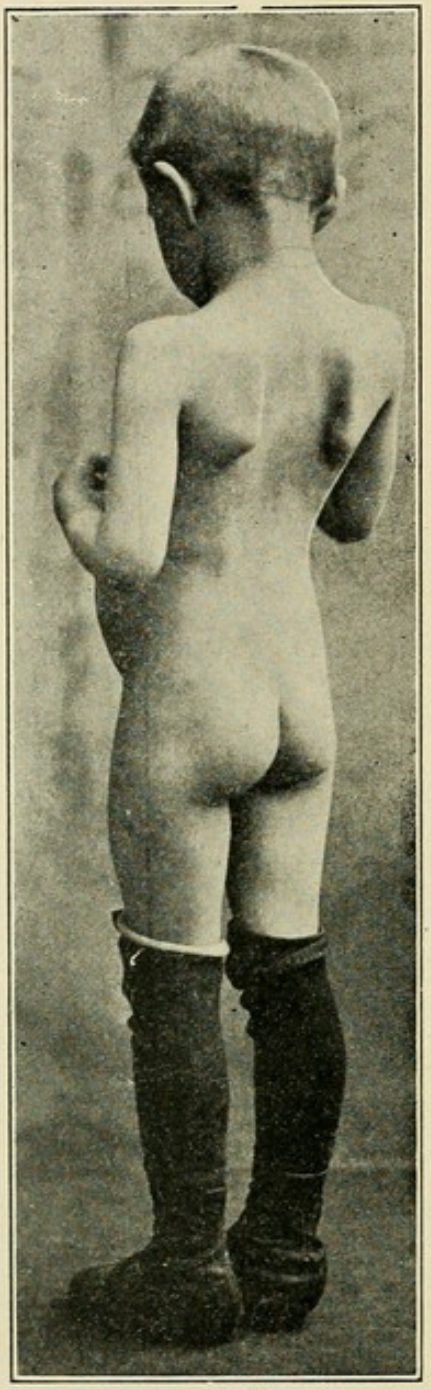


FIG. 155. BEGINNING DORSO-LUMBAR CARIES. No kyphos yet visible. Holds spine rigidly erect. Walks carefully with his shoulders held back in position seen in the illustration. Will not bend to pick up an object, but squats down. Complains of pains in belly. Boy of 6 years.

areas may become hyperesthetic. Patches of the skin may become anesthetic, although the seat of subjective pain, and the reflex movements be diminished.

With the exception of an exaggerated plantar reflex, which may appear early, motor symptoms are later in their appearance than sensory, and may be severe enough in upper cervical caries to seriously impair the action of the intercostal muscles and diaphragm; and in lumbar caries to produce paraplegia, with paralyzed rectum and bladder, and lost patellar reflex. Trophic symptoms are usually last to appear, the muscles wasting extremely; but bedsores are not so easily produced as might be expected.

The nervous symptoms result either from changes in the spinal nerves where they emerge from the spinal canal, or to disease of the cord itself at their point of origin, set up by the proximity of the inflammation or resulting pressure upon the cord. The arteries of the cord may be compressed by inflammation of lymphatic tissues near them. Spinal abscess may burrow in the canal and compress the cord. Hemorrhage may act the same way. When, as is commonly the case, the inflammatory softening affects only the anterior portions of the bodies of the vertebræ, leaving the arches and posterior parts of the bodies unaffected, it is very rare for the curvature itself, however acute it may be, to compress the cord or nerves. But in those more unusual cases where the laminæ and posterior portions of the bodies are affected, are found the most marked nervous symptoms even though there be little angulation. One of the most com-

mon causes of compression is the growth of masses of granulation tissue, so-called granuloma, within the canal. A rare cause is sudden collapse of carious vertebræ, producing prompt paraplegia. Pressure upon or laceration of the cord have sometimes been produced by sequestra.

Only the sensory disturbances, appearing early, are likely to be puzzling as to their point of origin. Usually in the cases presenting paralysis the disease is more advanced and a kyphos is sufficiently in evidence to aid in the diagnosis. (35)

With the hysterical spine, pressure over the spinous processes elicits great complaint. The carious spine is usually not very sensitive to pressure of the hand upon the back.

Abscess in its various locations has been described under the pathology. It is apt to occur in the majority of untreated cases; and will sometimes occur in spite of the best-directed treatment. It may come quite insidiously, without giving rise to any additional symptoms, but usually with the formation of the abscess there is an increase of the pain, restriction of movement, muscular rigidity, and also a greater impairment of the general health.

The symptoms and diagnosis of abscesses resulting from cervical caries will be found under the heading of retro-pharyngeal abscess.

In suspected dorsal or lumbar caries if no abscess be found pointing externally anywhere in the usual situations in the iliac, inguinal, or lumbar regions, or more rarely about the gluteal region or thigh, search should be made to detect it more deeply located.

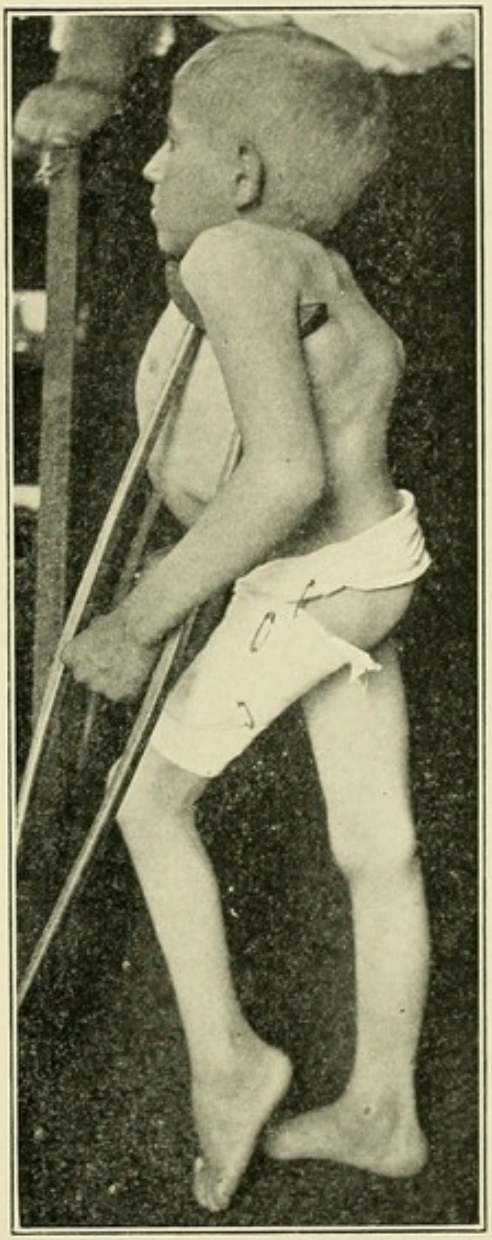


FIG. 156. TYPICAL DORSAL CARIES, AND ALSO HIP-JOINT DISEASE. Boy 12 years old. Diseased since 2d year. Two years ago sinuses on thigh were irrigated with creolin solution, some of which the boy coughed up after each irrigation.

With the child lying upon his back and his thighs flexed and abdominal muscles relaxed, deep palpation along the course of the psoas muscle may reveal the presence of abscess. Digital exploration per rectum may furnish information of value; especially in differentiating from sacro-iliac disease. Careful percussion and palpation about the loins should be employed. Abscess must be differentiated from herniæ and tumors. Abscesses are dull on percussion, fluctuate, and on pressure disappear gradually without gurgling. Herniæ generally appear in the hernial canals, are somewhat tympanitic on percussion, and, on applying the taxis, are apt to gurgle, and when they disappear do so suddenly. Either may have an impulse on coughing.

A history of typhoid fever preceding spinal symptoms will direct attention to that form of osteitis or periostitis called the typhoid spine.

Acute septic osteomyelitis may attack the spine. It is apt to affect a number of the vertebræ at once and very acutely and violently.

Syphilitic disease of the vertebræ may occur. If this is borne in mind other syphilitic lesions, scars, or the history will prevent a mistake, and the therapeutic test confirm the diagnosis.

Prognosis.—Pott's disease of the spine may result in recovery with more or less deformity, or in death by exhaustion from the discharges, general tuberculosis, amyloid disease with albuminuria, from the bursting of abscess internally, general sepsis from infection of abscess open externally, meningitis, peritonitis, myelitis. Hemorrhage from erosion of a blood-vessel by abscess may cause death. Tubercular meningitis is more common in children than in adults; and pulmonary phthisis less so.

The prognosis in children is better than in adults. Prognosis is much better if the disease is discovered and treatment instituted before the formation of abscess than after abscess has formed. The disease is always chronic, running a course of months or years even in favorable cases.

The symptoms may be ameliorated and improvement be inaugurated in a few months or even in a few weeks, but a cure is not to be expected short of several years. The expectancy of life following cured spondylitis is according to the severity of the lesions as evidenced by the amount of resultant deformity. Every patient who survives Pott's disease of the spine will be permanently deformed. The peculiarities of the deformity will vary somewhat according to the region diseased and the amount of destruction of bone. But there is always shortening of the body which makes the arms and legs appear disproportionately lengthened, and in walking the arms are swung backward to maintain the equilibrium. Dorsal caries produces deformity of the sternum, and often an alteration of the voice.

Motor paralysis indicates a severe and advanced condition but does not preclude recovery both from the disease and the paralysis.

Sensory paralysis and spastic contractures of muscles indicate disease of the cord itself, and therefore darken the prognosis, but do not make it hopeless.

Treatment.—The first principle involved in the treatment of tubercular spine is that of rest. Partial rest can be secured by removing superincumbent weight, or by preventing motion. Complete rest can be secured only by both removing superincumbent weight and preventing motion. This is best done by placing the patient horizontally on a flat mattress and using also a fixative splint, brace, jacket, or other apparatus. In practice various modifications of this rule are in vogue—concessions to the wishes of the friends of the patient or the patient himself, who does not want to stay in bed, or does not want to wear a jacket or brace. But that does not alter the principle involved; and I am quite certain, from personal observation, that many a case of spinal caries which might have been cured within a reasonable time, with little suffering and slight resulting deformity, has been dallied with in halfway measures until abscess, kyphosis, and nervous phenomena have demonstrated serious advances of the disease and forever precluded a satisfactory course and termination. It is true that many cases do perfectly well by taking off weight alone, keeping them in bed on a flat mattress, especially if they are adolescents or adults. With children, who by comparison are much more restless, fidgety, and thoughtless of consequences, this is not so apt to succeed. It is true also that many cases recover with the use of jackets, braces, or other fixing apparatus which prevent motion, the patient being in the meantime allowed his liberty, going about, indoors and out of doors. Nevertheless it is more safe and certain, on undertaking a case of spinal caries in a child, to take off the weight by putting the patient to bed, and to secure immobility by applying such means as may be necessary according to the location and stage of the disease, and the behavior of the patient. These thorough measures will usually arrest the disease as promptly as it can be done, will aid in improving the general health of the patient and start him on the road to recovery. Then, perhaps, after a few weeks or months, or sometimes even a year, of complete rest, he can be allowed to go about with a jacket, jury mast, leathern collar, or other apparatus. I am well aware of the objections urged against confining a patient to bed. "It will weaken him to lie in bed." "It will keep him shut up indoors too much." "He will not get any exercise." Not one of these objections is valid. Every surgeon who has had experience with this disease and this plan of treatment has seen patients who are suffering pain, who are having bad nights and fretful, worrysome days, who are pale, losing weight, and failing in

appetite and strength, make a complete change in a few weeks by putting them at rest in bed. Pain is relieved, quiet sleep is restored, appetite and cheerfulness return, improved color and increased weight are apparent, and strength of heart muscle, and of voluntary muscles is really augmented. Rest of the spine in bed does not preclude open air and sunshine, massage and passive exercise and active exercise of the extremities. Bradford and Lovett have stated their opinion that the tendency to tubercular meningitis is increased by prolonged recumbency. But the spinal tuberculosis is already present and active and the meningeal involvement only a possibility. This possibility only makes it the more necessary to control the active process as promptly as possible by thorough treatment from the earliest discovery of the condition. To secure rest of the spine we may resort to sandbags, the frame, the jacket, the brace, the collar or head extension. The frame, one of the best means, is made of gaspipe, wood or bamboo, upon which canvas is stretched. The frame is arched to any desired convexity or left flat with a light steel arch superimposed. Fenestration and felt pads prevent undue pressure upon the kyphosis. A second fenestration under the buttocks makes care of the dejections easy. Jackets are made of plaster of Paris, leather, poroplastic felt, aluminum, rawhide, paper, etc. For general usefulness and cheapness nothing compares with gypsum; and it is sometimes an advantage to have a jacket that cannot be removed by the patient. By means of a strip of muslin passed beneath the jacket and projecting at both ends and the use of alcohol and powders the skin can be kept sound. A new jacket may be needed once in a month or three or six months.



FIG. 157. LEATHER JACKET FOR SPINAL CARIES.

Every surgeon knows how to put on a good plaster jacket. The rules are simple—yet not every surgeon puts on a good plaster jacket. There is an art in it. Before the plaster is applied a snugly fitting undershirt or stockinet is put on. A plaster jacket may be applied with the patient partially suspended, his heels off the floor. But he is usually laid prone upon a strip of strong unbleached muslin which is stretched lengthwise upon a frame, having a windlass

at one end. By adjusting the tension of the muslin a degree of straightening of the spinal curvature may be secured (36); but no forcible correction should be attempted. Pads of felt or prepared wool or cotton batting should protect bony prominences, for instance the iliac crests and the kyphosis. In developing girls, pads which can afterward be removed should prevent undue pressure on the mammæ. The "dinner pad" is not usually necessary. A three to six inch plaster bandage, five yards long, is convenient. Each bandage should be immersed in water until air bubbles cease to rise from it. Beginning at the level of the trochanters the bandage is quickly applied encircling the body and rising half a width at a time until the arms are reached. Each layer should be smoothly pressed down upon that beneath. When the jacket is sufficiently thick, the patient should be kept in correct position until the plaster sets. The muslin support is then cut across at the upper and lower ends of the jacket and remains a part of it. The jacket is cut out to fit under the arms, and the edges everywhere pressed away from the skin. The stockinet may be turned from top and bottom and sewn together in the middle to cover the plaster.

The spine brace is of many varieties. A good type is the Taylor brace. A steel band with its center at the spine partly encircles the pelvis below the iliac crests and above the trochanters. From this pelvic band rise two uprights, one on either side of the spinous processes, resting upon the transverse processes, and extending to the tops of the shoulders, one at each side. The uprights are connected by a horizontal bar just below the angles of the scapulæ. A leather strap or webbing or a padded cord extends from the top of each upright down in front of the shoulder of the same side to the horizontal bars. There are many modifications of this brace. The Taylor brace proper has a leather cuirass or apron, covering the belly and lower part of the thorax and held to the metal parts at the rear by straps and buckles. The brace is best made over a plaster model prepared by casting it in a plaster jacket or collar as the case may be, put on the patient and then cut and sprung off. Or it may be made from a diagram and measurements. The child, with naked body should be laid prone. A few touches with burnt cork, blue pencil, solution of argyrol or bits of adhesive plaster will mark the points for measurement. The outline of the spine is carefully noted with a strip of lead laid on and bent to fit. This strip of lead laid upon paper guides a pencil. The tapeline finds the measurements of every part, which should be plainly indicated on the diagram.

A headpiece can be attached to a brace or to a jacket by incorporating its support in putting on the jacket. A headpiece consists of a steel upright or, sometimes, two uprights, extending from

the spine brace or the back part of the jacket to the level of the base of the skull. From the upright support a steel band extends forward, and being properly padded supports the occiput and lower jaw. (See Fig. 159.)

The collar is made of plaster of Paris, of leather with steel reinforcements, of felt leather-lined, of woven wire leather-lined. The collar spreads out upon the shoulders, upper part of the back and chest, whence it takes its bearing, and is fitted to the base of the skull and lower jaw which it supports and renders immovable. (See Fig. 160 and the Calot jacket, Appendix 36.)

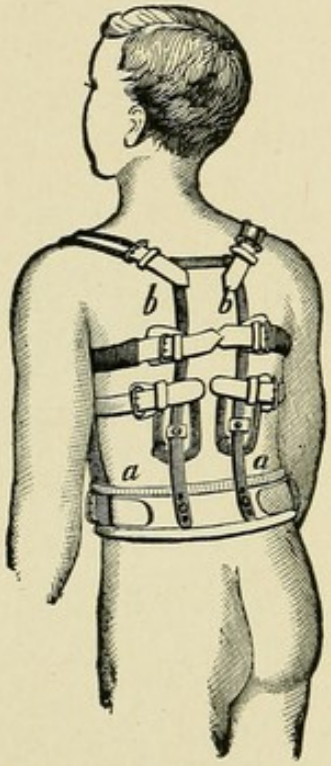


FIG. 158. WASHBURNE'S BRACE for Pott's disease.

Head extension apparatus has a padded sling fitted under occiput and lower jaw, with the patient in bed or upon a frame. The sling is connected with cord, pulley, and weight, to make extension and so fixation of the cervical spine. The various appliances having been described, it remains to state the principles of their action, the cases to which each is applicable and the methods of their use. Sandbags may be useful in recumbent cases while other apparatus is being made or in case of coexistent skin disease, abscess or glandular swellings or pressure-sores which interfere with the use of fixed apparatus. The canvas-covered frame with the light steel strips at the margin of fenestration for the kyphosis and arched with convexity upward, in common with the brace, has some action as a lever The fulcrum being upon the transverse processes, at the seat of the deformity. it prevents the collapse of the diseased vertebral bodies, indeed limits pressure upon them by compelling the carrying of weight or receiving pressure upon the posterior portions of the column, namely the transverse and spinous processes. They act more efficiently by immobilizing the diseased tissues, preventing the irritation of motion, securing rest. It is often taught that the jacket, by pressing upon the body at every point, sustains it upon the base-line of the jacket, namely the pelvis, relieving the diseased vertebræ of weight, provided the disease is within the lower portion of the jacket, that is, the lumbar region or the dorsal region below the seventh dorsal vertebra. But I believe that by

far the greatest benefit that is derived from the jacket, as from the frame, brace, or extension apparatus, is because of immobilization. Foundation for this belief is found in the fact that even in high dorsal caries, a jacket extending up the back and front of the thorax and more or less perfectly immobilizing the spine, far above the point where any weightcarrying could be possible, will often result in benefit. This explains why the jurymast with sling allowing head rotation has been discarded for an apparatus which holds the head immovable. It is in cases of cervical and high dorsal caries that head support and head extension are applied. The pulley and weight for head extension are used only for a short time in actively progressing cases until the progress of the disease has been controlled, then the head extension or support is relied upon for immobilization.

That form of apparatus should be applied which maintains the diseased parts as nearly as possible immovably fixed in their normal position without the use of violent force or undue pressure at any point. The horizontal position aids in securing rest and should be used in actively progressing cases. After the activity of the disease process has been controlled, the upright position and then going about with jacket or brace are allowed. Mechanical treatment will probably be necessary for from two to five years or possibly for life, unless operative treatment shall prove a means of shortening it. The general treatment of tuberculosis as laid down in Chapter lv. is indicated in all cases of spinal caries.



FIG. 159. SPINAL BRACE with head support, sumilar to Taylor's.

A method of effecting immobilization of the diseased joints in Pott's disease by operation has been devised and practised by R. A. Hibbs.[1]

The operation is as follows. A longitudinal incision is made directly over the spinous processes of the kyphosis and including one sound vertebra above and one below those diseased. (If the X-ray does not reveal the extent of the disease one must be guided by the kyphosis). The incision goes through the skin, supraspinous ligament and periosteum to the tips of the spinous processes. The periosteum is divided upon both the upper and lower borders of

[1] Hibbs: N. Y. Med. Journ., May 27, 1911; Am. Surg., May, 1912; Jour. Am. Med. Assn., Aug. 10, 1912.

each spinous process and the laminæ are stripped from them outward to the bases of the transverse processes. The muscles are not detached from periosteum and ligament but the flaps are pushed aside *en masse*. Then, beginning with the lowermost, each spinous process is partly cut through at the base upon its upper side and bent downward so that its tip rests upon the bone next below. From

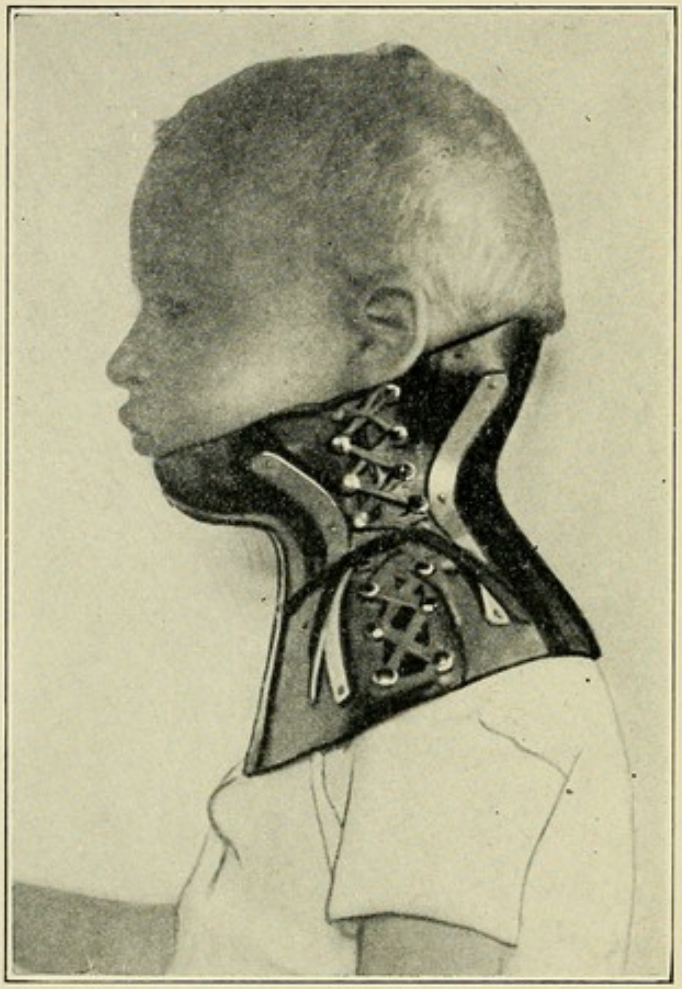


FIG. 160. LEATHER COLLAR FOR CARIES OF CERVICAL SPINE.

the lower edge of each lamina (bared of periosteum) a small strip of bone is raised and turned downward with its free end in contact with the lamina next below. The flaps consisting of periosteum, split supraspinous ligament and muscle are brought together and sutured over the prostrated spinous processes with interrupted sutures of chromic gut, and the skin sutured with silk or plain gut. Gauze dressing and an ordinary spinal brace is applied, with its upright bars wide enough apart not to press upon the wound. Rest in bed is required during eight to ten weeks; then sitting up is al-

lowed for four weeks. After twelve weeks walking is permitted. The brace is laid aside after another month, unless the patient is under five years of age, in which case it is used six months. The effect sought in this operation is the deposition of new bone between the raised periosteum and the denuded bone, fusing the vertebræ, bridging between them or at least forming a bony splint, thus producing fixation and consequent rest. In seventeen per cent. of Hibbs' cases, fusion of two or more vertebræ was demonstrable and curative results are reported in practically all the cases. It is probable that this osseous splint would form even if there were no bone grafts raised from the laminæ and the spinous processes were not fractured and turned downward. But this latter step in the technique appears to strengthen the bridge, and it certainly lessens the deformity, especially in the lower dorsal region. The operation has been used in patients of all ages from two and one-half years to middle life, and in cases that have run from three months to ten years. Hibbs also suggested that in the very young it might be necessary to graft bone from the leg. This has since been done by Albee,[1] and Whitman.[2]

Albee splits the spinous processes longitudinally, bending the lateral halves on one side so as to open a fissure into which a splint of bone (with its periosteum, triangular on cross-section) taken from the crest of the tibia, is placed, and sewn with kangaroo tendon. If necessary to meet the curve of the kyphosis, he bends the graft with or without notching it. He keeps the patient on a Bradford frame from six to ten weeks. Of the two procedures Hibbs' seems more reasonable. Both require more time for their ultimate proving.

Abscess from spinal caries is to be treated conservatively. If it point and need for evacuation becomes urgent that should be done by aspiration with strict antiseptic precautions and the puncture sealed. Some open with a knife and inject bismuth paste. The formulæ for preparing bismuth paste and direction for its use will be found under treatment of empyema. Unless the infection is evidently a mixed one, it is probably better to reserve this procedure for abscesses that refill and for chronic sinuses.

In paralysis from Pott's disease the treatment is conservative. Patient and persistent rest and fixation of the spine, massage and perhaps electricity to the lower extremities, together with the general treatment recommended for tuberculosis, will usually restore the lost functions.

[1] Albee: Jour. Am. Med. Assn., Sept. 9, 1911, p. 885; N. Y. Med. Jour., Mar. 9, 1912.

[2] Whitman: Am. Surg., Dec., 1911.

CHAPTER XVII

SURGERY OF THE AIR-PASSAGES

Malformation and Other Obstructions of Nasal Passages—Falls or Blows upon the Nose—Neoplasms in the Nose—Hyperplasia of the Lymph Tissue of the Pharynx and Naso-Pharynx — Enlarged Tonsils — The Uvula — Obstruction by the Soft Palate—Foreign Bodies in the Nose—Foreign Body in the Gullet—Tongue-Swallowing — Retro-Pharyngeal, or Post-Pharyngeal Abscess — Chronic-Pharyngeal Abscess.

Disorders of the air passages which come to the surgeon for relief are usually in the form of obstructions to the free passage of air, due to malformation, edema, hypertrophy, new growth, foreign body, or inflammatory exudate; although troublesome discharges may be the cause of complaint, or altered voice, or a recent traumatism, or a too wide opening as in hare-lip or cleft palate. This latter will be considered under a separate heading.

Any condition which interferes with the free and abundant respiratory flow to and fro through the natural passages is a serious menace to health and development. No one not familiar with infants would be willing to believe that even a simple rhinitis or adenoids of common size could produce the severe degree of discomfort, restlessness, dyspnea, interference with sucking, and disturbed sleep which experienced pediatricians know as ordinary results.

Ordinary rhinitis, acute, chronic, hypertrophic, atrophic, syphilitic in its milder forms, or tubercular, seldom come to the surgeon for the partial or temporary obstruction produced, being, excepting the last named, and the later manifestations of syphilis, amenable to medical treatment.

MALFORMATION AND OTHER OBSTRUCTIONS OF NASAL PASSAGES

Congenital atresia of the nostrils, absence of one or both nostrils, or of the entire nose, may occur.

Permanent obstruction of one or both nostrils may occur by malposition of the cartilaginous nasal septum, and this may be congenital or acquired. Or the vomer or the ethmoid, or these with the cartilage may depart from the normal line, and cause obstruction in

the canal of the nostril, sometimes in the form of a wedge or ridge, and often with a corresponding concavity in the opposite nostril.

Malformation or hypertrophy of the turbinated bones, inferior, middle, or superior, one or more, may encroach upon the lumen of the nostril. Hypertrophy of the superior is more rare, that of the middle more extensive when it does occur, and that of the inferior more common. The openings of the nostrils into the vault of the pharynx may be congenitally abnormally small in all dimensions, or narrowed to mere slits, or may be entirely occluded by encroachment of their bony walls, or by a projection formed of the upper cervical vertebræ.

Syphilitic ulceration may result in collapse of the bony supports of the naso-pharynx, and obliteration of its spaces. (Figs. 27 and 28.) Repair subsequent to ulceration or to traumatism, even the traumatism of clumsy surgery, may produce synechiæ—adhesions between the walls of the nostrils, notably between the turbinated bones and the septum.

Treatment.—Any of these conditions, excepting the severe malformations at the naso-pharynx, may be treated with surgical means appropriate for the removal of the obstruction and restoration of a freer air channel. One important rule in these operations is to remove as little as possible of the muco-periosteum or perichrondrium; and certainly in removing "spurs" or deflections of the septum *not* to leave an opening through into the other nostril as is sometimes done. Deviations of the septum in children may sometimes be straightened by forcing them into an over-corrected position—repeating the procedure at intervals or retaining the correction by stiff rubber tubing. In removing enlargements of the turbinated bones in children the scissors will often be found more serviceable than the saw.

FALLS OR BLOWS UPON THE NOSE

After a fall upon the face or blow upon the nose a careful examination should be made to determine the patency of the nasal canals. If displacement of fragments has occurred they should be lifted into place by an instrument passed within, and can generally be held in position and protected by small pads externally at either side of the nose, secured by adhesive strips. Rubber tubing in the nostrils can be used to maintain patency, but is seldom necessary. A dislocation of the anterior end of the septum nasi from the nasal ridge is not uncommon, and if the muco-periosteum is torn through, may prove astonishingly difficult to hold in place. I have sometimes resorted to silver wire suture. Abscess of the septum may occur and require opening. (See also Section on Fracture of Nasal Bones.)

NEOPLASMS IN THE NOSE

Neoplasms in the nose other than adenoids (which see) are not common.

Mucous polypus is not near so common as in the adult. When brought to view it is easily recognized by its luster, its translucency, and its paler color as compared with the mucous membrane. It is apt to shift out of sight. It feels soft to the probe and eludes the instrument. It is usually pedunculated, and can be removed with the wire snare. When one is removed search should be made for others.

Swollen mucous membrane covering a crooked septum or, more likely, that over a turbinated, may be mistaken for polypus, but should be distinguished by its firmer consistency and darker color. Darker color as well as absence of pedicle should distinguish nevus which may occur in the nares. It is well also to bear in mind in this connection Mr. Owen's reference to the case of Mr. Bernard Pitts, in which a meningocele projected into the nares and was even by that competent surgeon unfortunately mistaken for a polypus.

Fibromata, or fibro-sarcomata, while rarely if ever found in the naso-pharynx in infants or young children, are not very uncommon after the tenth year, especially in boys. They may usually be distinguished by touch from adenoids and are generally single and sessile. Fibromata are more often attached to the sides than to the vault of the naso-pharynx. They give symptoms similar to those of adenoids. But sarcoma is likely to be painful and to bleed spontaneously.

The prognosis, even in fibroma, if not removed by operation, is quite serious, as the tumor may grow to immense size, with corresponding pressure, distortion, and ulceration of the surrounding structures. If sarcomatous elements are present in the growth, early operation affords the only hope of averting a fatal ending in the course of a few months or at farthest a few years, probably after frightful deformity and great suffering.

Fibromata, if sufficiently pedunculated, may be removed by the galvano-cautery, care being taken to thoroughly remove the whole growth. They are often, if small, removed with the ordinary snare, and the stump cauterized. The removal of a large fibroma or sarcoma from the posterior nares is a much more difficult undertaking. It may be attacked through the mouth, the patient's head being inverted, the soft palate split up, and, if necessary, a part of the bony palate divided. After thorough removal of the growth, with a snare if possible, the base is to be thoroughly cauterized with galvanic or Paquelin cautery, and the palate closed as in staphyloraphy.

Sarcoma of the nose can be removed by resection of the superior maxillary bone, in some instances leaving the orbital plate.

HYPERPLASIA OF THE LYMPH TISSUES OF THE PHARYNX AND NASO-PHARYNX

The lymphoid tissue at the base of the tongue, the palatal tonsils, one at each side of the throat, and the pharyngeal tonsil in the naso-pharynx forming the so-called lymphoid ring, are subject to hyperplasia.

Adenoids.—Enlargement of the tonsils has long been dealt with as a pathological condition of some importance. Since Meyer's work, the profession, through clinical observations, reports, essays, and discussions on every hand, has become more or less familiar with "adenoids," "adenoid vegetations," "hyperplasia of the pharyngeal tonsil," "post-nasal growths."

Lymphoid tissue in ultimate structure resembling the lymphatic glands and the Malpighian corpuscles of the spleen, normally undergoes an involution during infancy, childhood, and youth. In early life the pharyngeal tonsil presents in the pharyngeal vault a somewhat furrowed and but slightly thickened layer of lymphoid tissue covered with ciliated epithelium.

When hypertrophied we have spongy masses or nodules, sessile or pediculated, structurally papillomata with a lymphoid parenchyma and a very vascular mucous and epithelial covering, frequently enveloped with mucus or mucopus.

Opinions differ as to whether deviated septum, hypertrophic rhinitis, enlargements of the turbinates and other obstructions favor the growth of adenoids or are instead caused by the adenoid enlargement.

We sometimes find the other partial obstructions without adenoid vegetations with no unusual deviations from normal development and symmetry. Numerous discussions have been indulged in as to whether repeated colds or catarrhs produced adenoids, or whether the symptoms attributed to the cold or catarrh were not themselves produced by the pre-existing adenoids. However, we know that victims of adenoid growths are frequently and sometimes constantly affected with what passes for "a cold in the head." Similarly climate, mechanical irritation, general lymphatism, race, sex, scrofula, or tuberculosis and syphilis have entered into the discussion. Also the effects of measles, scarlatina, and diphtheria and whooping-cough, typhoid fever and heredity.

Infants may be born with adenoid growths or they may come at any subsequent time, though most cases come to the surgeon's attention in childhood up to the eight or tenth year. In late years the removal of adenoids is the commonest operation performed at the nose and throat dispensaries. One writer (Lenox Brown) found

adenoids in as high as eighty-eight per cent. of all naso-pharyngeal hospital cases, and places their frequency, as compared with enlarged palatal tonsils, as six to five. Not all writers place the percentage quite so high, but all agree on their extreme frequency, on their greater frequency than enlarged palatal tonsils; all allege that notwithstanding all that has been said and written to enlighten the profession on the subject that they are still often overlooked; that their effects are very deleterious, and that their removal can only be effected by surgical means and is followed by most gratifying results.

Symptoms.—The symptoms and effects fairly attributable in whole or in part to postnasal vegetations are obstructed breathing, mucous or muco-purulent discharge from nostrils or into pharynx, altered speech, mouth-breathing, snoring, disturbed sleep, difficult suckling in infants, partial deafness, catarrh of Eustachian tube, otitis media catarrhal and suppurative, deficient oxygenation of the blood, alterations of the contour of the face, deformities of the chest, impaired cerebral circulation and consequently development, loss of memory, stunted growth, croup and laryngismus, asthma, stammering(?), local or general convulsions, torticollis, altered voice and articulation, deaf-mutism, irritable pharynx, capricious appetite, palpitation of the heart, drowsiness, sullen disposition, retarded dentition, retarded puberty, high arching of the palate with narrowing of the nostrils—certainly a formidable indictment with many counts. Not that all these signs and symptoms are present in all cases or in any one case. Any one or all of them may be absent and yet adenoids present. Even mouth-breathing and snoring may be lacking, or the patient may be able to breath freely with the mouth and either nostril held shut.

The alterations in the facial appearance of a case of long standing are—a dull vacant look with mouth open and staring eyes, the nostrils narrow, the bridge of the nose wide, the eyes seeming wide apart, and the jaws enlongated and flattened over the malar bones. The palate is high and narrow, and the dental arch too small to accommodate the teeth, which crowd and overlap.

The type of thorax is that commonly called "hollow-chested and stoop-shouldered." Its antero-posterior measurement is small. The angles of the scapulæ point backward and the clavicles are very much S-curved, thus bringing the shoulder joints prominently forward and approximating them across the narrow upper thorax. The sternum is often lowered with relation to the vertebræ and the upper dorsal and cervical spine curved forward. The ribs droop suddenly from their attachments to the spinal column, nearly obliterating the intercostal spaces posterially, but curving upward to the sternum the spaces are widened in front.

The typical face and thorax of the victim of adenoids are well shown in Figs. 161 and 162.

Diagnosis.—The diagnosis can be made almost to a certainty

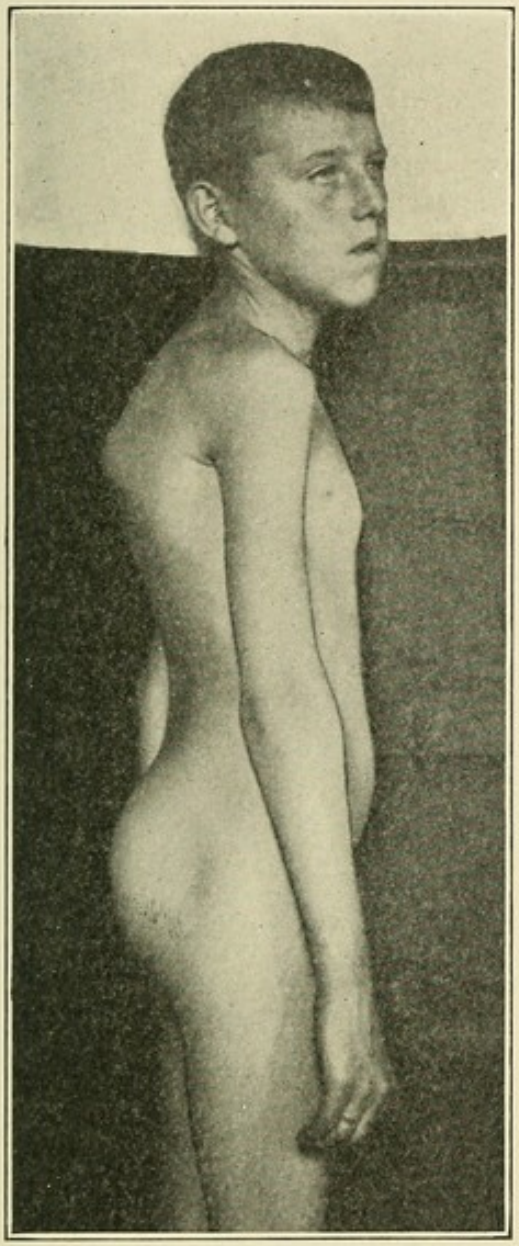


FIG. 161. SHOWING THE EFFECTS UPON THE FACE AND FIGURE OF OBSTRUCTION OF THE UPPER AIR PASSAGES BY HYPERTROPHY of the lymphoid tissues of the naso-pharynx.

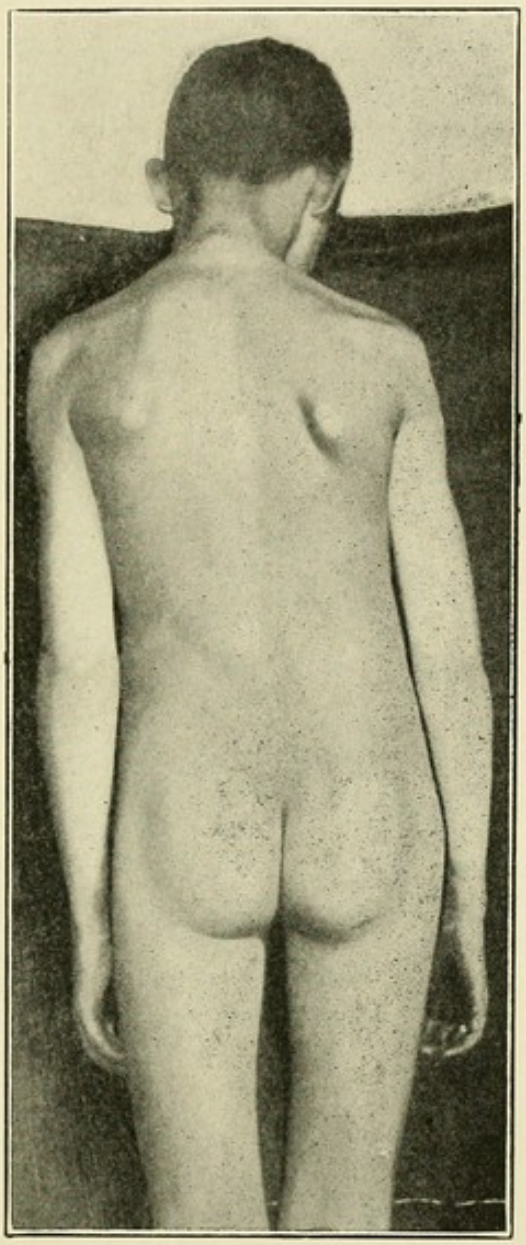


FIG. 162. EFFECTS OF ADENOIDS AND ENLARGED TONSILS. Same as Fig. 161. Back view. Dorsal and cervical spine curved forward. Lower angles of scapulæ point backward.

by inspection of the patient, the evidence being corroborated by an account of the symptoms. In some children the growths can be seen through the nostrils or with the throat mirror. Diagnosis is easily verified by a digital exploration of the pharyngeal vault. In

daily work, digital exploration is so much more satisfactory and rapid that it is usually relied upon. The surgeon's right index finger, with palmar surface upward, is passed behind the velum palati, and in two or three seconds' time has explored the vault and posterior nasal openings.

Treatment.—The only treatment of adenoids that can be advised as satisfactory is their clean removal, with some form of edge-tool. Immediately the question arises, "If operated, will they return?" The answer is, "As a rule, when carefully removed, they do not recur. But if they did recur within a year or in a half year, it would still be better to remove them." It is not advisable to operate for adenoids in the presence of diphtheria, scarlet fever, measles or other acute illness. Treatment of adenoids by internal medicines is useless. It is true that many patients with adenoids stand in need of tonic and alternative medication. Syrup of the iodide of iron, or other ferruginous preparation, cod-liver oil, hypophosphites, malt and other reconstructive agents, though they have no effect on the growths, are useful to such patients in a general way; but they produce a much greater benefit if his air passage is first cleared so that he can secure an unstinted supply of oxygen. Local application of astringents or antiseptics to the growths may, if persisted in, produce improvement in the symptoms, but are slow, tedious, and unsatisfactory as compared with instrumental ablation, and are not without danger to the Eustachian tube and middle ear. The use of caustics upon the growths is difficult if thoroughly done, inefficient if not thoroughly done, and is a clumsy and dangerous procedure by comparison. Scarifying and crushing the growths have also been advocated and may dispose of the obstruction. These methods have nothing to recommend them over a clean removal. There can certainly be no advantage in leaving shredded or compressed and bruised investments of the growths hanging to the vault of the pharynx.

The snare might serve for removing one or two pediculated vegetations. But where, as usual, there is a sessile mass, there are other instruments more serviceable. Various instruments have been devised for the removal of adenoids, and many modifications of the various types, to suit the ideas of many different operators. For example, the ring knife, the metal fingernail, the cutting forceps (small and nearly straight, for use through the nose, larger and curved for use through the month), the curette, the curved scissors, the sharp spoon, the adenotome and others. Some operators prefer to work through the nostrils. To me that seems like crawling in through a small window when one might walk in through an open door. Some operators prefer to have the patient in an upright position; others want him recumbent; and, if recumbent,

one hangs his head over the end of the table, while another prefers to lower it slightly. Some do not use an anesthetic, so that the patient may sit upright. Some administer the anesthetic and then place the patient upright, strapped to the back of an operating chair,

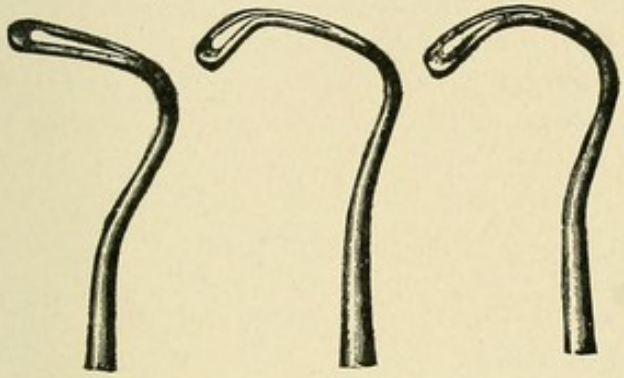


FIG 163. GOTTSTEIN'S ADENOID CURETTES.

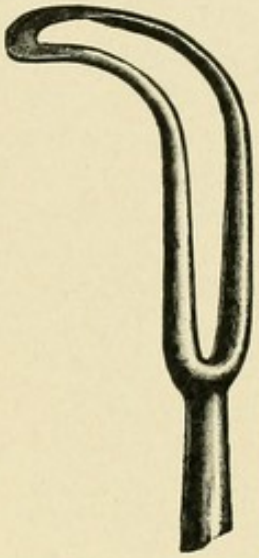


FIG. 164. KIRSTEIN'S ADENOID CURETTE.

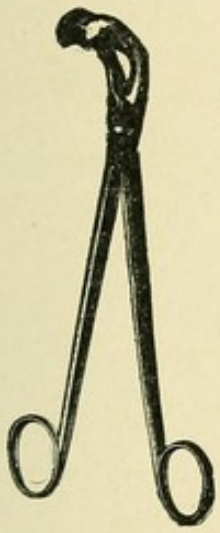


FIG. 165. DOYEN'S FORCEPS.

his head held by an assistant. Deaths have been reported in both positions. If an anesthetic is to be used, I would rather take the chances with the patient recumbent and his head lowered sufficiently over the end of the table so that the blood will not readily run into the larynx, and his face turned sufficiently to one side so that the blood can readily run out of his mouth or be swabbed out.

I prefer, if the child be docile and his confidence has been secured by a few previous painless examinations or treatments, to dispense with the anesthetic and operate with the patient sitting, using a sharp Kirstein curette or the cutting forceps of Deible. Some surgeons prefer a Gradle's guillotine, which has a fenestrum and a knife like a tonsilotome, but is curved upward to fit the post-nasal space. If the post-nasal space is small, or the growths numerous or broadly sessile, my choice of instruments is the curette. (See Figs. 163, 164 and 165.) Occasionally the spoon forceps is a necessity, or the double-edged ring knife. I use Dalby's metal finger-nail but very seldom of late. The bare finger-nail makes a ragged surface. In young infants a uterine curette, bent to the proper angle, may suffice. From habit I have used chloroform, if any anesthetic, as less irritable to the respiratory tract; but ether can be used with satisfaction, and is probably safer, especially in

these cases, which may be associated with lymphatism. Cocaine is useful in older children in a 2 per cent. solution. General anesthesia by ethyl-chloride or nitrous oxide may be used. Whatever general anesthetic is employed, very little of it should be used. The reflexes are never abolished. The patient can always cough and clear his throat. An assistant should hold his hands. When enough anesthetic has been given—probably just as the pupils begin to contract—the head is drawn over the end of the table and lowered, a gag placed between the teeth, and the mouth opened. The head and gag are held by an assistant—the anesthetizer if no other is to be had. If enlarged tonsils are to be removed, it is better to do that before the adenoids, taking first the tonsil less easy to seize in the tonsilotome, for later the blood obscures the field. After the tonsils come the adenoids, in rapid succession, unless one should encounter dangerous bleeding, which, in rare cases, may occur. (See Tonsilotomy.)

The adenoid operation is all by touch. It is convenient to have a dozen or more swabs of absorbent cotton, well wound, on the end of small sticks. I find butchers' skewers, six inches long, convenient for making these stick sponges. Hemorrhage is sharp for a minute, but generally ceases spontaneously.

Practically no after-treatment is necessary except that after any anesthesia. Some patients complain of severe headache on first recovering consciousness, but this gradually subsides. Vomiting of blood swallowed is apt to ensue. The child should remain in the house for some days in the cold season. Dust is to be avoided. There is generally no traumatic fever. Sprays and douches are not advised. Secondary hemorrhage may occur, but need not occasion alarm. Otitis media or pneumonia are possible sequellæ, thought to be caused by blood running into Eustachian tube or into lungs. The latter, at least, should be avoided by proper position of the patient. Most patients experience marked beneficial results very promptly after operation, as evidenced by improved general vigor, growth, and development. Some, particularly the younger ones and cases not of long standing, recover nose-breathing and natural intonation almost at once. Others, usually older children and older cases, may need training to break the confirmed habit of mouth-breathing, either while awake or asleep. A chin support, with a piece to cover the mouth, to be held in place with straps over the head, to be worn at night, may help. Or adhesive strips across the mouth may have a good physical or moral effect. Such cases often need, also, corrective gymnastics, particularly the "setting-up" exercises and breathing exercises for their undeveloped lungs, flat chests, and rounded, drooping shoulders.

ENLARGED TONSILS

A strict classification would place enlarged tonsils with diseases of the pharynx, but the practical importance of this very common ailment depends on the obstruction to the air passage occasioned thereby, and it is convenient to consider it in this connection.

There is no disease or condition, unless it be adenoids, which more frequently requires the services of the child's surgeon than enlarged tonsils.

They may be present congenitally, though this is rare. Nor are they so very commonly met with in infancy. But after the period of infancy they seem more frequent, and through childhood and early youth occur in greatest numbers, decreasing toward puberty. At least it is true that the patient suffers less from the ailment as the development of that period increases the capacity of the throat. It appears, too, that in the hyperplastic form, shrinking takes place in the enlargement as age advances, through contraction of connective tissue.

Bosworth describes two distinct forms of enlarged tonsils. First, the hypertrophic form, in which the lymphoid tissue is increased in quantity, with a comparatively slight increase of the stroma of the gland, and an increased vascular supply. This produces an enlargement irregular upon the surface, with large crypts, deeper red in color, more spongy to the touch. In the second, or hyperplastic form, the increase is in the connective tissue stroma; the crypts are not in evidence; the enlargement is smooth and rounded, paler in color and firmer. While these two types are met, it is the experience of every practitioner that they are apt to be combined and cannot always be so distinctly differentiated. One or both tonsils may be affected. In general shape and dimensions the enlarged organs vary greatly, being regular or irregular in outline and projecting slightly toward the median line or meeting the opposite tonsil or extending downward or upward or in all directions. Or the enlarged tonsil may be attached to the margins of the faucial pillars and, instead of projecting beyond them, carry the pillars with it in its distension. There may or may not be in the same case enlargement of other portions of the lymphoid ring—notably the pharyngeal tonsil—much less frequently the lymphoid tissue at the base of the tongue. In regard to etiology, it is not always possible to decide that this case or this type of case comes by heredity while another is produced by irritation, and another by the strumous diathesis. Hereditary predisposition, repeated irritations, recurrent inflammations, struma, the rheumatic or the lymphatic diathesis, digestive disturbances, rickets, diphtheria, scarlatina, dentition; bad hygienic environment, such as dampness, lack of fresh air and sunlight, foul gases, re-breathed air of closet-like sleeping rooms, lack

of proper food or over-feeding, bad feeding generally, syphilitic taint, are all apparent causes, predisposing or exciting, of enlarged tonsils, although we find cases in which none of them can be detected as having any connection. In most cases more than one possible causative factor can be discovered.

Symptoms.—Enlarged tonsils of moderate degree will sometimes be discovered during routine examinations or by accident, when there were no symptoms or appearances arousing suspicion of their presence. But as a rule their results, or at least their accompanying symptoms and signs, are many and marked, and include all those enumerated as belonging to post-nasal adenoids (which see), whether affecting respiration, the mouth-breathing and the nightmare, speech, hearing, deafness or tinnitus, secretion, impairment of smell and taste, deformities of nose, face, thorax, the reflexes, cough and laryngismus, or general condition; and add to these dysphagia, foul breath, greater impairment of intonation and more frequent implication of adjacent lymphatic glands at the angle of the jaw. Of late years the tendency of writers has been to place less stress upon enlarged tonsils as causative of this formidable array of symptoms, and more upon the adenoids. But there can be no doubt that either is capable of producing them, and that they often coexist, the adenoid being more likely of the two conditions to escape detection.

Prognosis.—The probabilities are that no spontaneous improvement of chronically enlarged tonsils will take place before puberty, and that even then the condition will not be entirely abated. In the meantime the child, besides suffering many symptoms distressing to itself and annoying to others, will be seriously impaired in its general health and experience deleterious results in ill-developed nostrils and dental arches, crowded and overlapping teeth, in malconformation of face and figure, and in use of lungs and voice, not to be eradicated for the remainder of its life. Also, in the meantime, as with adenoids, if attacked by diphtheria or scarlatina or by any throat or lung affection, to which its liability is increased, danger is appreciably augmented.

Diagnosis.—The diagnosis presents few difficulties. The swelling of acute inflammation can be readily excluded by the absence of the febrile disturbances and tenderness, the redness and altered secretion of the acute condition. But a chronically enlarged tonsil may be acutely inflamed or its crypts filled with a collection of cheesy or cretaceous material, perhaps foul smelling and irritating.

A peritonsilar abscess may push a tonsil into prominence, giving it the appearance of enlarged tonsil adherent to the pillars.

Postpharyngeal abscess may simulate it somewhat, and is not always in the median line or on both sides, as some writers state,

and does not always tend to point anywhere in sight. However, the abscess can generally be distinguished by greater difficulty and especially pain on swallowing, by diffused, if not prominent, swelling, by touch, and perhaps by rigidity of the neck and deep swelling perceptible behind the angle of the jaw.

Ashby and Wright describe the occasional appearance of "a large yellow mass . . . blocking up the whole of that side of the pharynx. It is soft and fluctuating, and on incision gives exit to a large quantity of thick débris of mucus, pus, cholesterine, etc. This condition we have sometimes thought to be a congenital mucoid cyst."

The possibility of neoplasms of the tonsil is to be borne in mind.

Treatment.—Treatment is demanded by the presence of the enlarged tonsil, together with any of the symptoms attributed to this condition. The treatment is either constitutional or local. A discussion of the constitutional treatment would repeat all that has been said on that topic in the treatment of adenoids. The usual medical treatment of enlarged tonsils is the treatment of accompanying conditions, such as disordered stomach and bowels, rickets, rheumatism, colds and catarrhs. There is no remedy with specific virtues for this condition. It is possible that medication, general and local, may affect hyperplastic conditions, but the hypertrophic remain slightly, if at all, influenced. In all cases, good nourishing diet, warm clothing, dry feet, fresh air, preferably by the sea or in the country, and sunshine are to be recommended. Such drugs as iodide of iron, glycerophosphites, phosphorus, cod-liver oil, lactophosphate of lime, guiacum, salicylates, and alkalies are to be considered. Taken alone—that is, without operation—medical treatment of enlarged tonsils is notoriously unsatisfactory.

Local treatment is either palliative or radical. Appropriate palliative treatment is such as that stated by D'Arcy Power, as follows: "Astringents should be employed where there is reason to suspect that the enlargement is due to chronic irritation, rather than to true hypertrophy. The astringents I have been accustomed to use are glycerine and tannic acid, a solution of nitrate of silver, four grains to the ounce, or the solution of sulphate of zinc, containing a drachm to the ounce. These solutions are painted over the tonsil night and morning by means of a camel's-hair brush in a handle."

Other agents may be used, as compound tincture of iodine. Some use alum or tannin, or both together, in powder form or in glycerine. Tincture of the chloride of iron, one or two drachms in the ounce of glycerine, is recommended by Beverly Robinson. Adrenalin chloride is a newer remedy.

These seem to me to represent the limit of the useful milder means of dealing with this condition. And it is only in a selected

number of cases that these are useful. In the majority they will be found powerless. Among them all the compound iodine and the tannin and alum are the most useful, without harming the teeth or leaving the parts feeling stiffened and uncomfortable.

Some advise the use of much stronger solutions of silver nitrate, ten or twenty grains to the ounce; or the solid stick, or perchloride of iron, or chromic acid, or the galvano cautery or intra-parenchymatous injections of acetic acid or carbolic acid.

These I do not employ and cannot understand the logic by which Robinson criticises Cohen's suggestion of electrolysis because of the doubt that "one child in a hundred would permit the continued introduction of needles into the tonsils," while he advocates the use of the galvano cautery and chromic acid, described as follows: "If the tonsils be scarified in two or three places with the cautery, the useful result of these transcurrent cauterizations can be increased by the application, on these burned surfaces, of a saturated solution of chromic acid, applied by means of a flattened or round metallic probe, roughened at its point." I quite agree with Ashby and Wright when they remark that "The only efficient mode of treatment is by removal; caustics and the actual cautery are inferior methods of obtaining the same results," and with Edmund Owen, who says: "Other ways of dealing with the hypertrophied tonsils have been suggested, such as electrolysis and puncture with the blade of the thermo-cautery. Of the former I have no experience, nor do I desire it. The igni-puncture I have once tried, but then I made a permanent passage through the tonsil of the caliber of a slate pencil, and there it remained until, some months afterward, the rigid mass was amputated. When once it has been decided that removal of the tonsils shall be undertaken, the more quickly and effectually the operation is accomplished the better."

No sooner is operation proposed than one is met by the popular notion that removal of the tonsils will injure the voice. But voice and speech have already been injured by the disease, and one assures the parents and friends of the child that operation will result in benefit only, to the vocal apparatus. Injury could only follow if extensive scar tissue result. Next, one meets the superstition that operation on the tonsils damages the sexuality of the individual, which fallacy one can deny as unfounded in fact. Finally, it is objected that the enlarged tonsil will grow again after operation. To this is answered that regrowth of the tonsils after amputation seldom occurs, and that after complete tonsillectomy it cannot occur. Operation is not advisable during an attack of inflammation; nor if scarlatina or diphtheria is prevailing in the home or immediate neighborhood.

Preparation for operation is useful, especially if there exists a purulent catarrh of the nasopharynx. Swabbing with solution of argyrol in water (10 per cent.) daily, will improve the condition. Ferruginous tonics are in order. In children of hemophiliac tendencies calcium chloride, gallic acid, gelatine or blood serum may be used beforehand. Operative treatment consists in tonsillectomy or tonsillotomy.

Tonsillectomy has in recent years gained great favor, in that it more thoroughly removes diseased gland tissue and prevents not only recurrence of the enlargement but repeated local inflammations and more remote affections caused by absorption of infectious material from the diseased tonsils. It is a more serious operation than tonsillotomy and is usually done under general anesthesia in children. The position is dorsal, with the head drawn over the end of the table and turned to one side toward the light. Good light is necessary. Then the anesthetic is laid aside. The gag being placed, a tonsil is seized with volsellum forceps and the margins of the pillars separated from it. This is conveniently done by Tyding's tonsil knife or similar slender blade. But a pair of sharp-pointed scissors curved on the flat and used closed, or a dissector can be used. The tip of the index finger is introduced and working from above downwards the tonsil with its capsule is separated from its attachments, all but that portion including the vessels at its base. During this rapid dissection, care should be taken not to pull strongly upon the volsellum which is used to steady the organ rather than to make traction. The loop of a strong wire snare is now slipped over the volsellum and on down over the tonsil to its pedicle, which is severed at one motion of the hand, taking care not to drag upon the instrument, in so doing. If both tonsils are to be removed, it is most convenient to operate first upon the tonsil on the side toward which the face is turned, as it is lowermost and the blood does not so much obscure the field. The second tonsil is now removed in the same manner. If adenoids are to be removed this is done last. Pressure with stick sponges for a few moments usually controls the hemorrhage, but spurting vessels may have to be seized with hemostats and sometimes even ligatured. The aftertreatment is similar to that for tonsillotomy at the end of this Section. Children usually manifest little inconvenience after the first day or two.

Tonsillotomy (at present out of fashion) consists in removal of a part of the tonsil, generally as much as projects beyond the pillars, or even more, by means of knife, scissors, tonsillotome, or cutting forceps, cold wire snare or galvano-cautery. If special instrument is not at hand the work can be done by seizing the tonsil with a volsellum and cutting upward with blunt-pointed bistouri. Tonsillotomes are in many patterns. Some have a prong or fork

attached, designed to pierce the projecting portion of the tonsil and draw it through the ring and hold it transfixed, or to seize it when severed. My own preference and that of most operators at present is the simpler instrument with fewer parts, without the prongs or fork. It is less apt to get out of order and is more easily cleaned. Besides, the transfixing mechanism might, if it worked at all, draw

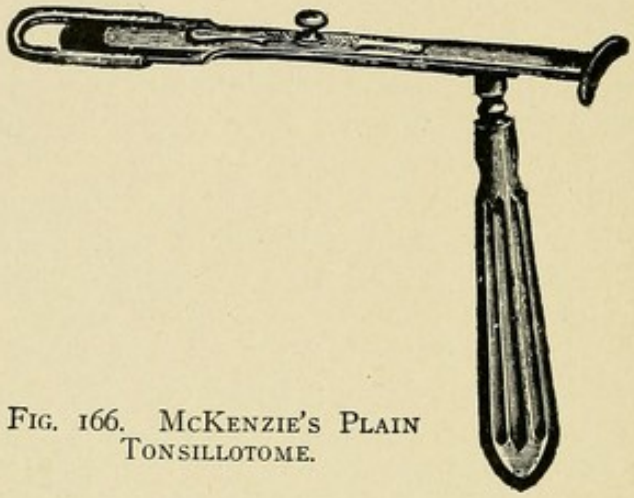


FIG. 166. McKENZIE'S PLAIN TONSILLOTOME.

an uncertain amount of the tonsil under the blade. (See Figs. 166 and 167.)

Some operators provide two tonsillotomes in readiness, so that in removing one tonsil after the other in rapid succession, no time

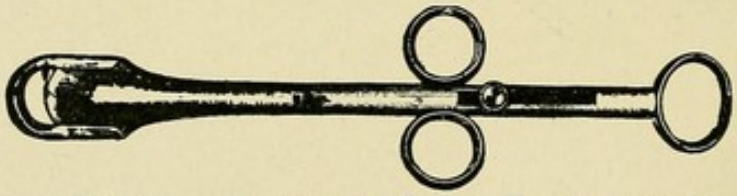


FIG. 167. BAGINSKY'S PLAIN TONSILLOTOME.

is lost in disengaging the severed portion of the first from the instrument. A tonsil may be so ragged and so friable that the most serviceable instrument is a sharp spoon or the spoon forceps.

The cold-wire snare, or ecraseur, or the galvanic loop, are preferred in cases of extremely large, dense, fibrous tonsils, or in a child of hemophiliac tendencies, or who is markedly anemic and weak. It is a mistake to select too slight an instrument of the snare variety. The cold-wire apparatus is much simpler, more easily managed, and more certain in its operation. It is placed where the division of tissues is wished. In placing the galvanic wire, it must be remembered that the tissues will be charred somewhat deeper than the track of the wire. The wire should be heated only to a dull red, and that intermittently, and tension made only while the

iron is hot. With either the cold or the hot wire the division should be made deliberately, and care taken not to drag upon the parts.

In regard to anesthesia: In simple amputation of one, or even both, palatal tonsils in a fairly tractable child, no anesthetic is necessary. Even with an intractable patient, if efficient assistants are at hand, anesthesia may be dispensed with. Tonsillotomy, while disagreeable to the patient, is not painful. As to pain, there is no comparison between tonsillotomy and the extraction of a tooth. Tonsillotomy is less painful than the adenoid operation when done with a curette. But if adenoids and palatal tonsils are both to be removed it is better to give an anesthetic. In any case the anesthetic makes the operation much more comfortable for all concerned, and in case the snare is to be used it is imperative. Any general anesthetic may be used. Nitrous oxide alone scarcely gives time enough. Cocaine may be used in older children. But as the general anesthetic is used more on account of fright than pain, cocaine does not take its place; and, besides, children are not all equally susceptible to cocaine. It is not wise to undertake the operation upon any child without assistance at hand adequate to control the patient in any event, and a mouth gag should always be used. A convenient form is shown in Fig. 168. A child perfectly docile at first may become frightened into a panic and make a desperate resistance after only one tonsil has been removed, or perhaps while alarming hemorrhage is taking place.



Fig. 168.
Mason's Mouth Gag.

In holding a patient's head and gag, the assistant should draw the gag backward between the jaws and keep away from the trigger which allows the gag to collapse.

If a general anesthetic is used the position is dorsal, with the head drawn over the end of the table, as described under operation for adenoids. If no anesthetic or a local anesthetic is used, the position is the same as the sitting position for intubation. If both tonsils and adenoids are to be removed the tonsils should come first.

As to hemorrhage: It is well to pause after removing each tonsil long enough to see whether the hemorrhage is excessive. I have never met serious hemorrhage after excision of the tonsils, though at times it has been so sharp as to cause uneasiness lest it continue; and, having questioned surgeons and laryngologists of my acquaintance, who also have performed very numerous tonsillotomies, I find that none of them have ever had a death, and very seldom experienced any really dangerous hemorrhage. Owen says

serious bleeding is exceptional. Ashby and Wright: "We have never seen bleeding follow the operation to any serious extent." Yet cases are on record where the danger was escaped only by using active means for hemostasis; and numerous cases have occurred of blood loss which greatly retarded the patient's recuperation. Bearing these facts in mind, on the general principle that it is well to be saving of blood while operating, it is a good plan to have always at hand the means for controlling hemorrhage. I have been in the habit of making ready a swab or stick-sponge, dipped in a saturated solution of tannin and alum in glycerine, and, after the first rush of blood from the severed tonsil had been cleared away, applying the stypic, with pressure, to the bleeding surface. In case

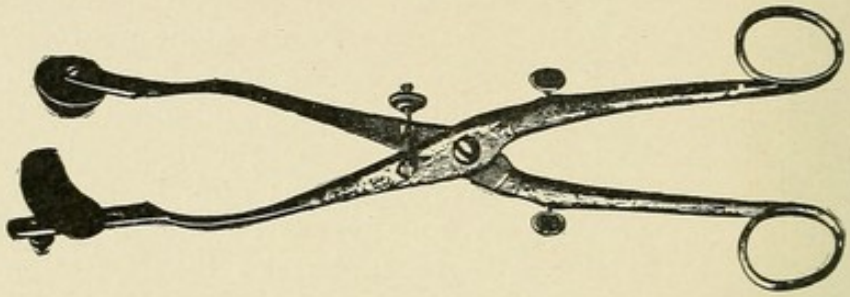


FIG. 169. STOERCK'S TONSIL HEMOSTAT.

of more persistent bleeding from an open vessel, one or two hemostatic forceps or a tenaculum or vulsellum will enable one to deal with it. R. J. Levis suggested a plan of thrusting a tenaculum deeply through the tonsil, under the bleeding vessel, or through the base of the whole tonsil if bleeding is general, and by giving the instrument a decided twist, sufficient torsion is used to control the flow. By closing the teeth tightly on the projecting handle of the tenaculum and bandaging the jaws tightly together the torsion is maintained. Or a gauze sponge, squeezed out of water as hot as can be borne, may be applied. Or hot water projected against the bleeding surface from a syringe. Various special instruments have been devised as tonsil hemostats. For instance, Stoerck's. (Fig. 169.) As may be surmised from the cut, one blade is intended to be passed within the mouth, the oval pad placed upon the bleeding surface, while the other is placed externally. The blades are then clamped together by the bolt and fly-nut, and, the handles being removable, the instrument can be shortened and left in position as long as may be desirable. Dr. Beverley Robinson describes "as a more useful instrument," "A long metallic holder, with a convex metal button, somewhat larger than a penny, projecting from its distal

extremity, supported by a firm metal rod half an inch in length. Around this button a thick layer of sheet spunk may be wrapped or tied tightly. . . . This instrument is far preferable to different kinds of double-clamp pressure forceps which have been described."

Less rapid, but persistent, hemorrhage may be held in check by the use of the tanno-gallic mixture, sometimes called Mackenzie's mixture, composed of tannic acid, six drachms; gallic acid, two drachms; water, one ounce. Of this a half teaspoonful should be sipped and swallowed at short intervals.

When adrenalin chloride and similar preparations of the suprarenals, by whatever name known, were introduced to the profession it was expected that one of its fields of usefulness would be in tonsillotomy, and it was extensively tried. But it was found to temporarily shrink the tissues to such a degree as to materially interfere with the operation; and that, although hemorrhage was lessened for the time being, it was liable to occur when the effect of the drug had passed.

The after treatment of tonsillotomy cases is simple, consisting in the use of protection against taking cold for several days; soft, unirritating foods, and of bland gargles or sprays of normal salt or potassium chlorate, or argyrol solution, sometimes followed by a protective coating of liquid vaseline, and the avoidance of dust. Spongy granulations may need the application of a solution of silver nitrate or tannic acid, alum, hamamelis or similar astringent. Iodine or strong solution of argyrol may be useful. After operation a persistent use of general tonics, hematinics, and often anti-rheumatics, aids improvement.

THE UVULA

The uvula may be chronically enlarged as a result of repeated inflammation, leading to hypertrophy; or its mucous membrane may be so redundant, or its muscular fibers so relaxed as to produce persistent cough or snoring and thick speech. Snipping off a portion is the remedy.

I once knew a case—a babe of twenty months—which came to me as an instance of "double tongue." What appeared like a small tongue, nearly one-third of the width and one-third of the length of the normal tongue, rested upon the latter organ, with its free end forward. It occasioned a very considerable obstruction to breathing and swallowing, especially when it was pushed backward into the pharynx, as sometimes occurred. The growth, upon examination, proved to be the uvula, or to have its attachment to the uvula, and

was probably a papilloma. The parents refused operation, as they had found begging profitable by exhibiting "the baby with two tongues."

OBSTRUCTION BY THE SOFT PALATE

The free opening between the post-nasal space and the pharynx may be interfered with by congenital deformity of the velum palati, or by its adhesion to the post-pharyngeal wall and cicatricial contraction as a result of diphtheritic or other inflammation. Such cases may be improved by plastic operation and the use of dilators adapted to the peculiarities of each case, with the object of increasing and maintaining the patency of the naso-pharyngeal space.

FOREIGN BODIES IN THE NOSE

Inanimate Bodies.—No class of patients, not even the demented or insane, present so many cases of foreign body in the nose as do children. The practice of placing them there is by no means confined to the feeble-minded, though for the most part to quite young children. Some children have a propensity to repeat the performance. Almost any article of a size and shape to be easily admitted to the nostrils may be introduced. Beans, buttons, paper wads, pebbles, bits of pencil are examples of the commonest.

The patients do not by any means always come to the surgeon with a history of a foreign body. In many cases such a condition is not even suspected by parents or nurse.

The foreign body may be lodged in any of the nasal fossæ, most frequently the inferior meatus, but may have been thrust higher or farther back. In a recent case the delicate vascular and sensitive lining of the nasal canals might be scarcely more than irritated, or might be acutely inflamed and greatly swollen, depending on the size, shape, and consistency of the offending body and length of time it had been present. In older cases often ulceration has taken place, with muco-purulent discharge or the formation of abundant soft granulations which bleed at a touch or upon blowing the nose. The swelling and inflammation may even be perceptible externally upon the nose. As a rule, hard, impervious bodies, like buttons or pebbles, make less disturbance than one which becomes saturated with discharges and fetid. A foreign body remaining long in the nose may become incrusted with the salts of the discharges, phosphate or carbonate of lime—a so-called rhinolith. Numerous instances are on record of foreign bodies remaining in the nose for many months, and even for many years, before they were discovered, and this notwithstanding that a number of doctors had been visited, who had given treatment for catarrh or other ailment.

One of my cases came with a history of obstructed breathing,

purulent, fetid, and sometimes bloody discharge of several weeks' duration. The patient was a child of some four years. The nose was swollen externally and tender. On introducing a probe it encountered an elastic mass and was followed by a flow of blood. For a moment I paused to consider the possibilities of abscess with necrosis, of sarcoma, angioma, or lupus. But, exploring with the forceps, I felt something fibrous, and, taking a strong hold, drew forth a sponge of the size of a hickory-nut.

Every case presenting obstruction to the breathing or discharge from the nose should be very carefully examined. If the obstruction or discharge be upon one side only one is especially suspicious of a foreign body, and more so, as Holmes remarks, if the mucous lining of the other side is absolutely healthy. However, search should be made for deviated septum, which is rather common; or an enlarged turbinate, which is more unusual; or polypus, which is uncommon; or the rare angioma or other growths. Syphilitic ozena is bilateral. In some cases the foreign body will be detected at a glance or at the first passing of the probe. In nearly every case anterior rhinoscopy, after careful removal of the discharges with warm normal salt or sodium bicarbonate solution, or the use of the probe, will make the diagnosis.

If the parts are too sensitive to allow satisfactory examination, cocaine may be used. Adrenalin chloride helps by still further shrinking the tissues. An effort may be made to expel the body by closing the open nostril and directing the patient to blow forcibly through the obstructed one. Or by driving a stream of warm salt solution into the open nostril, the mouth being held open. Or, if necessary, a general anesthetic may be administered.

A dressing forceps may seize the body very well if it be of yielding material. But usually a loop of wire or a scoop is better for a round, hard body, being more easily slipped by so as to draw from behind. A very good combination of loop and scoop is made by bending the closed end of a hairpin. Or a Bellocq's canula, or the finger passed through the posterior nares may thrust the foreign body out forward. There is some risk in pushing it back into the pharynx, lest it fall into the larynx. A rhinolith embedded in the tissues may have to be crushed before it can be removed. In some cases the habit of thrusting foreign bodies into the nose may be cured by removing one *without* an anesthetic. In all ordinary cases, after the offending substance has been removed, it is surprising how rapidly repair takes place, although considerable ulceration and distension has occurred. A simple antiseptic wash of boric acid or weak carbolic acid, or even normal salt solution, carefully warmed to blood heat, is all that is required; but a powder or a salve, such as campho-phenique or vaseline, may afterward be applied.

Flies or Their Larvæ in the Nasal Passages.—Cases of flies or their larvæ in the nose or its accessory sinuses I have never met, and must borrow an account from other writers. A good summary is given by Dr. Delavan in "Keating's Cyclopedia." Most of the cases have occurred in tropical or warm countries. A fly of the order muscidæ enters the nostril of a sleeping person and there deposits its eggs. These are quickly hatched and cause tickling and sneezing, and then irritation, formication, bleeding with redness of face, eyelids, and excruciating pain, often erysipelas, frontal headache, and, unless properly treated, convulsions, coma, and death. The local symptoms and appearances might vary somewhat, according to the principal location of the larvæ—for instance, in the frontal sinus or in the antrum of Highmore. Rapid and extensive destruction of mucous membrane, cartilages and bones have been occasioned in this horrible manner in cases not soon recognized or not energetically and properly treated.

The diagnosis is easy if one can get a sight of a larva, either upon examination or by its being sneezed out. Formerly such cases were treated by syringing with solutions of tannin, alum, tobacco and the like, or insufflations of snuff or calomel. Dr. Delavan's article refers to the more commendable method of Dr. John Ellis Blake.[1] This consists in the use of vapor of chloroform or ether, preferably chloroform, applied to the nose or to the infested sinus. The larvæ, to escape suffocation from the vapor, escape to the open air. This plan has the great advantage of not merely destroying the pests, but of removing them. The use of cocaine or cocaine and adrenalin previously to the anesthetic by opening the sinus as wide as possible for the ingress of the vapor and the egress of the maggots, as well as relieving the pain, would work to great advantage. Cases of other living things—for example, ascarides, ticks, leeches, and so forth—have occasionally been reported. Sternutatories are recommended. Removal with forceps may be necessary.

FOREIGN BODY IN THE GULLET

Foreign body in the gullet may cause obstruction to the air passage, and is therefore mentioned in this place. It will be discussed in connection with the esophagus.

TONGUE SWALLOWING

This is a not very infrequent condition, in which the length and mobility of the tongue are sufficient to allow it to be turned backward into the gullet, thus obstructing the breathing, even threatening suffocation. Usually watching the babe and drawing the tongue

[1] Boston Med. and Surg. Jour., April 10, 1862.

forward with the finger is sufficient to relieve it; and later, better control of the organ ensues. Mr. Owen suggests the propriety of plastic operation in the floor of the mouth to secure sublingual adhesions; and that even tracheotomy might be demanded as a precaution against fatal dyspnea.

RETRO-PHARYNGEAL, OR POST-PHARYNGEAL ABSCESS

Retro-pharyngeal abscess is a disease not at all infrequent in both infants and children, and one which is singularly insidious and apt to be mistaken for some other disease.

Practically the condition may be divided into two varieties—acute and chronic.

As to etiology, the acute form usually depends upon the presence of pyogenic organisms often found in throat or larynx, or adjacent tissues of mouth, middle ear, or nares. It is apt to follow, although sometimes rather remotely, a more superficial inflammation, such as tonsilitis, pharyngitis, scarlatinal angina, diphtheria, measles, otitis media, purulent rhinitis, although in some cases no history of previous inflammation can be elicited and no probable cause found. It may be due to direct injury or to burrowing of an abscess originating elsewhere.

The chronic form is an accompaniment of caries of the cervical spine, the active organism most frequently responsible being the tubercle bacillus. The acute abscess is usually situated in a lymphatic gland located about the level of the axis, or in the loose areolar tissue between the pharynx and the fascia of the pre-vertebral muscles, especially if it has tracked from the ear or tonsillar region.

In the chronic form resulting from spondylitis, or Pott's disease of the cervical spine, the pus, or that which resembles pus, collects behind the deep fascia and the anterior common ligament. It is well to note in this connection that retro-esophageal abscess may occur, its location being sufficiently indicated by its name.

Symptoms.—The symptoms in the acute variety of retro-pharyngeal abscess are fever and malaise, fretfulness and anorexia, dysphagia, stiffness of the neck muscles, dyspnea, altered voice, which may be somewhat nasal or more hollow, so-called "duck voice." (Duparque and Labric.)

The alteration in voice and the dyspnea varies with the amount and situation of the swelling, and is usually sufficient to attract attention to the throat. However, if the abscess is small or situated low down or is somewhat flat, even the routine inspection of the throat may fail to discover it. Or if the tonsils or pharynx are inflamed, or there is chronic enlargement of the tonsils, or adenoids are present, or hoarseness, or croupy cough, attention is apt to be diverted from the real trouble. The fever and other evidences of

acute onset of illness may be so slight that the fretfulness and evident discomfort and the failure to drink or eat are attributed to widely different causes. Usually the dyspnea when produced by retro-pharyngeal abscess is continuous, but I have seen it come paroxysmally, resembling laryngismus.

History or complications may be misleading. Once being called to a child in the fifth week after severe diphtheria, and hearing its nasal voice and witnessing its dysphagia, the food also regurgitating through the nose, my first idea was of post-diphtheritic paralysis. And this was correct. But on examining further I found also a retro-pharyngeal abscess which the symptoms of paralysis had very nearly led me to overlook.

Diagnosis.—The diagnosis is easily made in most cases if only one bears in mind the possibility of this disease. The tumor may point in the middle line, or more laterally so as to blend with a tonsillar enlargement. It may be so high or so low as not to come into view on inspection and only be discovered by touching with the finger, which should always be employed in such an examination. The abscess wall may be so thin and distended that pus will show through, and feel soft and fluctuating; or it may be so deep and, early in the case, the tumefaction may be so flat, as to be difficult of detection by palpation. In examining with the finger the child must be held and the mouth kept open as described in examining for adenoids. Even the infant with no teeth can pinch severely. The examination should be made deliberately, in perfect safety, with the bare finger. The metal finger-shield, such as used by some in intubation, is a hindrance. Movements of the head are more painful, leading to more resistance and fixation of muscles than one finds in tonsilitis, in croup, or in passive edema of the glottis. Pressure over the sides and particularly the front of the throat increases pain and dyspnea. Only a careless examiner would mistake the condition for croup or bronchitis. Angioma or edema of the glottis would require more care to differentiate. Many a case of retro-pharyngeal abscess has for some days been mistaken for tonsilitis.

Prognosis.—In the acute form the disease runs its course in from ten days to five or six weeks. It may rupture spontaneously or burrow farther down into neck or thorax. There is danger of suffocation if the swelling be large enough to compress the larynx or trachea or if it produce edema glottidis. If it discharge its contents into the air passages it may produce sudden death, or set up a pneumonia. Fatal hemorrhage may ensue upon erosion of a blood-vessel.

The majority of cases get well if discovered and properly treated.

Treatment.—If a retro-pharyngeal phlegmon is discovered be-

fore pus formation can be detected, the early treatment may be confined to general antiphlogistic remedies and supporting the patient; but as soon as abscess can be detected it should be opened. In the ordinary acute form with the pus collection anterior to the fascia of the prevertebral muscles and pointing in the pharynx, the opening is best made in that situation. I can see no advantage in dissecting deeply through sound tissues at the side of the neck to discharge an abscess located superficially and anatomically accessible through the pharynx. The chronic abscess due to spondylitis, or other origin, or the acute abscess but deeply seated, is a different problem, and will be considered later. As to the method of opening the abscess: I do not, as some French surgeons have advised, use an aspirator or trocar before incision, with the idea of preventing suffocation by the sudden rush of the pus into the throat. There is a positive disadvantage in the preliminary aspiration, by making the bulging less distinctly felt or seen and also of increasing the liability of cutting deeper than the anterior wall of the abscess. Nor can I agree with the directions given by Mr. Owen, who says, "The patient should be anesthetized; when he is propped in the sitting posture, the head should be brought well forward, and, the mouth being fixed open by a gag, a free incision made into the bulging tumor with a guarded bistoury."

Nor with Dr. Grenet, who says: "The child then is seated in the assistant's lap with the head held straight and fixed, and the mouth well opened by a gag; no anesthetic is required. . . . The child's head must be sharply bent forward so that the pus may be expelled outside . . ." The object of putting the patient in this position is to avoid the pus being "drawn with a convulsive inspiration into the larynx, and the child suffocated" (Owen), or "of its falling into the windpipe, giving rise to spasm of the glottis" (Grenet).

For the ready exit of the pus, the safety of the patient under anesthesia, as well as the convenience of anesthetizer and operator, a preferable position of the patient is lying horizontally or with the head lowered and turned to one side, usually the side upon which the abscess is located if it be lateral. An anesthetic may be used; but in the majority of cases may well be dispensed with. The gag is a necessity. The incision may be readily made with a guarded bistoury, at the most fluctuating point felt by the left index finger. In most cases I prefer to use as more convenient a sharp-pointed scissors, thrusting in the points with the instrument closed and then spreading the blades to make a free opening; besides, such a wound bleeds less and is not so apt to adhere at its edges and close before drainage is complete. One makes the opening vertically and as near the median line as the situation of the abscess cavity will allow. The

abscess should be emptied by pressure of the finger or stick swabs and the throat and mouth washed out with boracic acid or other mild solution. The cavity may refill and require reopening, but not usually if the first opening be as free as it should be.

CHRONIC RETRO-PHARYNGEAL ABSCESS

The chronic form of retro-pharyngeal abscess usually arises in cervical caries and presents the longer history of stiffness of the neck muscles, the restricted head movements, the characteristic attitude and the pain and tenderness which belong to that disease. It will not present the febrile disturbance of the acute variety, though there may be hectic. The most frequent seat of cervical spondylitis is in the bodies of the third, fourth, and fifth vertebræ. In a less number of cases the two upper vertebræ are diseased, although rarely these two alone. Whatever the exact location of the lesion, the weight of the head, or an extra weight upon the head, or jarring is badly borne; and the attitude is such as best to avoid jarring of the diseased area, usually the cervical spine being curved backward while the spine below is curved forward. Often torticollis is present, usually, though not invariably, when the disease is in the lower cervical region. In the torticollis of cervical spondylitis the head is rotated toward the contracted muscle, while in congenital wry-neck the head is turned in the opposite direction. The symptoms of pain, and reflex muscular spasm with limitation of motion will vary somewhat with the location of the lesion. Pain is referred to the periphery of the nerves irritated, therefore, those arising at or below the diseased point. In atlo-axoid disease the pain is in the upper part of the neck about the ear or occiput, though it may extend to the upper part of the thorax. In disease of the lower cervical vertebræ the pain is felt lower on the sides of the neck, extending into the arms and chest. In atlo-axoid disease reflex muscular spasm is most marked in the rotators of the head, whereas with the disease below the nervous supply of the rotators the flexors and extensors of the neck are thrown into contraction. Attempts at rotation or of flexion and extension will discover in which direction motion is limited, and the probable location of the disease. If the disease have advanced so far as to destroy nervous tissue or seriously compress it, paralysis, motor or sensory, generally motor, and corresponding in location, will result. Meningitis may occur. Sudden collapse of diseased bone may crush the cord fatally.

Spinal caries before the formation of abscesses may be difficult to distinguish from acute trauma, from muscular rheumatism, from hysteria, from lateral curvature of the cervical spine, and from adenitis; and after the appearance of abscess it is to be distinguished from the acute variety, from mucous cyst, and from a softened gumma, or an angioma. Traumatism may usually be excluded

by the aid of the history. In muscular rheumatism the muscles themselves are sensitive to pressure, the condition is relieved by heat and anti-rheumatic medication, and a little time. In hysteria the symptoms are subjective, pain being the most complained of and located at the supposed seat of the disease rather than in peripheral nerves. Light pressure occasions great complaint, but if the attention be diverted firm pressure can be borne. Reflex spasm is absent. Any apparent deformity can be overcome if the patient's attention is drawn to some other exercise or he be directed to lie prone on the table. In lateral curvature there is no pain, muscular spasm or limited motion. It is uncommon for deeply located adenoids to take on inflammation leading to abscess without implication of those more superficially placed where their condition could be detected. It should not be forgotten, however, in the differential diagnosis, that more than one diseased condition may be co-existent. For instance, acute retro-pharyngeal abscess or acute cervical adenitis in a case of spondylitis. Fig. 170 shows a case of cervical spondylitis in which also extensive adenitis exists and has gone to suppuration. Such a case could be readily mistaken for one of adenitis alone, the deeper seated bone disease being overlooked.

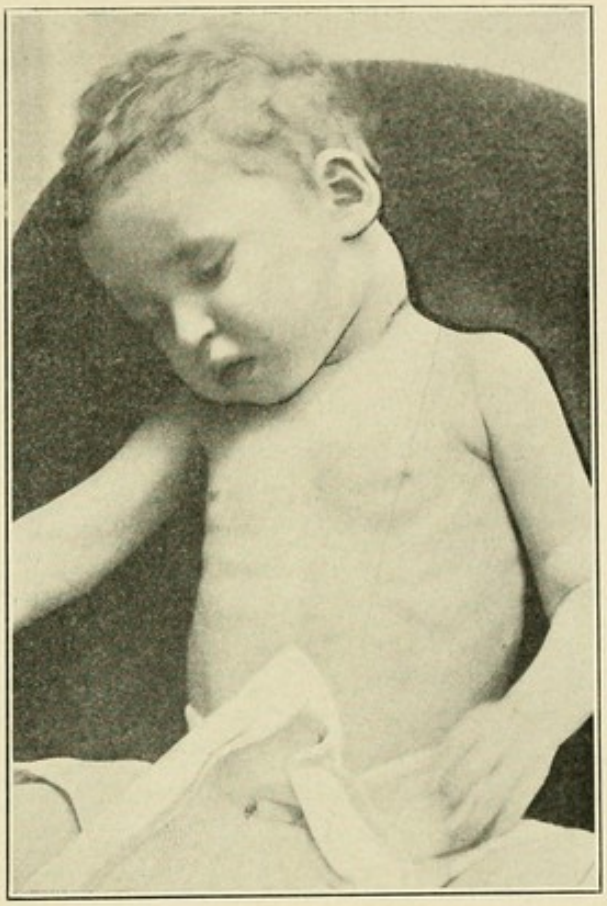


FIG. 170. TUBERCULOSIS OF LYMPHATIC GLANDS OF THE NECK with discharging sinus. Caries of cervical spine also present. No connection of the sinus with the spondylitis. It would be very easy to overlook the spondylitis in such a case. Boy aged 3 years.

Acute abscess can be differentiated by its history and febrile movement. Mucous cyst has no pain, tenderness, fever, or muscular reflexes, nor has an angioma. A gumma could probably be detected by other evidences of syphilis. In the ordinary case of cervical caries which has advanced as far as disintegration of a portion of one or more vertebral bodies, a bulging can be felt on examination through the mouth, and we have the chronic retro-pharyngeal abscess, a far more serious kind than the acute form before described.

Treatment.—The treatment of cervical spondylitis, embracing as it does hygienic and reconstructive measures, together with rest to the diseased parts, secured either by position or fixative apparatus or both, will be considered in the Section on Tuberculosis of the Spine. The treatment of the abscess in the retro-pharynx is appropriate here.

In marked contrast to the advice to open the acute abscess as soon as discovered, one counsels delay in the deep-seated—the tuberculous—the chronic form; unless there is undoubted fluctuation or much bulging in the retro-pharynx which persistently increase after perfect rest to the parts and reconstructive agencies have been faithfully employed. If, however, after fair trial these means fail to produce a subsidence of the symptoms, and reabsorption of the swelling, it will become imperative to evacuate. This should not be done through the retro-pharynx. This abscess is not one which will run an acute course of at most a few weeks and undergo a reparative process. It is one which will continue for months or years, in connection with deep-seated tuberculous bone disease, and is liable to become secondarily infected. Therefore the opening should be external where the cavity can be drained, disinfected and dressed. With the patient under anesthesia and the skin surgically cleansed, an incision of an inch length, more or less, should be made along one of the borders of the sterno-mastoid muscle (anterior border, according to Burkhardt, posterior border, Chiene). The incision is carried only through the skin and superficial fascia, avoiding any visible vein. The mouth is now held open by a gag, and a grooved director thrust into the incision is guided by the index finger of the other hand, toward the abscess which is located in the retro-pharynx. When the abscess is reached pus will flow along the director. A hemostat is then passed along the groove of the director into the cavity. By partly opening the forceps as it is withdrawn a sufficient opening is made. The cavity should be thoroughly emptied and irrigated with a hot antiseptic solution, a drainage tube inserted and the opening covered with abundant antiseptic gauze and pads of jute, oakum or cotton held by a bandage.

Complete rest to the parts in such position as will facilitate free drainage, secured by sandbags, splints, fixation apparatus with all the treatment appropriate to spinal caries are in order. At first daily dressing and irrigation will be required, iodine and iodoform being the antiseptic agents most recommended. Later the intervals between dressing may be longer, if there is no temperature and the discharge lessens without becoming obstructed. Finally iodoform gauze may take the place of the drainage tube and it in time be withdrawn if the reparative process finally warrants the closure of the sinus.

CHAPTER XVIII

SURGERY OF THE AIR PASSAGES—*Continued*

EDEMA GLOTTIDIS—ACUTE SIMPLE LARYNGITIS, SPASMODIC LARYNGITIS, SYPHILITIC AND TUBERCULAR LARYNGITIS—TUMORS OF THE LARYNX—FOREIGN BODIES IN THE LARYNX, TRACHEA OR BRONCHI—MEMBRANOUS LARYNGITIS (MEMBRANOUS CROUP; DIPHTHERITIC CROUP; TRUE CROUP)—AËROPOROTOMY.

EDEMA GLOTTIDIS

THIS swelling of the mucous and submucous tissues of the glottis may come in the presence of the general anasarca of nephritis, or accompany the local manifestations of scarlet fever, measles, variola, or even typhoid; may be induced by Ludwig's angina—septic cellulitis in proximity to the larynx, or by erysipelas, or adjacent peritonsilar or retro-pharyngeal abscess. Also by direct trauma, scald by overheated drinks, or steam or flame and smoke inhaled, or by irritant chemicals or foreign bodies.

The condition and appearance of the parts will vary according to the cause of the attack and the period at which it is examined. There may be merely an accumulation of serous fluid in the cellular tissues with very little change of color which is lighter if changed, and no destruction of tissue; or there may be intense inflammation with accompanying deep redness, tense swelling, even ulceration and pus. In secondary cases lesions of a primary disease may be very evident; but I have once seen dangerous edema of the glottis from nephritis following an unrecognized scarlatina in which the general anasarca was so slight as to have escaped the notice of the attending physician until the dyspnea supervened. The edema of the glottis is always a serious and often a grave condition. The course and prognosis depend on the cause and severity. Ordinary scalds or burns of slighter degree will be recovered from under appropriate treatment. The severe ones will die before help reaches them or from resultant bronchitis and pneumonia in spite of treatment.[1]

[1] See Holmes' Surgical Diseases of Children, p. 290, *et seq.*

In scalds the edema does not usually go below the vocal cords. There may be some resultant scarring and contraction at the rima glottidis. Burns from inhaled flame and smoke are more grave, as pneumonia is very likely to occur. In all accidental cases, shock, dysphagia and spasmodic dyspnea are troublesome additions to the constant stenosis. I particularly dread cases coming with septic celluitis—so-called Ludwig's angina, a streptococcic infection sometimes secondary to scarlatina or diphtheria, the swollen and infected tissues rendering tracheotomy difficult and dangerous. Cases with nephritis can be tided over if the general dropsy subsides. Too often there is also edema of the lungs. Cases with measles recover after intubation unless secondary broncho-pneumonia occurs with its gluey and tenacious muco-pus. All cases require prompt and active treatment or suffocation may result.

Treatment.—The dyspnea is the most urgent symptom, and at least a part of it is likely to be spasmodic. Mr. Holmes urges "the propriety of abstaining from operation as long as possible," and employing means to relieve shock, and laryngeal spasm, and to support the patient. The inhalation of warm, moist air may afford some relief to the spasm, as in cases of ordinary croup. Also the use of ipecacuanha; and in cases resultant from accident the careful exhibition of an opiate to quiet pain and relieve spasm and combat shock. Stimulants may be necessary. In the more passive congestions the use of cocaine or adrenalin, alum solution 3 to 5 grs. to the oz, or a spray of picric acid locally may relieve the reflex irritation or contract the swelling for a time. Inhalation of compound tincture benzoin from hot water has been recommended. In the acute nephritic and in the phlegmonous cases resulting from infection the heroic use of mercury is indicated, as we used it in diphtheria and "membranous crop," as it was formerly called, before the days of antitoxin. A grain of calomel every hour, or a quarter grain every quarter hour may be given until purging ensue; or it may be used by inunction, or, better still, by inhalation of sublimated mercury under a tent, as originally recommended by Corbin, and advocated by Northrup and many others. It was common to sublime 5 grains of calomel every two hours for two days and nights, and then continue at intervals of three hours on the third day and four hours on the fourth day. Sometimes in urgent cases 10 grains were used at a time and repeated every half hour for four or five times. Cases were reported in which 40 grains were used every hour or two hours until 5000 grains had been sublimated. The teeth and mouth should be well washed after each administration. Leeches may be used. In streptococcic cellular infection I use with satisfaction a combination of ichthyol, mercury and iodine (see Section on Septic Cellulitis), rubbing it in gently over the swelling and then

leaving the surface smeared with the ointment and covered with oil silk.

Sthenic cases of edema are relieved by ice bags over the larynx. Owen quotes with approval H. D. Palmer's suggestion of using in the scald or burn cases, frequently administered doses of a mixture of cod-liver oil and lime water, as much for the sake of a dressing as for its food value. It is probable that the dysphagia will necessitate resort to rectal feeding, which should not be long postponed but carefully and systematically employed. If the dyspnea becomes too severe operative means must be resorted to. Scarification within the larynx is more talked about than performed. There is doubt about its doing good and danger of doing harm. Notwithstanding that much has been said against intubation—of its injuring the swollen and softened tissues—of the danger of making false passages, and of its futility in ultimately saving the life of the patient—it will probably be chosen, at least as a tentative measure, by surgeons familiar with it. Tracheotomy may be required later. If there be an extreme amount of dense swelling or of destruction of tissue, tracheotomy will be the choice in the first instance. The operation will be described in the Chapter on Aëroporotomy.

ACUTE SIMPLE LARYNGITIS, SPASMODIC LARYNGITIS, SYPHILITIC AND TUBERCULAR LARYNGITIS

It is seldom that mechanical interference is necessary in acute simple laryngitis or in spasmodic or false croup, yet the surgeon is occasionally called to such cases and should remember their existence. Their differentiation will appear in the diagnosis of diphtheria.

Syphilis of the larynx is frequent in infancy as one of the early symptoms of the hereditary disease, corresponding to the secondary manifestations of acquired syphilis. There are superficial lesions and hoarseness, but usually no stenosis. The more severe evidences of the tertiary stage are seldom found affecting the larynx in early life. When they do appear it is in older children, attacking the epiglottis, aryepiglottic folds, the posterior laryngeal walls, and vocal cords, presenting deep inflammation, ulceration, or condylomata. Or inflammation of the cartilages with great destruction may take place, producing obstruction to the passage of air during the inflammatory process or by contraction during healing.

Treatment.—Intubation is resorted to with great relief of the dyspnea, and giving much better results than tracheotomy. The tube may have to be used for weeks or months. Potassium iodide, iodide and mercury should be used early and energetically.

Tubercular Laryngitis should be borne in mind as a possibility in youth or adolescence. I have never seen a case requir-

ing surgical interference in infancy or childhood. Its general treatment is that of tuberculosis, which is also usually present in lungs, adjacent glands or elsewhere. Its local treatment is effective only against the common pyogenic organisms which aid the tubercle bacillus in its work of destruction. Such antiseptics and emollient agents as argyrol, eucalyptol, menthol, guiacol, creosote, iodoform, in aqueous mixtures or with albolene or liquid vaseline in various proportions, may be sprayed or injected with a suitable syringe into the larynx. Nitrate of silver, sulphate of zinc or other powerful astringents may be used upon the lesions by skilled hands.

TUMORS OF THE LARYNX

The tumors of the larnyx usually enumerated are papilloma, granuloma, fibroma, myxoma, chondroma, sarcoma, and epithelioma. The malignant growths might almost as well be omitted, as they almost never appear in children. All the others are extremely rare, excepting the first two, which deserve attention.

Papilloma is the commonest tumor of the larynx in childhood and is not infrequently met. It may be congenital or it may follow the irritation of one of the exanthems in older children, or come from no discoverable cause. It may be single or multiple, pedunculated or sessile; and situated anywhere between the epiglottis to below the vocal cords, usually upon the anterior half of the glottis, often at the commissure, but may be attached to any part. The symptoms are hoarseness of long standing, chronic cough, sometimes aphonia, and dyspnea which may be paroxysmal or continuous.

The laryngoscope should always be employed if the size of the fauces permit, even if local or general anesthesia is necessary, and may discover the pink or whitish warty-looking growths. Notwithstanding that the child may be quite docile, and trained to the examination, or cocaine or chloroform used, the small size of the parts and the abundant secretion of mucous may foil the examiner, and compel him to return to a consideration of the general symptoms for his diagnosis. Of these general symptoms spasmodic fits of dyspnea, as Holmes remarks, "Seem really to be the only diagnostic sign between tumor of the larynx and chronic laryngitis." Direct inspection by Kilian's method may succeed. Tracheotomy for exploratory purposes is justifiable. Prognosis is guarded.

Treatment.—Intubation might afford relief and cases of cure have been reported by its use. The most favorable cases for intubation are the subcordal, where the tube can exert pressure upon the growth. O'Dwyer's foreign body tube or his fenestrated tube may facilitate endo-laryngeal examination or endo-laryngeal treatment. In other cases the presence of the tube seems to irritate the neoplasm and hasten its growth. A single papilloma, and especially

if it be pedunculated, can be removed by the skillful use of endolaryngeal methods—forceps, or snare followed by chemical or electro cautery. But multiple and particularly sessile growths will probably require tracheotomy or thyrotomy. (See Chapter on Aëroporotomy.) On account of the liability of recurrence of the growths when removed by operation, some surgeons have preferred to limit the operative interference to a tracheotomy, the growths disappearing in the course of a few months to several years, when the larynx may be closed.

Granulomata of the Larynx are not so frequently met as formerly, when tracheotomy was more often practiced. They may occur from the irritation from the intubation tube, but such an occurrence must be extremely rare. If dyspnea result removal would be necessary. Following the withdrawal of a tracheotomy tube this can sometimes be done through the yet unclosed wound. Thoroughly removed and cauterized, there is less danger of recurrence than with papilloma. The same may be said of polypus, which has been reported under similar conditions.

FOREIGN BODIES IN THE LARYNX, TRACHEA OR BRONCHI

During sudden inspiration while laughing, crying, running, coughing, sneezing or eating or from fright, a foreign body is accidentally drawn or falls into the open windpipe. The foreign body may be any small article a child may have to play with or to eat, reported cases enumerating such objects as pins, beads, tacks, buttons, corn, peas, beans, fruit stones, nut kernels or shells, bits of eggshell or bone or gristle, a morsel of meat or bread crust, a lumbricoid worm wandered from the stomach, or a caseating gland burst through the trachea, or an intubation tube slipped down out of reach of the extractor. Such articles as ordinary sized coins, marbles, whistles, which have often been the cause of choking, have generally done so by sticking in the gullet, being too large to enter the larynx.

The foreign body may lodge at the rima glottidis, in the ventricle of the larynx, between the vocal cords, or pass on into the trachea, or into a bronchus, more often the right on account of its larger size and more direct line with the trachea. In any of these situations it may be loose or firmly held, and may cause more or less local damage or irritation according to the size and shape and substance of the foreign body.

The symptoms and results will also vary with the size, shape and substance of the offending body, and its point of lodgment. But in any event the patient is suddenly seized with violent cough and dyspnea, which are spasmodic and apt to be paroxysmal. Dyspnea may be so severe as to produce cyanosis, congestion of the vessels of the head and neck, lachrymation, distressing restlessness with

clutching at the air or at the mouth, profuse perspiration, exhaustion, collapse, convulsions or coma, and death. Or there may be periods of quiescence lasting a few minutes or a few hours, between the attacks of cough or dyspnea or of rapid respiration. There is suppressed or altered voice or whistling respiration. Or the symptoms change frequently, with a shifting of the position of the foreign body. Pain in the region of the windpipe or of the chest, or bloody-mucous expectoration may come on, or tenderness to external pressure over the front of the neck. Laryngitis, tracheitis, bronchitis, or pneumonia may develop.

If the foreign body become impacted in a bronchus, collapse of a corresponding portion of lung will likely follow. Atelectasis, abscess, septicemia, gangrene, hemorrhage, pleurisy, pneumo-thorax are all possible results. The foreign body may be spontaneously expelled in a paroxysm of coughing early in the case, or with much mucus, pus and blood even after abscess has formed, and recovery may follow.

Diagnosis.—Where there is a clear history of a child having in its mouth or of its playing with some article which has since disappeared synchronously with the sudden onset of typical symptoms and signs, the diagnosis is extremely easy. But he who asserts that the diagnosis of foreign body in the air passages of children is always easily or even readily made has had little experience. It can be extremely difficult and in some cases impossible. Besides a careful inquiry into the history, which should not be too much relied upon, and a close observation of the symptoms, ausculation over the windpipe and lungs, and percussion of the chest may be useful. The whistling of the air in passing the obstruction may fortunately be distinctly located, or the rattling of a loose body up and down the trachea may be unmistakable; or if the body completely occlude a bronchus a portion of lung will be silent. When the body is loose in the trachea the intervals between the spasmodic attacks of coughing and dyspnea are longer than when it is within the larynx. When lodged in a bronchus the cough is less spasmodic than when in the trachea and there may be, though not always, pain in the chest.

Digital examination should be made of the epiglottis and pharynx. Laryngoscopy should be patiently tried with local or even general anesthesia. As a matter of fact it seldom succeeds where other methods have failed. Diagnosis by direct inspection of the larynx, trachea and bronchi by the method of Killian, will likewise be referred to under treatment.

Radiography promises much in these cases, and, when the foreign body is sufficiently impenetrable to the X-ray, is of great service.

Prognosis.—Prognosis is always doubtful. This is a serious accident and the result is uncertain. Each case must be judged on its own features. Much depends on the size of the foreign body, the completeness of the occlusion its causes, its shape and surface, its consistency and its point of lodgment. If not of a shape to lacerate surrounding structures, if not of a size to obstruct the air supply to a fatal degree, if lodged high and seen early before inflammation, the prognosis is better than under opposite conditions. If loose in the trachea it is better than if lodged in a bronchus. A small, smooth, impervious object will be less dangerous than one which will absorb moisture and swell without dissolving or disintegrating. Bones or other articles which either lacerate the tissue or convey infection, or do both, are especially dangerous. A foreign body may be removed and leave behind a septic inflammation which may prove fatal, especially if it have extended to cellular tissues. As a rule, once the foreign body is removed, recovery follows, sometimes even in conditions apparently desperate. It may lodge for a time where no symptoms are produced, and then change its position and cause suffocation or occlude a bronchus or cause pressure and ulceration. There is no safety until removal is effected.

I shall never forget my first case of foreign body in the larynx. A girl of six years thought she had drawn into her larynx a piece of hickory-nut kernel. She was brought from the country to my clinic at the dispensary. There was partial aphonia and dyspnea, but it was quite moderate. I placed her in hospital, intending to operate. But a distinguished throat specialist and the senior surgeon, both my superiors on the staff, examined her and advised against operation. The laryngologist, on several occasions, on several days, inspected her larynx and attempted to remove the foreign body with laryngeal forceps. On the fourth day the foreign body shifted its position and dyspnea became extreme. The house doctor hastily summoned aid. I was first to arrive, and in a minute had opened the larynx and extracted the nut kernel, and the girl breathed easily. But it was her last breath. She was exhausted. Timely operation would have saved that child.

Treatment.—If an adult is at hand when the accident happens, a finger passed into the throat may hook out or push away a foreign body caught beneath or pressing upon the epiglottis; or by inverting and shaking the patient or slapping him forcibly upon the thorax it may be expelled even from the larynx or lower in the air passage. If, in spite of these efforts, immediate suffocation threatens, the windpipe must be opened at once, a cricolaryngotomy or cricotracheotomy being most advisable in such an emergency. If the symptoms are not so urgent, the patient getting, even with some effort, enough air for oxygenation, or if after a paroxysm of coughing and

dyspnea a period of quiescence takes place, preparations for thorough examination and for operation should be made before the patient is disturbed by any manipulation, change of position, or medication. It is true that a repetition of the inversion and slapping or shaking, or the exhibition of an emetic, as a hypodermic of apomorphia, or a dose of turpeth mineral or of ipecac, might dislodge and expel the foreign body; but it might, instead, cause it to change its position to some point producing such prompt suffocation that instant operative interference would be demanded. After preparation for an emergency the inversion or the emetic may be tried. If unsuccessful it becomes necessary to decide upon operative procedure, either by an endolaryngeal or an external method. Intubation with the ordinary tubes is not applicable to this class of cases. O'Dwyer's foreign body tube (Fig. 174), short and with wide lumen, may be introduced by one familiar with intubation. By holding open the larynx it may facilitate the expulsion during coughing or the removal by laryngeal forceps of any body not too large for the lumen of the tube. But a foreign body in the larynx may be pushed farther down by the introduction of the tube, or, if it be quite small and lodged in the ventricle, may be imprisoned there by the tube.

The laryngoscopic mirror and forceps and snares of various forms have long been employed, and in fortunate cases will succeed. The difficulty of using them, especially in infants and small children, with the diminutive anatomy and the swelling and the mucous secretion that are often present in these cases, bar many general surgeons from their use; while often the specialist in laryngology is inclined to regard this method of endolaryngeal work as the ultimate resource of justifiable surgical art. The direct, or Killian's method, has the advantage in the hands of one skilled in its technique, but is liable to do a great deal more harm in the hands of the unskillful, and, like the laryngoscopic procedures, is too often baffled by the small size of the parts and the abundant flow of mucus, which obscures the view and prevents effective work. If the proper instruments are to be had and the surgeon is familiar with their use, endolaryngeal methods should be tried first.

I believe that bronchoscopy by Killian's or Jackson's or similar instruments will come into greater prominence in the near future. Foreign bodies can be removed even from children and infants by this method. Upper tracheoscopy and bronchoscopy is described substantially as follows, by Jackson: Local or general anesthesia may be used even in children, but chloroform is used unless there is a positive contra-indication. The patient is placed horizontally in the dorsal position, with the head extending over the end of the table and supported in extreme extension by an assistant. A double bronchoscope battery is used, one cord being attached to the sep-

arable speculum and the other to the bronchoscope. The operator slides the separable speculum down over the dorsum of the tongue until the epiglottis comes into view. Then the epiglottis and all the tissues attached to the hyoid bone are lifted strongly with the point of the separable speculum, not using the upper teeth as a fulcrum. When the separable speculum is in a position with its axis corresponding exactly with that of the trachea, the depths of the latter are seen below the vocal cords. The bronchoscope is now introduced through the separable speculum until the tube mouth is near, but does not touch the cords. The respiratory movements of the cords are watched, and during an inspiration the bronchoscope is pushed through into the trachea. The gag is then inserted and the separable speculum is removed, leaving the bronchoscope in position in the trachea. No difficulty is encountered unless the larynx is abnormally contracted or the neck is made rigid by adhesions following the wearing of a tracheotomy canula. If there is bilateral abductor paralysis, so that the cords will not separate, it is necessary to push the bronchoscope between them. In such cases it may be easier to pass the bronchoscope with the obturator in place, as this prevents abrasion of the mucosa or catching the tube-mouth upon the arytenoids.

If endolaryngeal methods fail there yet remain extra-laryngeal operations, and in the present state of knowledge and practice it is probable that an extra-laryngeal operation would be chosen by the majority of surgeons throughout the country. Among these one may choose thyrotomy, cricothyrotomy, cricotracheotomy, or tracheotomy below the isthmus. For a discussion of operations and their technique the reader is referred to the Chapter on Aëroporotomy.

As to the choice between supra- and infra-isthmian operation in a case of foreign body, the precise location of which in the air tubes had not been ascertained, my decision would be in favor of opening above the isthmus. This opening would include the cricoid cartilage and several rings of the trachea, an opening large enough for the exit of the body. Power advises that the opening be made below the isthmus. This might be well in a large, lean child, or if the body were lodged in a bronchus or at the bifurcation. But if its whereabouts be undetermined the lower opening is farther away from the possible location of the body in the larynx. In the young or fat, short-necked child the greater difficulty of the infra-isthmian operation is not to be courted unless there is to be an advantage gained by so doing. The incision in the windpipe should be held open by sutures either attaching it to the skin or tied together behind the neck.

If the foreign body is not found in the opening, by lowering the patient's shoulders and head while he lies prone and inducing

cough, it may be expelled. Failing in this, a probe, or better, something larger, like a catheter, as Holmes suggests, should be passed upward through the larynx and so may dislodge it into the throat. A finger in the mouth at the same time should ascertain whether it passes, as it might be swallowed. If the body is discovered in the larynx, but cannot be thrust out or extracted with forceps, the incision must be extended upward between the alæ of the thyroid cartilage, thus exposing all within the larynx. The body being then removed the halves of the cartilage should be carefully reunited by sutures. If there is much inflammation a tracheotomy tube had best be introduced and retained for a few days or until the laryngitis subsides. If the body is not encountered in the larynx a laryngeal mirror or a Killian's or Jackson's tube may discover it below the opening in the trachea or a bronchus, whence it may be removed by forceps. If these instruments are not to be had a somewhat flexible probe, a loop of "stiffish copper wire bent near the closed end should be passed down" (Owen), hoping to snare and withdraw the substance.

If the body cannot be removed the wound should be held open by the sutures, dressed with a covering of several layers of gauze, and the child be kept a good part of the time lying prone so that the discharges and perchance the foreign body may find exit. In this as in all cases of external aëroporotomy the air of the room should be moistened and maintained warm and equable. At the daily visits of the surgeon, if the condition of the child and of the wound permit, efforts to locate or to remove the foreign body may be renewed. Inversion of the patient during the attacks of coughing excited by the dressing may aid the expulsion, as illustrated by one of my cases. A child of less than two years, while playing with shelled corn, was attacked suddenly with violent proxysmal coughing which gradually subsided. During the occasional fits of coughing a foreign body was heard to rattle in the trachea. But on tracheotomy I could not find it, and all efforts failed to dislodge it. I held the tracheal wound open by a suture at each side, tied around the neck, and left two of my students to watch the case. At my third visit, on inverting the patient during a fit of coughing and giving him a slap on the back, the kernel of corn was dislodged, came into the tracheal wound and was instantly removed.

MEMBRANOUS LARYNGITIS (MEMBRANOUS CROUP: DIPHTHERITIC CROUP: TRUE CROUP)

Innumerable essays have been written and discussions held in times past upon the questions of the identity of membranous croup and diphtheria, and upon the "constitutional" or "local" nature of the disease or diseases. The discovery, in 1884, of a small non-

motile, slightly curved bacillus with one large end, which have come to be so well known by the names of Loeffler and of Klebs, and the subsequent labors of Roux and Yersin, and of Sidney Martin and others, have solved a great many of the problems before so puzzling. We know that the two diseases are identical in origin and that although at first local, ferments and toxines resulting from the local disease profoundly affect the blood, the nerves and certain internal organs. (See Section on Diphtheria.) We are aware that organisms other than the diphtheria bacillus, usually a streptococcus, and even inflammations resulting from scalds or chemical burns, especially when following another specific infection, are capable of producing one of the peculiar features of diphtheritic laryngitis—the false membrane. Yet clinical as well as bacteriological experience has taught us that it is best to consider all membranous inflammations of the larynx diphtheria, until they are proven to be something else. The pathology and the lesions of diphtheria have been discussed under another section. It remains to be said, however, that the situation of the local lesion has much to do with the resultant remote or constitutional effects. Membranous diphtheria does not present the enlargement of the lymph-nodes, the profound toxemia, the soft pulse, albuminuria, the degenerations of blood, of heart muscle, kidneys, nerves, and other structures that accompany the pharyngeal or naso-pharyngeal form of diphtheria. For the absorbents of the laryngeal mucous lining are less numerous and active than those of the larynx, or the mechanical obstruction to respiration may kill the patient before the toxines have had time to be developed and absorbed. It is this mechanical obstruction or stenosis occasioned by the localization of the disease in the air passage that makes diphtheritic laryngitis one of the most important surgical ailments of childhood.

Symptoms.—The onset is usually less abrupt, more indefinite and milder than that of catarrhal or false croup, which otherwise it much resembles. Slight stridor, hoarseness, cough, moderate fever, excited manner and a quickened pulse—these are the apparently insignificant symptoms. There is only one characteristic that might arouse suspicion on the first or even the second day of the disease, even if the child had been previously quite well, namely, the steady and persistent progress of the symptoms. By the second, or at most the third or fourth day, the hoarseness merges into suppression of the voice, the slight stridor becomes more hissing and is accompanied by dyspnea, the excitement has become restlessness, the degree or two of fever has increased to three or four, and this has gone on regardless of treatment that would relieve ordinary croup. Even an emetic produces only temporary change, if any. The disease goes right on. The voice is usually entirely

suppressed. The dyspnea becomes extreme. Expiration as well as inspiration are forced, hissing and prolonged. At each inspiration there is a deep recession above the sternum and clavicles and at the epigastrium, all the accessory muscles of respiration being required to force the air in and out through the narrowed larynx. The skin is covered with perspiration. The restlessness has now become anxiety, or even terror. The child tosses about and turns in every direction for more air, and by looks and actions appeals to those about for help. The heart for a time labors violently. The lips and finger-tips may be cyanotic. As the heart weakens and as the blood collects in the chest, there may be pallor instead of cyanosis. Stupor supervenes, and finally coma, sometimes convulsions, and death. Occasionally the temperature runs up rapidly in the last few hours of life similarly to the fever of the convulsive state, reaching 105 or 106 degrees F. At any stage of the disease attacks of spasmodic dyspnea may be added to the continuous difficulty of respiration. Or suddenly increased obstruction or heart failure may terminate the life quite unexpectedly. This is particularly true of croup following pharyngeal or nasal diphtheria. The whole course will vary from thirty-six or forty-eight hours to a week. As a rule the younger the patient the sooner he will succumb. The great majority of the cases of all ages to which I have been summoned in consultation, have been on the fourth or fifth day of the disease. And more of my intubations for desperate laryngeal stenosis, for which the attending physician had usually exhausted medical resources, were made on the fifth day of the disease than on any other day. In some cases the disease extends rapidly to the bronchi or lungs before the larynx becomes occluded. The foregoing is a picture of the ordinary course of the disease when untreated. Under treatment, and in come cases without treatment, the pseudomembrane becomes detached, and is coughed out, in patches of the size of a finger-nail or larger, or in casts of the larynx and trachea; and rarely, in casts of larynx, trachea, and bronchiæ. Fig. 171 shows the most complete one I have ever had from a live patient. The patient from whom this membrane came during intubation, finally died; but the ejection of the false membrane often clears the larynx and proves the point of turning toward recovery; or the membrane may form again.

Prognosis.—There is probably no disease, unless it is smallpox, in which one generation has been permitted to witness such a great change in the prognosis. In my own earlier experience, previous to O'Dwyer's splendid achievement, cases of diphtheritic croup nearly all died. We could save a few of them by sustaining treatment, the heroic use of mercury, stimulants, the doubtful aid of the rest of the pharmacopea, and an occasional laryngo-tracheotomy. But the

mortality was probably 80 or 90 per cent. Parents would seldom consent to tracheotomy because it is a cutting operation and the surgeon could not promise certain recovery as a result. After we had intubation, with that and mercury (besides whisky, iron, chloral, strychnine, lime-steam, antiseptic vapors and the rest), I could save about one-third of my desperate cases, which otherwise would almost certainly have died. Since the advent of antitoxin, with operative measures and good management, the figures are reversed and one looks for the recovery of 80 or 90 per cent. of his personal and consultation cases.

Diagnosis.—The diagnosis is usually not difficult. Merely looking at a patient and listening to the sound of his labored breathing would not inform the observer what form of dyspnea he had met. If he noted the suppressed voice he would locate the trouble in the larynx. But it might be chronic laryngitis, or tumor or foreign body. The history would exclude all these. Foreign body would have a history of sudden onset and the others of chronic course, and none of them have fever. Spasmodic or catarrhal croup is hoarse but not voiceless; expiration is usually easier than inspiration, and it is apt to come suddenly and not to grow worse persistently when treated. Retro-pharyngeal abscess does not usually suppress the voice, but it alters its tone to a hollow or quacking sound; and the abscess swelling may be found on inspection or palpation; and it has a history of a week or two. Membranous laryngitis does not invariably suppress the voice. The breathing of capillary bronchitis or broncho-pneumonia more nearly than any other disease resembles that of true croup. But there is not the recession above and below the thorax, nor the laryngeal

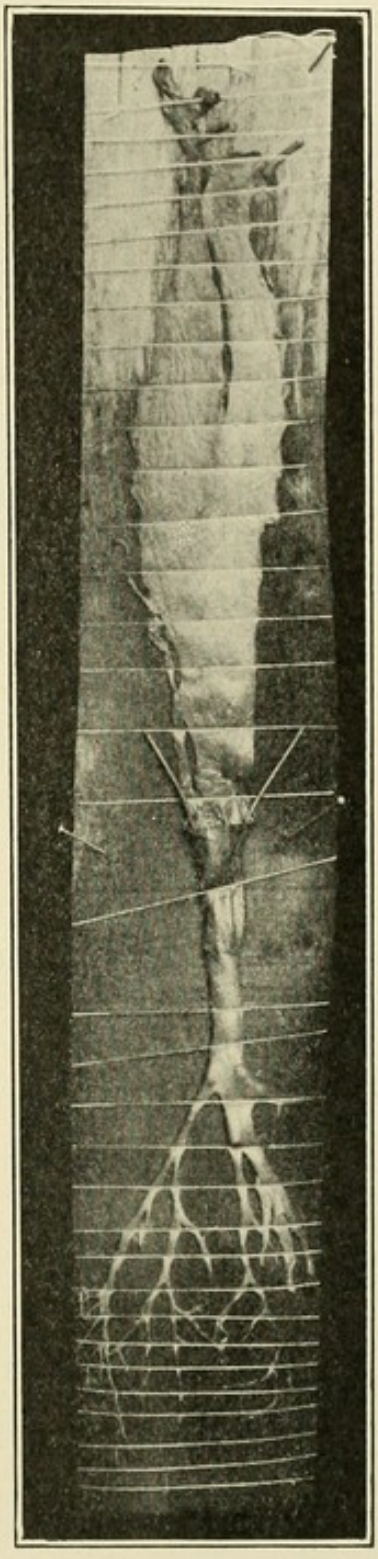


FIG. 171. SPECIMEN OF DIPHTHERITIC MEMBRANE coughed out during intubation.

stridor, and the physical signs can be found in the chest. A diagnosis of diphtheritic laryngitis is made if the illness is of two or three days' duration with severe, persistent and increasing dyspnea and suppressed voice.

Treatment.—The patient, if under two years, should have from 2000 to 5000 units of antitoxin. If in twelve hours no improvement or insufficient improvement has occurred, another dose of 5000 may be given. If the patient is over two years, 4000 to 7000 units may be given at first, or if the case is severe, 8000 or 10,000 units. When antitoxin was first introduced, and for some time thereafter, we got the same effect from 2000 units that we now get from 4000. After a time the manufacturers apparently measured the dose more strictly or changed the serum, for we found it necessary to give more units. By this time the innocuousness of the serum had been demonstrated, and some enthusiastic users of antitoxin advocated enormous doses, even scores of thousands of units. I have never found that necessary, or useful. If a proper dose is given at first, it is not necessary to repeat it in six to eight hours. Often a period of twelve to fourteen hours is required before effects are manifested. I believe that when a second dose is given in six hours the effects noticed six hours afterward are those of the first dose. The rule should be to give an adequate dose early, so that it need not be repeated. The age of the child should receive some consideration in measuring the dose, but the main thing to be considered is the severity of the attack. Mild cases at any age will get well if 3000 to 5000 units or less are given early in the disease. A second dose will not be necessary. Most cases of diphtheria get well with 4000 to 8000 or 10,000 units. It is very exceptional that 12,000 or 15,000 units is necessary. Those cases that are said to require 30,000 and 50,000 and 70,000 units are not pure diphtheria. One need not deny that the large doses of serum are of any benefit in such cases. But their effect may be rather as serum than as diphtheria antitoxin. Injections of normal salt solution also benefit many cases, of various kinds. "Early" in the disease means on the first day that a clinical diagnosis can be made. The bacteriological diagnosis should be made but not be waited for before giving the antitoxin.

In the absence of antitoxin, there is no remedy equal to mercury. One has often given a child of five or six years a grain of calomel or gray powder every hour until twenty or thirty doses were taken. Dover's powder sufficient to control excessive action of the bowels was used in conjunction. The latter also relieved the breathing and promoted the loosening of the membrane. Other sedative or stimulating expectorants were used. A better way to use mercury in diphtherial laryngitis is by sublimation as introduced by Corbin. The apparatus is as simple as possible. A tent is made

over the bed. Under the tent a spirit lamp is placed in the bottom of a vessel. A strip of tin or sheet iron is laid across the top of the vessel just above the flame of the lamp. A dose of five to ten grains of calomel is placed upon the sheet of metal and sublimed. This dose is repeated every two hours for the first two days and nights; or in urgent cases the intervals may be shortened to a half hour for four or five times. Or a smaller quantity may be used at short intervals. On the third day the intervals are prolonged. (Rotch, Morse and many others.)

The mouth should be washed after each dose. It is surprising how much mercury a diphtheria patient will take with marked benefit and no bad symptom. Nurse or parent remaining under the tent would be salivated. When antitoxin is used mercury in heroic doses is neither necessary nor so well tolerated. Mercury was the best, in fact the only valuable remedy we had, before antitoxin. The nutrition of the patient should be well kept up by careful feeding of easily assimilated foods. Stimulants, of which some form of alcohol is best, should be used as needed; though the enormous amounts of alcohol that can be taken with benefit by a child with pharyngeal diphtheria are not needed in the laryngeal form. Strychnia is a good stimulant in these cases; also camphor (in oil hypodermatically) and carbonate of ammonia. Oxygen is a great help if it can be procured for use until the intubator comes. Emetics in laryngeal diphtheria have been abused. Occasionally they give temporary relief, and sometimes, when the membranes have loosened, they are cast off in the act of vomiting. But the repeated use of emetics does no good, but a great deal of harm by exhausting the patient and disordering his stomach.

Inhalation of steam, steam from slaking lime, or other alkaline vapors, while they have no appreciable effect in dissolving the membrane, render the air more agreeable to the air passage and by this soothing effect lessen the tendency to spasmodic dyspnea. Moisture prevents drying of the secretions and parching of the mucous linings caused by the rapid breathing of the feverish patient. The old formula of J. Lewis Smith was composed of an ounce each of carbolic acid and eucalyptol with turpentine to make a pint. Of this a tablespoonful in a pint of water is kept simmering. It is usually grateful to the patient and has some value as an antiseptic; not probably having any power against the Klebs-Loeffler bacillus, but against other organisms apt to be present in mixed infections. The formula is improved both in quality and odor by adding a drachm of oil of cinnamon or a drachm of menthol or both. But nothing should be allowed to attract our attention away from antitoxin and aëroporotomy. Other treatment is useful in cases of mixed infection. The digestive ferments and all so-called solvents of false mem-

branes are useless. The naso-pharynx should be kept clean and clear by irrigation with warm normal salt solutions or borax and bicarbonate of soda solutions of equal strength, or boric acid five per cent., or any other mild antiseptic wash. A spray may be used in selected cases, but is not as efficient as irrigation. Some children can gargle with advantage. Irrigation, sprays and gargles are usually discontinued if the case is intubated. But mild ones may be used with the child recumbent. Certainly no astringent, or any coagulating solution like hydrogen peroxide should be used in the presence of an intubation tube for fear of causing an obstruction. Exteral applications have no effect upon the diphtheritic process, but cold, applied with the ice-collar, may limit inflammation; and in glandular enlargements with cellulitis, due to streptococcus infection, which sometimes complicates diphtheria, the following prescription or something like it (Park) may be applied: Resorcin (or naphthaline), 5; ichthyol, 5; mercurial ointment, 40; lanolin, 50. The skin is anointed with this and covered with oil silk and a light bandage.

Indications for Aeroporotomy.—The rules usually given for deciding when it is necessary to resort to some operation to let more air into the lungs are as follows: When the dyspnea increases or continues in spite of other measures for its relief. When the accessory muscles of respiration are at work, and the soft parts above and below the thorax recede on inspiration. When the vesicular murmur cannot be detected in the bases of the lungs, etc., etc. As a matter of fact the laryngeal stridor is often so noisy that one can hear nothing else. When the temperature begins to run high. Some would advise to defer until cyanosis threatens carbonic acid poisoning. But every man with experience knows that cases often die without cyanosis; or that cyanosis may be so closely followed by death that there is no time to summon aid or to operate. There is really only one rule for deciding when to operate. Mr. Owen has well stated it in his indication for tracheotomy: "When an insufficient amount of air is entering the lungs." Why physicians will wait, and wait, allowing a child to suffer and struggle for air, while the lungs are becoming engorged and the heart exhausted, when relief is so easily employed and so prompt in its effects, is hard to understand. Yet one has often been summoned at the eleventh hour after a physician had been in attendance two or three days, and found the patient moribund; and in several cases found the patient had ceased to breathe and was thought dead by the friends, and even by the physician. But prompt operation and artificial respiration sometimes saved him. It is criminal to delay and incur such chances. If medical means have been employed and still "an insufficient amount of air is entering the lungs" it is time for operative measures.

AËROPOROTOMY

Aëroporotomy includes all the operations for opening the air passage. (Kelley, Cleve. Med. Gazette, May, 1896.)

It is most frequently demanded for the stenosis caused by laryngeal diphtheria, yet tumors of the larynx, edema of the larynx from various causes, or foreign bodies in the air passage, or bloody operations of the mouth or throat or larynx, may call for aëroporotomy in one of its varieties, and the surgeon must decide which of several procedures is best adapted to meet the condition. Aëroporotomy is either internal or external. The internal operation consists in intubation of the larynx. The external is either supra-isthmian or infra-isthmian, that is, either above or below the isthmus of the thyroid gland. The supra-isthmian operation (sometimes called the "superior" operation), or supra-glandular, may be a laryngotomy, in which only the larynx is opened; or it may be a laryngo-tracheotomy (Bayer), often called a crico-tracheotomy (Hueter), in which the cricoid cartilage and the first two or three rings of the trachea are divided. The infra-isthmian operation (called by some the "inferior" or infra-glandular operation) is a tracheotomy. Each of these operations will be described and its special adaptations pointed out.

INTUBATION.—Doubtless many practitioners had, like the writer, acting upon the impulse to afford at least temporary relief, catheterized the larynx of the child suffocating with diphtheritic laryngeal stenosis, before we had any knowledge of intubation as it is understood and practiced to-day. But Bouchut of Paris, in 1858, conceived the idea of introducing a metallic tube which should be left in position in the larynx and through which the patient might breathe. The tube of Bouchut was like a small open-end thimble placed in the top of the larynx. The tube had a silk thread attached which was brought out at the corner of the mouth, and by which the tube could subsequently be removed. Bouchut published seven cases in which he had employed his tubage in laryngeal diphtheria, with relief of the dyspnea. The Paris Academy of Medicine appointed a committee, of which Trousseau was chairman, to investigate the new operation. Trousseau, who had revived and popularized tracheotomy, was at the height of his influence; and this new procedure, which was proposed to substitute tracheotomy, was pronounced impracticable, and therefore unjustifiable. This prevented Bouchut from continuing his experimental labors and probably deprived French surgery of the honor of presenting to the profession and to the world a new and successful life-saving operation. This honor was reserved for America. In 1880 Dr. Joseph O'Dwyer began his experimental study of the problem. He studied the anatomy of the larynx and the pathological anatomy of the disease at

the New York Foundling Asylum. He was gifted with a talent for patient investigation and with mechanical ingenuity, and when he had perfected his instruments and his operation he had remarkable results. He presented them to a profession far more receptive and progressive than the French Academy of fifty years ago. Intubation became rapidly established in the United States, thousands of successful cases being reported within a few years of its introduction. It is probable that history affords no example of an equally valuable surgical procedure with the necessary instruments for performing it, being so nearly perfected by one man, and of its being so quickly recognized and rapidly adopted by an appreciative profession. It is also probable that no other operation in a given length of time has indisputably saved so many lives. In Europe intubation won its way far more slowly and even yet is not employed nearly so often as with us. But there can be no doubt in the minds of those acquainted with both external operations and intubation in laryngeal diphtheria what the final verdict of the profession over the whole world will be. Intubation will be the primary operation of universal choice in all but a comparatively few cases in which a mass of membrane is located too low for the intubation tube, or in which for some unusual reason it is impossible to introduce the tube. In comparing intubation and tracheotomy it may be said that neither operation precludes the other; and that either may possibly require the other in the sequellæ which occasionally follow.

The advantages of intubation over laryngo-tracheotomy are these: The consent of the parents to operation can usually be obtained because there is no cutting. Intubation relieves the dyspnea quite as certainly and completely when the larynx is the seat of the stenosis as does tracheotomy.

The operation involves no danger from hemorrhage and comparatively none from shock.

No anesthetic is necessary, therefore that danger is avoided; and also no anesthetist is required.

No skilled assistant is required.

The inspired air passes through the natural channels and is thereby warmed and moistened.

The air current ventilates the posterior nares, which otherwise become more foul and poisonous.

The patient can cough more forcibly and expel tenacious mucus better than through a much larger tracheal wound.

There is no wound to become infected by diphtheritic or pyogenic organisms. There is no danger of emphysema of cellular tissues; and no scar.

The after-care is very simple, requiring no trained attendant.

There is less likelihood of difficulty in dispensing with the intubation tube than with the tracheotomy tube.

The disadvantages of intubation are: There is a possible danger of pushing loose membrane before the tube and thus blocking the air passage; or of passing the tube between the false membrane and the wall of the windpipe. Either of these accidents may happen also in tracheotomy.

Sudden inhibition of respiration from irritation through the recurrent laryngeal nerve. This is theoretically correct, but very seldom occurs in practice.

The tube may become occluded suddenly by a piece of mem-

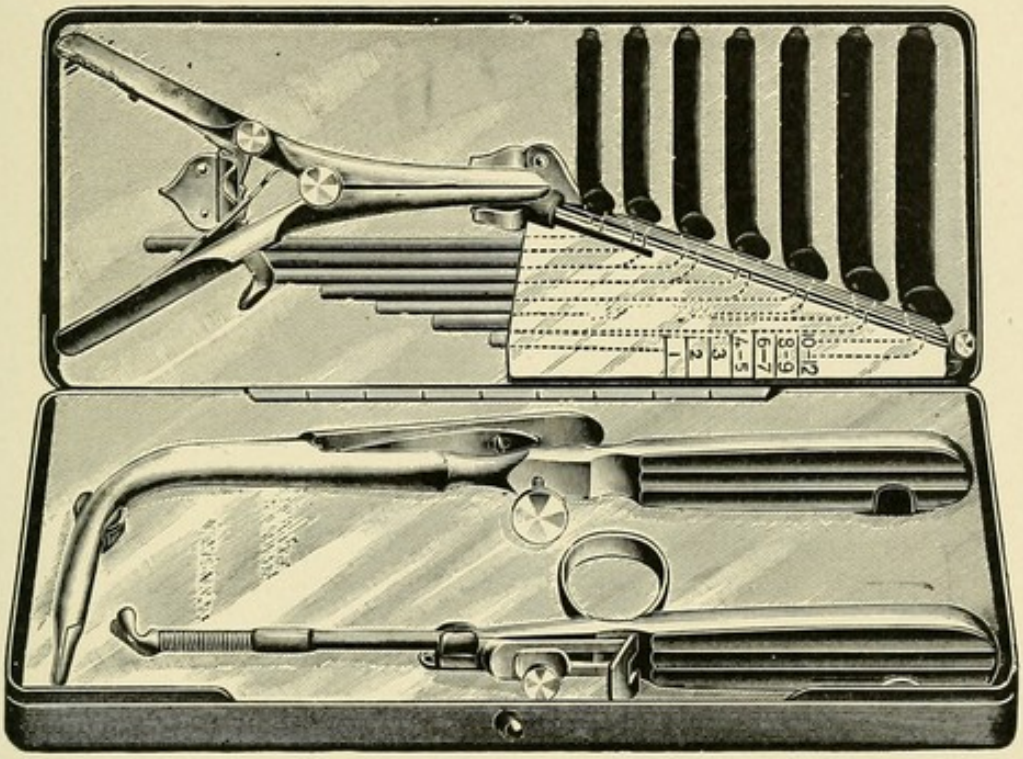


FIG. 172. SET OF O'DWYER'S INTUBATION INSTRUMENTS. Mouth gag, tubes graduated sizes, gauge, obturators, introducer, and extractor.

brane or by tough mucus, and suffocate the patient, or it may require that the tube be removed and cleared. The same thing may happen with a tracheotomy tube.

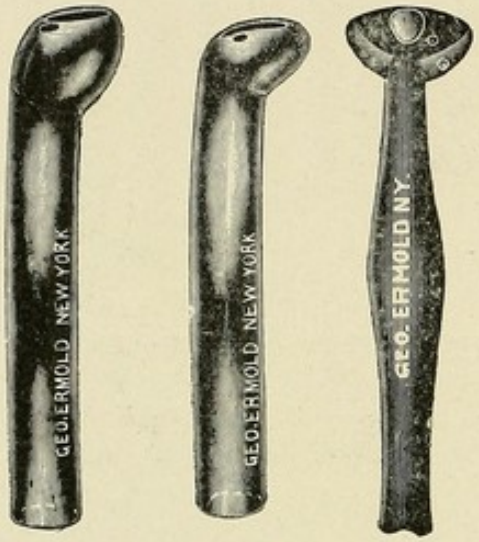
The trachea may be obstructed by false membrane below the reach of the intubation tube.

The advantages of the external operation are: It opens the air passage at a lower point and may thereby clear a lower obstruction.

It allows the removal of loose membranes within reach of the opening.

Notwithstanding that innumerable efforts have been made by many different men to improve O'Dwyer's instruments, and numerous modifications have been introduced, they are still accepted as the

best models by the majority of experienced operators. The instruments consist of a set of six tubes ranging in length from 1 9-16 inches to 2 11-16 inches and thick in proportion, designed to fit a child of any age from one year or less up to puberty. The tubes are shown in Fig. 172. They were formerly made of metal; but that plan was discarded in favor of hard rubber, metal-lined. This does not become encrusted with lime-salts like the metal, and is lighter. The opening through the tube is oval in form, being longest antero posteriorly. The upper and lower portions of the shaft of the tube are of the same oval shape, but enlarge toward the center of the tube, which is almost cylindrical. The large head at the top of the tube is somewhat quadrangular, one angle projecting posteriorly, so that when placed in the larynx it rests between the arytenoid cartilages. The anterior angle is beveled off, so that the epiglottis can better descend over the top of the tube. The head of the tube is well rounded beneath, to rest upon the inferior ventricular bands. The neck just below the head is quite narrow laterally where it passes between the true vocal cords, while the bulging center of the shaft being below the cords aids in holding the tube in position during coughing. The lower end of the tube, especially its anterior edge, has a thickish rounded edge to avoid abrasion of the mucous lining, not only in the act of introducing the tube, but in its rising and falling at every act of deglutition. Through one margin of the head of the tube is a small hole or eyelet. Through this hole a braided silk thread is passed, and, its ends being tied together, forms a loop by which the tube could be recovered, if by chance the operator were to pass the tube into the esophagus instead of the larynx, or by which the tube could be instantly withdrawn if obstruction follow its introduction. Tubes are sometimes "built up" for granulation tissue (Fig. 173, i., ii., and iii.), and are useful in cases of prolonged intubation. There is also a foreign body tube, short and with wide lumen. (Fig. 174.)



i. ii. iii.

FIG. 173. "BUILT UP" TUBES USEFUL FOR GRANULATION TISSUE, and in cases of retained tube.

The introducing instrument is seen in Fig. 175. It consists of a handle to which is attached a shaft and obturator of a size to fit

each tube. The obturator fits the lumen of the tube and plugs its lower opening with a bulbous, rounded end. It is just tightly enough engaged in the tube to retain the latter until it is detached by a push of the thumb upon the button placed on the upper side of the handle.

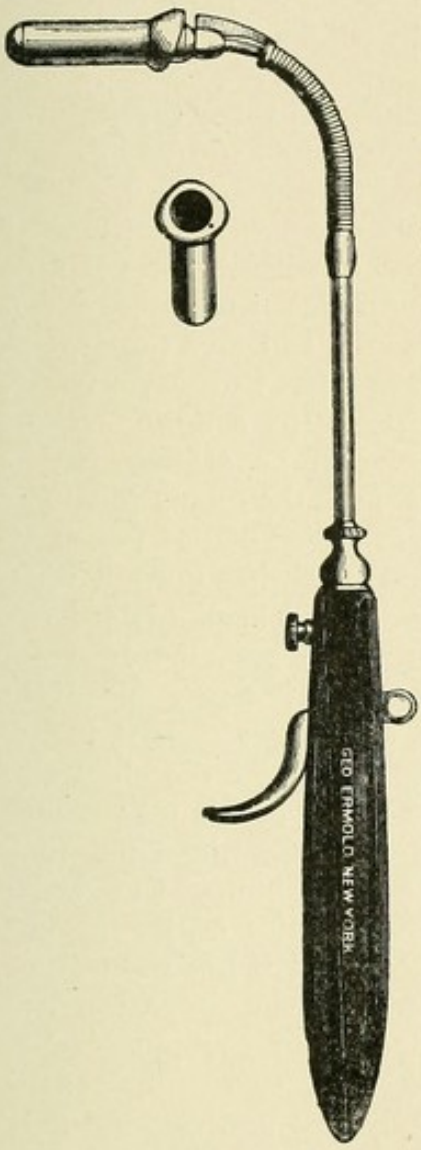


FIG. 174. FOREIGN-BODY TUBE, AND INTRODUCER.

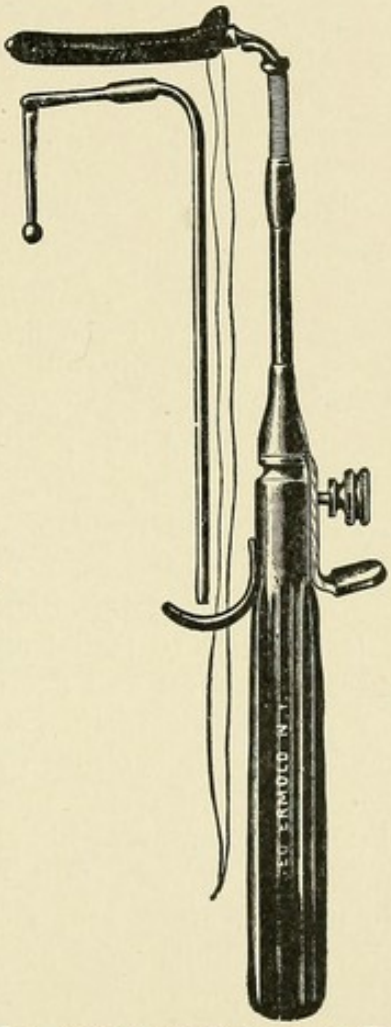


FIG. 175. INTRODUCER WITH TUBE, threaded. An obturator, detached.

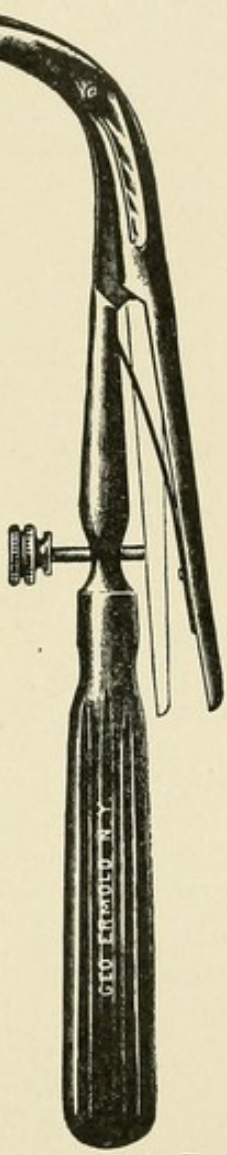


FIG. 176. THE EXTRACTOR.

The extractor (Fig. 176) is a handle having a shaft curved at right angles like the introducer with the obturator. At the lower extremity of the curved portion are two small beak-like blades, which are made to separate by thumb pressure on a lever at the handle. The beaks are introduced closed into the top of the opening in the tube, and when expanded they impinge on its interior strongly enough to withdraw the tube from the larynx.

The mouth gag is shown in Fig. 177. The metal ring recom-

mended by some instead of a mouth gag, designed to be worn on the operator's left index finger to prevent the patient from biting, is both unsafe and inconvenient.

The gauge has marks showing the size of the tube for the given age of the child. The operator should use judgment in selecting the tube according to the child's size and development as well as his age.

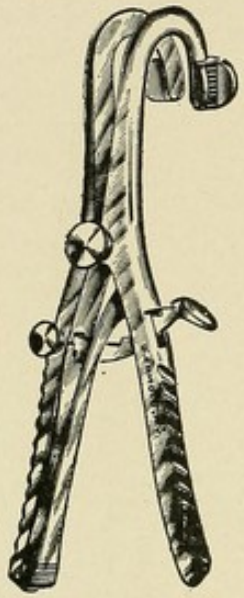


Fig. 177. Mouth gag.

Braided silk, of a size to run easily through the eyelet in the head of the tube should be at hand. About eighteen inches of thread makes one loop.

Introduction of the Tube.—The instruments should be laid within reach, with the proper tube selected and threaded and placed upon the introducer. It is well to warm and wet the instruments by dipping them in a bowl of warm water, before using. A half dozen or a dozen bits of gauze or old muslin should be at hand to be used as handkerchiefs and then burned. The patient may be placed in either one of two positions. The first position is sitting upright upon the lap of the nurse with his back toward her left shoulder. His arms are crossed in front of his abdomen. The nurse clasps his right wrist in her left hand and his left wrist in her right. And she is told not to lean back, not to let the child slip down, not to squeeze his chest and not to let go of his wrists until further orders. I prefer this method to swathing the child in a blanket or sheet, which is almost sure to become bunched up under his chin, where it gets in the way of the handles of the instruments; or if tight it will compress his chest, and if not tight allow him to get a hand free. An assistant (any intelligent person will do, but a physician is preferred) stands behind the nurse's left shoulder and holds the child's head between his two palms He is told to hold the head straight with the body and vertical, and keep the gag back between the teeth with his left index, and keep his thumb off the trigger of the gag. These points are explained to nurse and assistant before any attempt is made to use the gag, as the child is usually docile up to that point. A child who has no teeth or only front teeth needs no gag. The operator's finger is kept well in the right side of the mouth. All being in readiness the child is encouraged and reassured, if he be old enough to understand; the gag is placed in position, the introducer with the tube is picked up and held lightly in the fingers, the loop of silk caught with the little finger. The directions one usually reads are to pass the left index finger back into the throat and hook up the epiglot-

tis, then pass the tube in along the finger as a guide and introduce it into the larynx. A better way is to merely touch the base of the tongue with the left index and as the larynx rises and opens place the end of the tube in it and press it down. In either maneuver the tube is carried into the mouth with the handle of the introducer held low. When the end of the tube comes to the opening of the larynx the handle is elevated, bringing the tube to the vertical position and exactly in the middle line of the larynx. It is then pressed downward with the lightest possible pressure, of the fingers merely, is detached by the trigger of the instrument, and is held in the larynx by the tip of the left index while the obturator is removed. The child now usually has a paroxysm of coughing. The gag is removed and the discharges wiped away by the operator, being careful not to pull upon the thread attached to the tube. Sometimes, if the child is badly asphyxiated or toxemic, the reflex irritability is badly obtunded and the paroxysm of coughing is long delayed. It is better to leave the thread attached to the tube until several coughing spells have thoroughly cleared the air passage, which may take five to fifteen minutes Usually the thread can be removed without reintroducing the gag, if the lowermost thread of the loop, having been previously marked, is gently pulled upon. But if it does not come with the slightest traction it is better to reintroduce the gag and hold the tube down in the larynx while withdrawing the thread. The nurse may now release the child's wrists and place him in bed.

The other position which may be employed is with the child flat upon his back. Some direct to have him rolled in a blanket, but I prefer to have his wrists held by a person who also controls his thighs. This leaves his chest free and nothing in the way. If the operator has no assistance he may fasten the hands with a towel about both wrists and passed behind the patient's thighs and pinned firmly to the sleeves.

The advantages of the dorsal position are said to be that fewer assistants are required. But it really takes just the same number to operate conveniently. There is some advantage, however, in that it is easier for the heart of a very weak patient. He need not be removed from the horizontal position in bed.

The time required to introduce the tube is about five seconds. It is often done in three seconds. It should never take longer than ten. This longer time may be occasioned by a twist of the head of an unruly older child who takes the assistant unaware, or by a very small mouth or low arched palate, or greatly enlarged tonsils, or a stiff edematous epiglottis. No attempt to introduce the tube should be prolonged more than a few seconds. If the attempt fails it is better to desist, let the child have a few breaths, and then try

again, rather than to make a prolonged attempt. A beginner is very apt to persist until the patient is asphyxiated, or to pass the tube into the esophagus, or to push the membranes before the tube into the trachea. This latter accident will seldom if ever occur if the tube is properly placed in the middle line and down in the larynx before the obturator is withdrawn. To remove the obturator too soon and then push the tube home with the finger is apt to gouge the false membrane or the mucous membrane of the larynx.

In case the tube is placed and one does not get the rush of air through it, but the patient makes ineffectual attempts to breathe, the tube must be withdrawn at once. It may be found plugged by a bit of membrane at its lower end, in which case it should be cleared and introduced again. But if membrane has been pushed down ahead of the tube and blocked the trachea so that the patient is getting no air, laryngo-tracheotomy must be done instantly. If he is getting a little air, it may answer to intubate with one of the special tubes (Fig. 174), with large caliber, known as foreign body tubes, through which he may be able to expel a mass of membranes.

Occasionally the act of intubation in a case of several days standing will detach loosened membranes, and these, in a paroxysm of coughing, will be expelled together with the tube. This occasions such relief of the dyspnea that no tube may be necessary. If the tube be not directed in the middle line of the larynx its end may be caught in a ventricle and then if a little too much force is used it may be thrust through the larynx, making a false passage.

After Intubation.—There is just one essential point in the management of the intubation case. This should be fully explained and demonstrated to the nurse or parents, namely, the child cannot eat solid foods, he can only drink, and all drinks must be taken in the recumbent position with the head a little lower than the body but in a straight line with the spine. A position lying on the nurse's lap with the head hanging over her knee, as one sees illustrated in some text books, is not correct. The drink or food falls into the naso-pharynx, instead of being caught by the muscles of deglutition. All that is necessary is to have the liquid pass the open end of the tube and enter the pharynx. During the first day or two swallowing is not well performed. If the child drinks while in the upright position, or in any position excepting with the top of the tube pointed a little downward, the liquid may enter the trachea through the open tube and excite paroxysmal coughing. This position during feeding, suggested by Casselberry of Chicago, is really the only point of any value that has been added to O'Dwyer's treatment. Children can take milk, egg-nog, strained gruels, ice cream, and such liquids or semisolids. Nursing infants may be left at the breast. If a child will not swallow nutriment he must be nourished by enemata. Good nourishment is very important.

It goes without saying that intubation in no sense takes the place of treatment by antitoxin or of any medicinal treatment that may be indicated. It is merely a mechanical means of overcoming the laryngeal obstruction until such time as the disease subsides or has been conquered by nature, by antitoxin or medication.

After intubation the child generally falls asleep and often rests for several hours. The tube may not require the slightest attention for a day or two or three days. In rare cases the tube may become obstructed by loose membrane below it, in which case if not fitted too tightly, tube and membrane will be expelled by cough. Cases have occurred in which too large a tube was used or the tube had become impacted, or the obstruction had taken place when there was so little air in the lungs that coughing was impossible or ineffectual and the patient succumbed. But this is very unusual. Cases of spontaneous descent of the tube in the larynx have been reported, causing great difficulty in extubation or even requiring tracheotomy. This seems to me impossible unless a tube far too small for the child be used.

The tube may become gradually occluded with mucus, and especially with food particles and mucus together, if the feeding is badly managed. This may require extubation for clearing the tube; or, all being in readiness for extubation, a drink of whisky and water may excite cough that will clear the tube.

The child may expel the tube by coughing. If this occurs soon after intubation it is probable the tube is too small. If the tube is unobstructed this explanation is certainly the right one. In some cases recession of swelling and loosening of membranes occurring some hours or days after intubation will cause the tube to be coughed out. In this case the surgeon should be immediately informed what has occurred. Yet it may be that the trouble is over and reintubation is not required. In some cases of auto-extubation the larynx seems perfectly clear at first, but in an hour or a few hours stenosis returns.

Extubation.—The average time that a tube is worn in the larynx is five days. Many cases are extubated in two or three days. There is no absolute rule. One must be guided by the conditions in the individual case. Ordinarily, if there is fever or the child is very weak and yet taking food well, it is better to wait. It can seldom be useful to attempt extubation before the third or fourth day, and one has no misgivings about leaving the tube in place a week if all is going on well. With the advent of antitoxin there was a tendency to shorten the period extremely, some operators priding themselves on the short time the tube was worn. Undoubtedly antitoxin does shorten by two days or more the time it is necessary to wear the tube. But that fashion of extreme haste passed by. The use of the hard rubber instead of metallic tubes

had an influence to lengthen the time; for the gutta-percha tube does not become roughened by incrustation like the metallic tube, and causes no irritation by remaining a sufficient time to avoid the necessity of reintubating. Occasionally one is persuaded to extubate as soon as possible by the child's refusal to take the necessary amount of food, and failing to retain nutrient enemata.

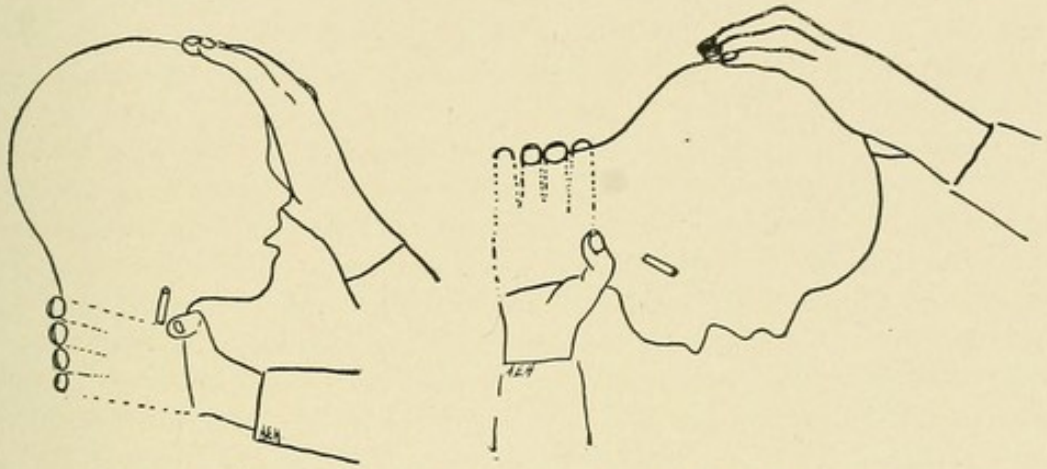
Extubation may be performed with the patient either sitting or lying, in the same positions as for intubation; and the positions and duties of the assistants are the same.

In nearly all cases, when preparing for extubation, the operator should select a tube of size similar to the one he intends to remove and have it threaded with silk and ready upon the introducer; for it not infrequently happens that upon removing a tube from the larynx, dyspnea will return so severely and so suddenly that unless reintubation be instantly performed the child will suffocate. Extubation is somewhat more difficult of performance than intubation, especially in a very young child with small mouth and low palate. The gag is used. The left index finger finds the head of the tube and keeps the epiglottis raised. The closed beak of the extractor is introduced into the opening at the top of the tube and then opened so as to seize the tube, which is then gently lifted out with a reversal of the motion used on introducing it. That is, it is lifted straight up until it clears the larynx, then the handle of the instrument is depressed as it is withdrawn from the mouth. The error most likely to be made in efforts at extubation is to pass the beak of the extractor between the tube and the rim of the glottis and then by spreading the blade lacerating the tissues. Before using the extractor the width to which the beak can be opened should be regulated by the set screw, being only sufficient for the size of the tube. Extubation may be performed by digital expression without the use of instruments. There are two principal methods, Renault's and Marfan's. (See Figs. 178a, 179a, 180a, 181a.[1]) Renault's method is a modification of that originated by Bayeux and is executed as follows: The child sits on the edge of the bed or on the lap of the nurse, who confines its hands at its sides. The operator, facing the child, places the pulp of his right thumb in front of the child's throat opposite the lower end of the tube, while his hand encircles the neck, his fingers at the nape. His left hand is placed upon the child's head, the fingers upon the occiput. The right thumb now gently pushes the tube upward until its lower end is level with the cricoid cartilage. The body of the child, by flexion on the thighs, is now swung rapidly forward, thus throwing the tube into the mouth, whence it is extracted by the fingers.

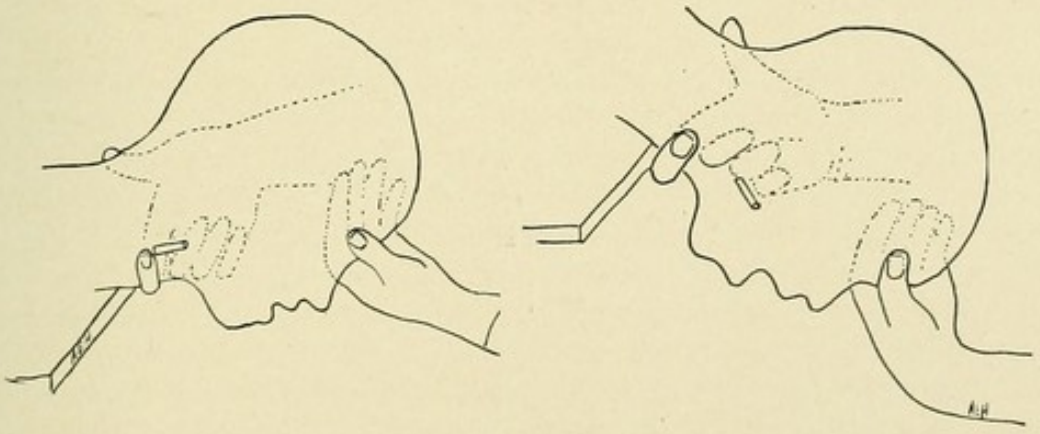
In Marfan's method the child lies prone with its head and neck

[1] J. R. Clemens, Archives of Pediatrics, Feb., 1908.

extending beyond the edge of a table or bed. Its forehead is supported on the left hand of the operator, who places the pulp of his right index finger upon the trachea below the tube and his thumb on the nape of the neck. The child's head is now gently extended with the left hand, and the right index feels the lower end of the tube. The head is now flexed, while at the same time the tube is pressed upward into the mouth. Of the two methods, Marfan's is



FIGS. 178a and 179a. RENAULT'S METHOD OF EXTUBATION.



FIGS. 180a and 181a. MARFAN'S METHOD OF EXTUBATION.

the better, but for my own use I still prefer the instrumental extraction.

After removing the tube, the operator should wait twenty or thirty minutes to see whether dyspnea returns. If it does not in that length of time it probably will not for several hours, and he should be on call during that time. If the patient gets through the first succeeding night without dyspnea it will probably not return. It is well to deprive the patient of food for two or three hours before

extubation and to use a preparatory dose of codeine, morphine, bromide or chloral, or similar cough sedative. After extubation food should be given with the same precautions as while wearing the tube, for several hours, as the muscles controlling the movements of the epiglottis and the act of deglutition are not well controlled. Aphonia, or at least a degree of hoarseness, may be expected to remain for a few days or a week or in some instances for several weeks. I have never had it to remain permanently.

Retained Tube; Prolonged Intubation.—Many cases require but one intubation and one extubation a few days later. It is not uncommon to be obliged to extubate and reintubate two or three times at intervals of a few days before the tube can be permanently dispensed with. But cases in which serious difficulty is experienced in getting along without the tube are not nearly so common in intubation as in tracheotomy Almost always the tube can be finally left out after five or six extubations in the course of a few weeks. Yet cases are reported in which it seems impossible for the child to breathe without the tube. He appears perfectly well with the tube, yet if it is removed the dyspnea returns either immediately or a few hours later. Some of these cases also cough out the tube readily several times a day or night, and are very distressing to the patient himself and his friends and to the surgeon. A special tube with a larger central portion, or even a larger ordinary tube will be better retained. (Fig. 173, iii.) Patients have been known to wear tubes for years, notwithstanding frequent attempts to do without. Opinions are not unanimous as to the real cause of this condition. Some of these cases when explored by laryngotomy have presented nothing apparently accounting for the symptoms. Exuberant granulations, which are so common after tracheotomy, seldom give trouble after intubation. Special tubes are made for such conditions. (Fig. 173, i, ii.) Rogers considers this troublesome condition a chronic inflammation of the mucous and submucous tissues resulting from the original diphtheritic laryngitis. He treated it successfully by very gradual dilatation with larger and larger tubes, until, after treatment extending over months, when the patient had worn a tube very large for his size, he was able to do without any.[1]

Intubation for Chronic Stenosis of the Larynx.—Intubation has several very useful applications in addition to that in acute stenosis in diphtheria. It is very useful in cases of retained tracheotomy tube. In papilloma of the larynx it has been used with success. (See Section on Papilloma of the Larynx.) It is useful in stenosis or partial stenosis, either inflammatory or cicatricial, resulting from trauma, burns, scalds, caustics, simple inflammation, tuberculosis, syphilis, malignant growths, ankylosis of the arytenoid articulations, hysterical spasm of the larynx and other conditions.

[1] Annals of Surgery, May, 1900.

LARYNGOTOMY.—Laryngotomy, or as it is sometimes called, thyrotomy, has its most frequent indication in the presence of tumors of the larynx, which could not be removed by endolaryngeal methods. It is therefore described as it would be performed for the removal of a tumor. As Holmes long ago pointed out, and has since been reiterated by other surgeons, laryngotomy for the removal of a growth needs a preliminary tracheotomy. For this purpose an infra-isthmian tracheotomy is better than one above the isthmus which is too near the laryngeal wound for convenience. However, a supra-isthmian tracheotomy may be made. When it is possible, the preliminary tracheotomy should precede the laryngotomy by a few days. Thus an air supply is provided for both during and after the operation; and also the blood can be prevented from entering the bronchi by the use of Trendelenburg's tampon-canula, or in its stead by blocking the trachea above an ordinary tracheotomy tube with soft little sponges each securely tied to a string. To open the larynx, general anesthesia is required. For any variety of external aëroporotomy the following instruments and articles should be at hand: Scalpel, bistoury, two pairs dissecting forceps, a grooved director, several pairs of hemostats, scissors, sharp hook, a dilator, a couple of needles and a few sutures of silk, a tracheal dilator, a pair of small retractors, hard rubber or silver tracheotomy tubes of several sizes and different curves, with tapes for the same; small sponges with strings attached, a few feathers, gauze sponges, sterile gauze and antiseptics, a solution of cocaine. If a tumor is to be removed, a galvano-cautery apparatus, or a Paquelin, or chromic acid should be in readiness to cauterize the stump.

The patient lies upon the back with head exactly straight and well extended over a firm roll (of the size of his arm) which is placed beneath his neck. The incision is carried downward in the median line from the hyoid bone to the upper part of the trachea. The hyoid and crico-thyroid arteries and other vessels will be divided and should be tied. The sterno-hyoid muscles are drawn apart and the thyroid cartilage being well exposed its alæ are transfixed transversely with a silk suture. (Pitts.) The cartilage is divided precisely in the middle line, the suture passing across within the larynx being drawn out through the opening and cut in the middle, making a retractor for each ala. The interior of the larynx is thus exposed to view and a solution of cocaine is applied to inhibit reflex contractions. The growths are then removed with scissors and their stumps touched with the finest point of a Paquelin cautery. Some operators use chromic acid as a caustic and some remove the growths with the galvano cautery or sear the stumps with the galvanic point. The retractors are then removed and the alæ of the thyroid carefully sutured together; likewise the skin wound. The tracheotomy tube is still used for a few days after the operation on the larynx.

LARYNGO-TRACHEOTOMY OR CRICO-TRACHEOTOMY is the form of external aëroporotomy most often performed on children. Tracheotomy in one form or another is by no means a modern operation, having been known to the ancients under the name of bronchotomy, but was revived by Bretoneau in 1825 and by Trousseau in 1833. From that time until the introduction of intubation by O'Dwyer in 1885 it was the operation most commonly used for laryngeal diphtheria. Laryngo-tracheotomy, as well as tracheotomy, also has an application as a preliminary step in bloody operations upon mouth, throat or larynx, in cases of foreign body in the air passage, and in obstructions of the air supply from edema, inflammatory stenosis or the like. The advantages and disadvantages of intubation and laryngo-tracheotomy are pointed out in the section on intubation. This supra-isthmian operation has the advantage over that which enters the trachea below the isthmus, in that the trachea above lies nearer to the surface and the space in front of it is not so vascular as that at the lower part of the neck.

The anatomical conditions are very different in the child as compared with the average adult. The neck is short, for the reason that the sternum is higher—nearly the width of one vertebra higher—than in the adult. Consequently there is little room for work, and the trachea lies at comparatively greater depth. When one considers also the small size of the larynx, the thickness of the subcutaneous fat, the turgid condition of the veins usually present in the half-suffocated patients that usually require aëroporotomy, and the constant motion of the parts in the efforts at breathing, one begins to realize the difficulties of an operation that, practiced on the cadaver of an adult, appears too simple to require any instruction. When the operation must be done on short notice, in the night, with poor light, and no facilities, and the necessary danger of chloroform with an asphyxiated and almost exhausted patient, and of blood running into the trachea, and the distracted parents and friends of the child in hysterics, it is no easy or pleasant undertaking.

The instruments required are mentioned in the section on laryngotomy. All necessary preparation should be made before the patient is moved. If possible, one should have a trusty assistant besides the anesthetist. General anesthesia is necessary unless the patient is unconscious from asphyxia—too comatose to be roused by pain. All the light available should be placed to the best advantage. The patient's wrists should be securely rolled and pinned fast in a towel which passes behind him, as he lies on the table flat on his back. He should be held in position by someone who will not be frightened or turn faint. A cushion or small pillow is placed under his shoulders or a firm roll of the size of his arm put under his neck, so that the head is well extended. As Owen says, "The

trachea is to be pulled up out of the chest." The head should be held exactly straight with the body, otherwise the operator is very apt to miss the trachea. The operator stands at the patient's right side. The landmarks are the thyroid cartilage and the episternal notch. The thyroid cartilage is located by the left index, and an incision is carried down the front of the neck, precisely in the median line, a distance of one and a half or two inches. There is an advantage in having a good long skin incision. It gives room to work in the depth, and there is less danger of emphysema of cellular tissues from air expelled from the trachea. One should be careful not to get his incision too low, or he will find himself upon or below the isthmus. The first incision goes through skin and the usually abundant subcutaneous fat. The wound is now retracted and the dissection is continued until the straight ribbon muscles in front of the neck, the sterno-hyoids, and beneath them the sterno-thyroids, are found with the fascial septum connecting their margins. A blunt dissector (handle of scalpel or a grooved director or a dissecting forceps, closed) will separate the muscles in the middle line. If turgid veins are seen, the venæ colli media, they should be pushed aside, or if they must be divided they should be seized with hemostats and cut between. We now come to the trachea covered with a fascia or with the isthmus of the thyroid. Some operators advise to cut or tear right through the isthmus, others will say to ligate it at each side and divide between. The former produces hemorrhage, of which there is apt to be a plenty, and the latter takes time. Neither procedure is necessary. A better plan is Bose's. At the upper margin of the isthmus the fascia which binds it to the cricoid cartilage and the trachea beneath is divided, and the isthmus is forced toward the sternum by a blunt dissector or a narrow retractor, until several tracheal rings are exposed. A strong hook is inserted into the cricoid cartilage, which is pulled toward the chin. There will be some oozing of blood, but the trachea should be seen or plainly felt with the tip of the left index finger. A sharp-pointed knife, with its back against the retractor which protects the isthmus, pricks through the anterior wall of the trachea and cuts upward, severing two or three upper rings and then the cricoid cartilage, making an incision about three-fourths of an inch (19 mm.) in length. Immediately there is a rush of air out and in through the incision, spattering bloody mucus and sometimes membrane into the operator's face and eyes unless he is wary. A dilator is slipped into the trachea, and any fragments of membrane within reach are picked out. If the trachea is filled with tough mucus a feather passed down clears it.

Unfortunately, however, an inexperienced operator may find that his bistoury had not entered the trachea; he may have passed

it down at one side; and this is especially apt to be the case if the head is not held squarely and straight, and well extended, or he forgets to keep his incision precisely in the middle line. Or his knife may not have cut through the mucous lining of the trachea. This is very disconcerting. But he must keep his head, and take his bearings, sponge out the wound, see or feel the tracheal rings and, if he had not done so, incise them.

It is well to pass a silk suture through each lip of the tracheal wound and by tying these behind the neck the margins of the slit are retracted. A tracheotomy tube with tapes attached is passed between the blades of the dilator into its place, and tied at the back of the neck. The tube should not completely fill the tracheal wound; but it should be of the right curve so that neither edge of its lower end impinges on the tracheal wall. A child's trachea is something near the size of its index finger; but it is not difficult to tell the right sized tube if one is careful not to have it too large. Be sure the inner tube slips in and out of the outer easily and locks in readily, before inserting into the trachea; and be careful not to push false membrane down ahead of it; nor to push the tube between false membrane and the tracheal wall. With the first full breath the turgidity disappears from the veins about the throat. Sometimes, after a deep breath, the patient ceases to breathe—alarming the uninitiated operator. But this is only apnea, induced by the unusual supply of oxygen, and after a pause breathing is resumed. With a few breaths cyanosis disappears. If the patient does not cough vigorously, or the trachea seems blocked, a feather inserted and twirled around will excite cough and a mass of mucus or membrane forced up into the wound should be quickly caught with gauze sponge or forceps and removed. Or the obstruction may be forced out by sudden compression of the chest, and then artificial respiration kept up a half hour if necessary until the natural breathing is established. The front of the throat is covered with moist gauze, to filter and warm the air before its entrance into the bronchiæ and lungs.

Competent nursing is requisite. The nurse should be able to remove the inner tube and clean and replace it, and renew the gauze dressing; and should have sufficient skill and coolness to do this instantly if the tube should suddenly become blocked and the child be suffocating. She should not be allowed to brush the trachea with feather or camel's hair brush too often, as irritation may occur. The patient must not be left alone for a moment either day or night. A dilator should always be at hand, for use in case a tube became blocked or displaced, or required changing. The air in the room must be kept at a temperature of 70 degrees F. and moistened by steam. The tent over the bed, as often recommended, may be useful

if the proper temperature or moisture cannot otherwise be secured, or the room is draughty. But the air under a small tent soon becomes badly rebreathed.

The child must be supported with stimulants and food, whisky and brandy or peptonoids, wine, whey, egg water, gruels. If these cannot be readily swallowed, as may happen from diphtheritic paralysis or from fear of pain in the wound, he must be fed by gavage or by the rectum. (See Section on Gavage.) Great care should be exercised to avoid vomiting. Vomiting is a very distressing and dangerous symptom in patients wearing either tracheotomy or intubation tubes.

Among the drugs, quinia and strychnia are the best at this stage. Mercury by mouth inunction or sublimation may be used if necessary. If antitoxin has been used, mercury is not administered so heroically as without the serum.

Infra-isthmian Tracheotomy (the "Inferior Operation," or Infra-glandular Tracheotomy).—Between the isthmus of the thyroid and the top of the sternum the vertical muscles are more widely separated than above, and it would appear easier to reach the trachea in this situation. But it is more deeply embedded here than near the larynx, and, besides the skin and the fascial layers and a good deal of adipose tissue, which give the operator no anxiety, there is a network of veins that is difficult to pass without troublesome hemorrhage, especially when they are swollen with blood in a patient struggling for breath with laryngeal stenosis. In children an enlarged thymus gland may be crowded up to the lower margin of the thyroid. Moreover, there is more likely to be abscess from the wound extending into the mediastinum, or emphysema of the connective tissues, in the lower operation. Therefore, this operation is not usually chosen in diphtheria or cellulitis, but it may be preferred as a step preliminary to extensive operation upon larynx or throat, or in case of foreign body lodged in a bronchus. The preparation, the instruments and position of the patient are the same as described for the other varieties of external aëroporotomy. The incision is precisely in the middle line, an inch and a half or two inches (four or five cm.) in length, ending below at the episternal notch. After the skin and adipose are severed and retracted the blunt dissector is employed, and when connective tissue must be cut it is lifted with tissue forceps. Veins are held aside with dissector or blunt retractors. The arteria thyroideaima, extending upward along the front of the trachea, from the innominate artery to the thyroid gland, and the large inferior thyroid vein coming down, may be encountered, and should be avoided or secured before division. When the trachea is exposed, a flat retractor holds the isthmus of the thyroid toward the chin, while a knife pricked

through the trachea below cuts toward it. The dilator is introduced, the trachea cleared, foreign body removed by the patient's efforts at coughing, or by suspending him by the heels, or by long curved forceps, or a soft wire hook. Or the bronchoscope or a tracheotomy tube introduced, according to the purpose of the operation.

Permanent Removal of the Tube is a matter often requiring considerable management. As soon as the laryngeal disease has subsided and the child is in fit condition for slight disturbance, he should be practiced at breathing through the larynx by temporarily withdrawing the inner tube and placing a finger-tip over the outside opening or blocking it with a plug. This practice should not be too long delayed—not more than a few days, or the larynx becomes so unaccustomed to the rush of air that it does not want to tolerate it, closing spasmodically and producing dyspnea. When the child has learned to breathe quietly with the tube blocked, the latter should be removed for a time, while the dilator is held ready to open the trachea and reintroduce the tube if trouble arises. If all goes well the tube may be left out longer and longer at a time. But someone should be at hand who could introduce it; for occasionally, either gradually or suddenly, dyspnea may supervene quite unexpectedly. Dyspnea is more apt to come on at night or if the child becomes frightened or cries or swallows imperfectly. It may be weeks or months before the tube can be permanently laid aside. Intubation may have to be resorted to, as an aid in dispensing with the tracheotomy tube. One should not take it for granted that any difficulty of breathing which may be present is certainly spasmodic, or due to fright, or even to diphtheritic paralysis of laryngeal muscles. There may be actual obstruction by exuberant granulations, or by adhesion of the vocal cords. One could relate some interesting experiences along this line if space permitted.

THYMIC ASTHMA; THYMIC TRACHEOSTENOSIS; THYMECTOMY

Thymic asthma (37) has been alluded to in the section on Lymphatism. At present there is no clear understanding of the pathology of the condition in which dyspneic attacks or sudden death take place and nothing pathological but a hyperplastic thymus is found at autopsy. Jackson has demonstrated by tracheoscopy, in at least one case in the living patient, the purely mechanical nature of thymic asthma, proving what Friedleben, von Kundrat, d'Escherich and Paltauf have denied, that a hypertrophic thymus can compress the trachea sufficiently to obliterate its lumen, producing what he suggests calling tracheo-stenosis. It is probable that progress in the understanding and treatment of these cases will in the near future lead more frequently to operation. Some seven or more thymect-

omies for this affection have been reported and the results fully justify the operation. Jackson gives excellent points on the subject.[1]

A radiograph aids in the diagnosis. The dyspnea is expiratory, the intrathoracic pressure being then at its greatest, and is worse in the erect position. A positive diagnosis of tracheo-stenosis can be made with the tracheoscope, but upper tracheoscopy is probably not safe in these cases.

Tracheotomy as high as possible should be done, under infiltration anesthesia, the stenosis demonstrated with the bronchoscope, and then a tracheal canula, long enough to reach below the obstruction, should be inserted. The long tracheal canula is of great importance, not only relieving the dyspnea for the time being, but preventing undue pressure on the trachea and consequent asphyxia during the removal of the thymus which is to follow.

The thymectomy may now be postponed for some hours, days, or weeks, if necessary, for the child to recover condition. In thymectomy a transverse incision is made at or just below the upper border of the sternum, the flap retracted upward and the sternal attachments of both sterno-hyoids divided. The dissection is carried down to the thymus gland which will probably bulge into the wound. The little finger is passed down into the wound, breaking up the attachments of the thymus, taking care not to wound the pleuræ or the pericardium. The gland is gradually loosened and drawn out, any strong attachments being ligated and cut, and nearly the entire gland may be divided and removed after ligation. The finger should not be kept long in the mediastinum, for, although the long canula preserves the patient from asphyxia, there is serious cardiac inhibition, perhaps from compression of nerve trunks. All the ligatures may be attached to the upper border of the sternum, and the pretracheal fascia may be anchored by a stitch to the periosteum of the manubrium. The severed tendons of the sterno-mastoid should be reunited by sutures and the wound drained and sutured. Moist bichloride gauze and frequent changes are advisable, for it is extremely awkward to have an infected wound in the mediastinum. Almost complete thymectomy seems to have no effect whatever, neither on blood nor on nutrition.

[1] Jour. Am. Med. Assn., May 25, 1907.

CHAPTER XIX

THE THORAX

ITS ANATOMY IN INFANCY AND CHILDHOOD—DEFORMITIES OF THE THORAX—TUMORS, CARIES AND ABSCESSES OF THORAX—EMPYEMA.

ITS ANATOMY IN INFANCY AND CHILDHOOD

THE thorax of the infant differs in comparative size and in shape from that of the adult. At birth the thorax is smaller than the head, and although with the establishment of respiration and expansion of the chest, marked changes begin at once to take place, it is not until between the second and third year that the size of the thorax exceeds that of the head. And still its changes of shape and proportion are not complete, but progress steadily through childhood and youth, unless checked or distorted by various causes to be mentioned presently.

The relation of the thorax to the spinal column in the infant is noteworthy. Its uppermost limit, the top of the manubrium sterni, is usually at the middle of the body of the first dorsal vertebra (Ballantyne), while in the adult it is at the lower border of the second dorsal vertebra. This change is brought about evidently by the formation of the normal curves of the spinal column. With growth and development the lateral diameter of the thorax increases more rapidly than the antero-posterior. A cross section through the infant's thorax presents a more circular form than that of the adult. Its antero-posterior and lateral diameters have the proportions of 1 to 2. In the period of childhood the proportions are 1 to $2\frac{1}{2}$. In the adult 1 to 3 or $3\frac{1}{2}$. In the young child the lower part of the thorax is wider, especially in front, making room for the large liver and the stomach. In the infant and young child the ribs themselves are flatter and less curved, and although ossified are comparatively soft and yielding, being especially compressible at the costochondral junctions. So yielding are the chest walls that serious or even fatal injury can be done to their visceral contents without fracture or dislocation taking place, or even contusion being visible externally. (See Sections on Fractures and Dislocations.)

DEFORMITIES OF THE THORAX

Deformity of the thorax may be congenital, due to developmental error. For instance, in rare cases failure of the visceral plates to close may leave a vent in the region of the sternum. This, if not too large, it may be possible to close by plastic operation. Or

deformity may have its origin in intra-thoracic disease of the fetus. Or it may come later as a result of atelectasis pulmonum, of rickets, spinal curvature, pleurisy, pericarditis, paralysis, or chronic obstruction of the air passage, such as post-nasal adenoids and enlarged tonsils. Several instances of such deformities will be found illustrated under their respective headings, and also in Figs. 178 and 179. One of the most common alterations in the shape of the chest due to

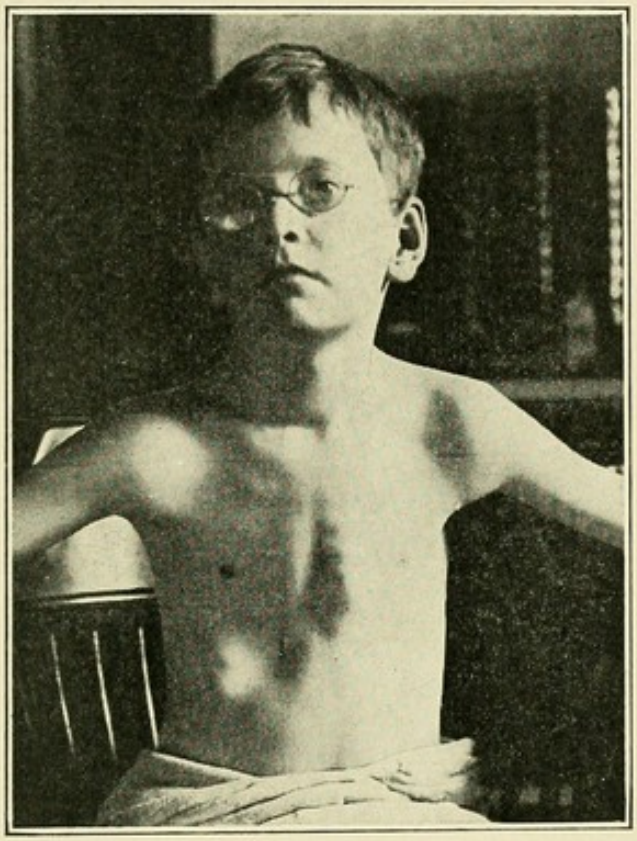


FIG. 178. DEFORMITY OF THORAX FROM RACHITIS.

rickets is that commonly known as "pigeon breast." The softened ribs and cartilages are unable to withstand atmospheric pressure, and become flattened or depressed, while the sternum, somewhat stiffer, stands out prominently. Quite frequently there is more than one agency in the production of the deformity; for instance, if there exists, in addition to rickets, also an obstruction to the inflow of air, the deformity is greatly exaggerated; and if ossification takes place with the parts in this position it becomes permanent. Another even more common type of deformity presents the flaring forward of the lower portion of the thorax due to gaseous distension of the stomach and intestines. This may remain permanently even after the cause no longer exists. The "funnel chest" is still another form. (Fig. 180.) Great care should be taken to prevent these deformities by removal of obstructions to free breathing, and attention to

the digestive organs, as well as to the general state of rachitis, for once the deformities of sternum or ribs are fixed in hard bone, they are well-nigh unchangeable. No band or pad or brace of any sort is of any use in overcoming them. The cause, if still existing, should be removed and systematic breathing exercises to expand the chest should be practiced many times a day. Firm pressure by the hand of the mother or nurse applied over projecting parts will, if persistently repeated several times a day, aid in the correction, especially in infants and young children. Dumbbell and wand exercises with overhead movements simultaneous with lung expansion, as well as general gymnastics, hygienic management, and the use of nutritious food, tonics and reconstructive agents, will promote more vigorous growth directed into more symmetrical proportions.



FIG. 179. RICKETY DEFORMITY OF THE THORAX. Such are usually superinduced by adenoids and enlarged tonsils. Fetal pleurisy may cause similar deformities.

TUMORS, CARIES, AND ABSCESS OF THORAX

TUMORS OF THE THORAX occasionally occur either upon its walls or upon its visceral contents or their coverings. Tumors of the chest walls may be fibroma, enchondroma, osteoma, angioma or lymphoma; although it is very apt to be sarcoma, or a tumor of mixed histological structure but malignant character. Tumor of lung or mediastinum is likely to be sarcomatous, and usually so obscure and so rapid in growth that by the time a diagnosis can be made operation is impossible of performance or hopeless. But if diagnosis of tumor, even sarcoma of lung or rib or any portion of chest wall can be made before inacessible parts are involved, it should be removed, together with a liberal area of surrounding tissues. If this is done early and completely there may be no recurrence.

CARIES of the bones of the thorax may occur from tuberculosis, syphilis, or following trauma. That of the vertebræ will be

discussed in the chapter on the spine; and tuberculosis of the ribs and sternum with diseases of bones and joints.

Caries of ribs may occur primarily or from empyema in the attempt of the abscess to escape from the chest. Caries or necrosis may result from the pressure of a drainage tube after thoracotomy.

Syphilitic disease should be treated with iodide of potassium, and perhaps mercury. With caries or necrosis the dead or diseased bone should be removed and the cavity packed with iodoform gauze until filled with scar tissue.

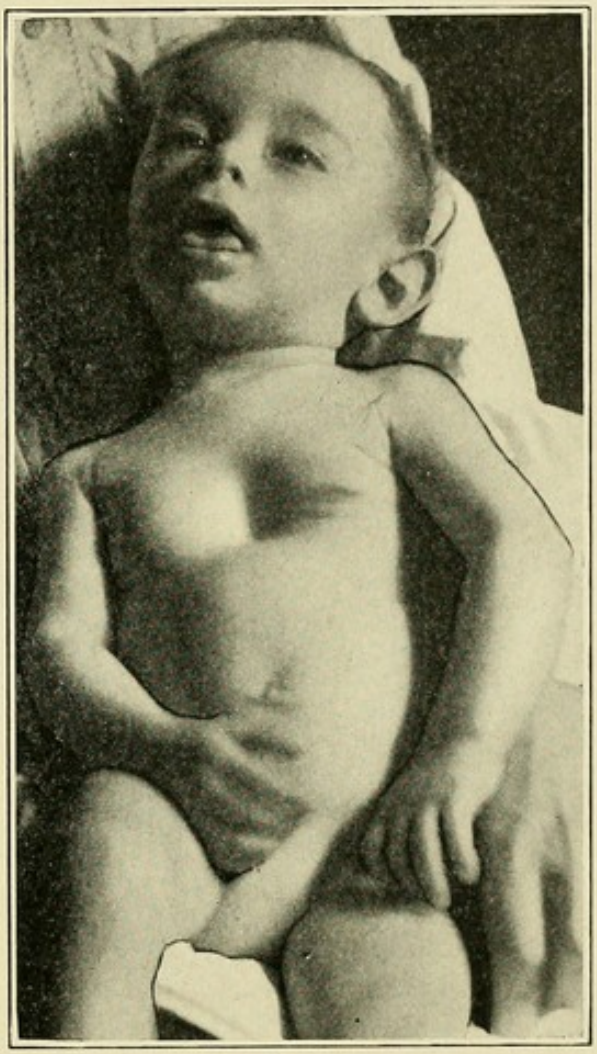


FIG. 180. "FUNNEL CHEST."

INFECTIVE INFLAMMATION may lead to purulent collections in the pleural cavity, the mediastinum or the pericardium, or the abscess in the lung, or in the chest wall, which may need surgical attention.

EMPYEMA

Empyema is one of the commoner surgical diseases of infancy, and particularly of childhood.

It differs in the young subject from the same disease in the adult in several points, namely, its greater frequency, its greater frequency in comparison with the whole number of cases of effusion in pleurisy, the greater obscurity of its symptoms and physical signs, its etiology, being less frequently due to tuberculosis, its greater damage to lung tissue, the greater deformity of thoracic walls and spine it produces in certain cases, its greater fatality if unrelieved by operation, its behavior after aspiration, and its better prognosis if properly treated by operation.

No babe is too young to have purulent pleurisy, as it can occur in the fetus. Liability to the disease seems to increase up to the fourth year, when it is at its height, then diminishing, slowly at first but more steadily after the fifth year, though it is compara-

tively frequent until after ten. It may be classified as primary and secondary. It is probable that with closer study of cases the primary list will lessen, being limited almost entirely to traumatism and possibly infection of a pleuritic effusion, and the secondary list will increase.

Malnutrition and exposure to cold or wet and lowered vitality from unsanitary living are predisposing causes; and any of the infections and eruptive fevers render the patient more liable to empyema, even if they do not furnish the infecting organism found in the pus. It is apt to complicate or to follow scarlet fever or measles, sometimes influenza, tuberculosis, typhoid or typhus fevers, pertussis or quinsy. It may accompany retropharyngeal or mediastinal, perinephric, hepatic or post-cecal abscess, or appendicitis, or osteomyelitis, or a purulent lesion or septic absorption from any part of the body. It is frequently secondary to an adjacent pneumonia, but may be also to bronchitis and even to nephritis or enteritis. It may also occur in connection with neoplasms or actinomycosis of pleura or lung.

An empyema, like a serous pleuritic effusion, may be unilateral or bilateral, and it may be free in the pleural sac, or confined by adhesions to the diaphragmatic surface, to an interlobar fissure or any large or small area of the pleural cavity. It may be a multilocular abscess from subdivision of the pleural space formed by fibrinous adhesions.

Morbid Anatomy.—The pleura may or may not have undergone great alterations aside from loss of its surface luster. Usually it presents considerable, and sometimes immense, inflammatory thickening. This may extend over both visceral and parietal reflections of the membrane, although one (more often the visceral) may be more affected than the other. Its surface is coated with a fibrinous exudate, which in its coagulation has entangled pus cells, leucocytes, and sometimes bacteria. In cases accompanying pneumonia the interlobular connective tissue adjacent is also thickened. If the pleura be tuberculous its thickening is more marked at the site of the tubercular deposits. In either simple or tubercular forms organization of the plastic lymph or fibrin exudate may lead to adhesions of adjacent membranes, thus obliterating part of the pleural cavity or producing sacculation.

The fluid first effused may be serous in character and contain only leucocytes and endothelial cells, or it may be also bloody. Of course, pleurisies showing nothing purulent are not at the time empyemas, but if there are present bacteria capable of producing pus, the fluid soon changes its character, becoming in a few hours or days pus instead of serum. Or the fluid may be pus from its first appearance and either creamy or watery in consistency, may be yellow,

clear or turbid, bloody or quite opaque. It may contain fibrinous flakes, strings, bands or rag-like pieces.

The microscope may reveal in the pus the diplococcus lanceolatus (Fränkel's pneumococcus) or the streptococcus pyogenes, or

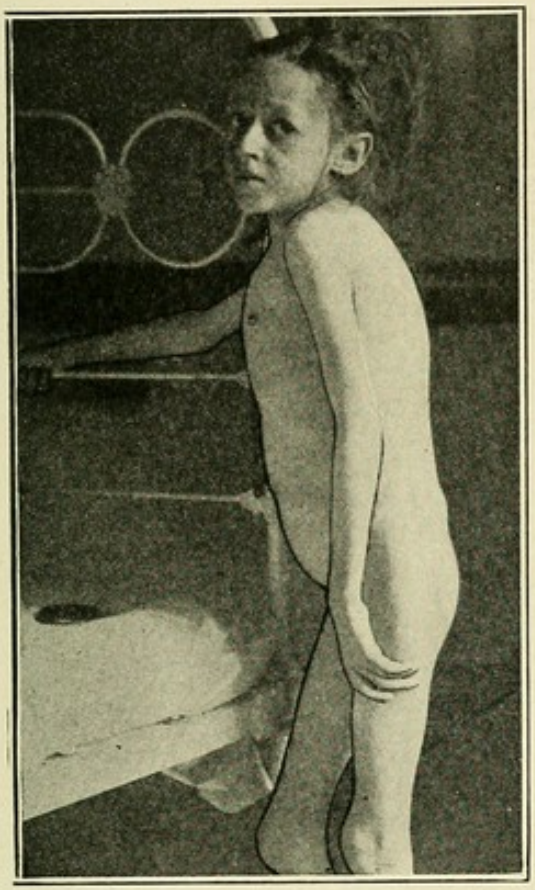


FIG. 181. Maggie D. Unusually large purulent collection in left pleural cavity. Distention of left side of thorax easily noticeable. Absolute flatness on percussion over entire left half, and even above the clavicle. Observe the complete obliteration of the intercostal spaces: also the emaciation. Nevertheless the patient was able to stand and even to walk about the room, such is the tolerance that becomes established.

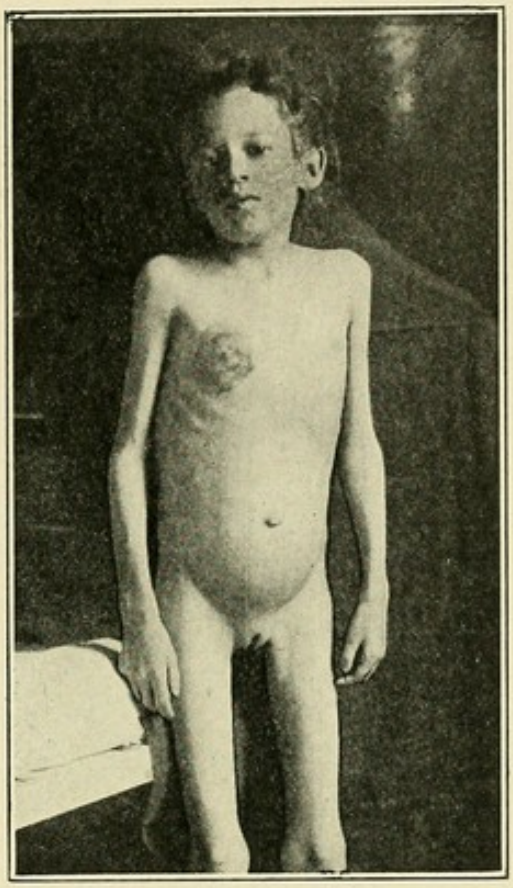


FIG. 182. Same case as Fig. 181. The distension of left half of thorax and obliteration of the spaces are easily seen. Also the fullness above the clavicle. The blackened patch in the right mammary region indicates the dullness of the displaced heart. Operated at Cleveland General Hospital. Patient entirely recovered with lung expanded, heart in normal position, and no deformity, after free drainage by resection of small portion of one rib.

the streptococcus longus, or Eberth's typhoid bacillus, or the bacillus coli communis, or the staphylococcus pyogenes aureus, or the tubercle bacillus; or two or more varieties may be present in the same specimen. Or the pus may be found free from organisms, which is a probable indication that the pleurisy is caused by the tubercle bacillus.

The amount of pus may vary from a few drachms to two or two and a half pints. If the quantity of pus is great the lung is compressed, and this compression, together with the hyperplastic condition of the interlobular connective tissue, may cause it to become solidified or carnified into a state of permanent atelectasis.

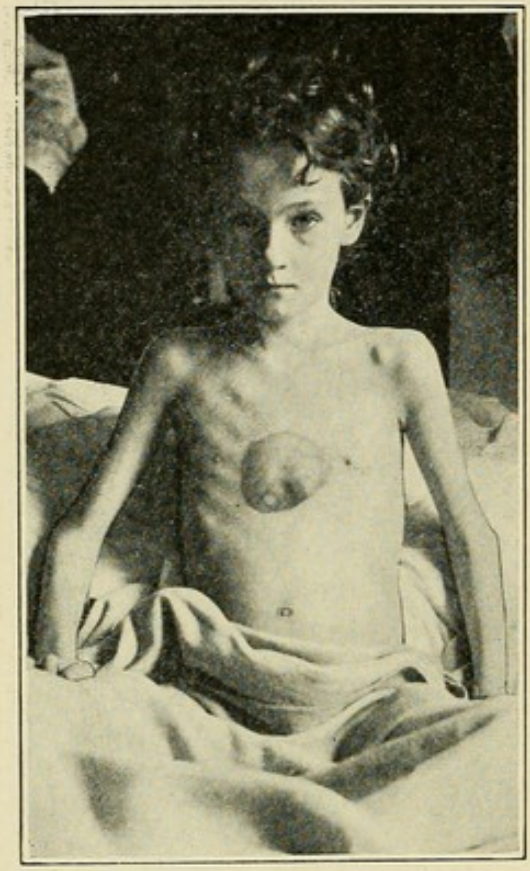


FIG. 183. EMPYEMA LEFT SIDE WITH DISPLACEMENT OF HEART. Measurement failed to detect difference between the two sides, but the obliteration of the intercostal spaces is readily seen. The emaciation in empyema resembles that of phthisis. Case referred by Dr. F. W. Hickin.

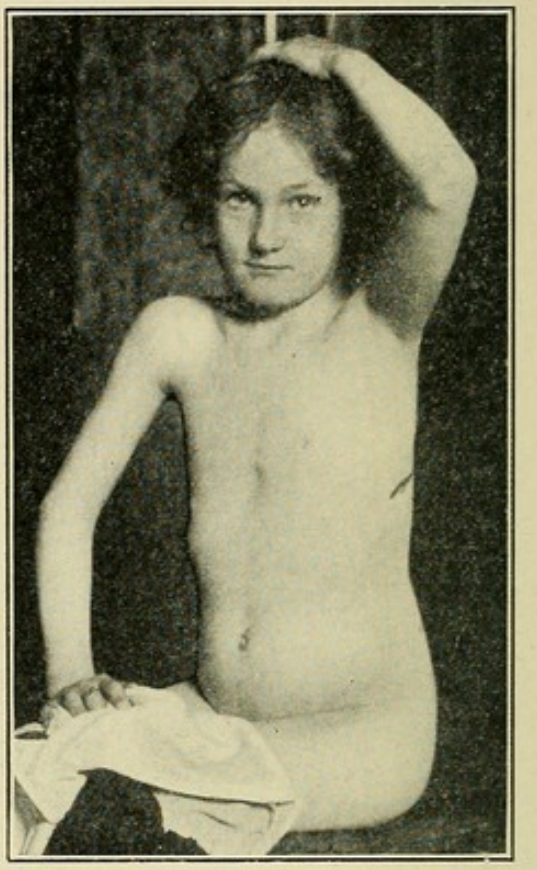


FIG. 184. Same as Fig. 183. Recovered without deformity after excision of rib. Fever disappears on draining the abscess, only recurring from blocking the flow or complications, appetite, digestion and assimilation improve. Note the gain in weight taking place in a few weeks.

In the ordinary acute cases in which compression of lung has not been too great nor continued too long before it was relieved, and the lung retains a degree of resiliency and inflatability, the inflammatory exudative thickening, both of the pleura and interlobular connective tissue, may undergo resolution and absorption and disappear or be organized into new connective tissue, leaving the tissues normal or nearly so. Or a degree of permanent thickening of the pleura and of the deeper connective tissues may remain. In these cases of lessened bulk of lung, with adhesions of the pleural layers,

the affected side of the thorax becomes retracted and a corresponding curvature of the spine takes place.

Symptoms.—The symptoms are those of pleurisy with effusion. The condition may come insidiously. One has seen children who were going about not supposed by their parents to be seriously ailing, but languid, short of breath on exertion, failing in appetite, weight and strength, and who, on being brought for examination, had no history of acute illness, but were carrying a pint or more of pus in a pleural cavity. There may be a hacking cough, slight irregular fever and night sweats. Most cases begin more frankly as a pleuro-pneumonia, sometimes with chill or convulsions, followed by fever, 102 to 105° F., a rapid pulse, shallow breathing, breathing rapid out of proportion to pulse rate, pain in the chest which is perhaps referred to the epigastrium or back, pain worse on coughing, cough which is half suppressed, expiratory moan, expanding alæ nasi and increasing dyspnea. The patient lies upon or bends toward or presses upon the affected side. A friction rub may be heard.

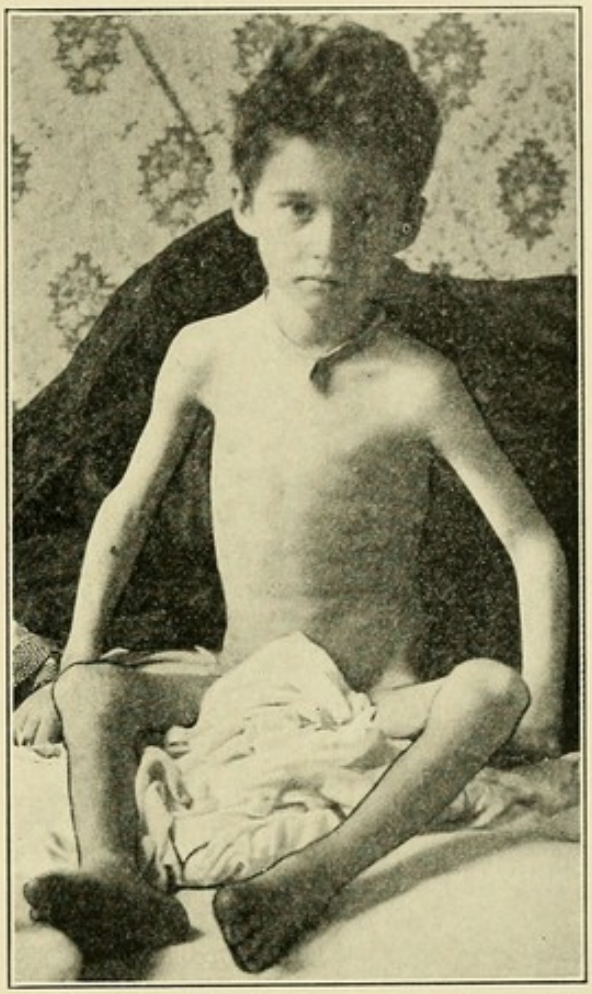


FIG. 185. ENCYSTED EMPYEMA left side with adjacent portion of lung consolidated. No bulging on affected side, but retraction, and no obliteration of intercostal spaces, yet a large pus collection was found. Drained by resection. Mixed infection. Slow but complete recovery. Boy aged 5. Case referred by Dr. F. W. Hickin.

If an effusion of considerable bulk is now poured out, and especially if it comes with a degree of rapidity, the attitude changes, and the patient turns and prefers to lie upon the back or to be propped up in bed and avoids bending toward that side or pressing upon it. Later on, tolerance is established, the dyspnea becomes less marked as long as exertion is avoided and the patient returns to the position of lying on the fluid-weighted side. With effusions of smaller

amount or coming more gradually, this change of position may not take place. The physical signs are well laid down in many recent text-books of medical pediatrics.

In the presence of an effusion there is impaired mobility of the affected side, and if there is a large effusion measurement shows that side distended. The intercostal spaces are obliterated and the apex beat displaced. But I wish to call attention to the sign or symptom of changed attitude just described; and to the facts that difference in the two sides cannot always be detected by measurement, and that there may even be retraction and the intercostal spaces not obliterated on the affected side. (See Figs. 181 to 185.)

Fluid in the chest being detected, the questions rise, is it serum or pus? and shall it be dealt with by mechanical means or by medicines alone?

If the fluid has remained in the chest several weeks after the onset of the illness it is more apt to be purulent. If there had been a preceding attack of scarlet fever, measles, whooping-cough or any other eruptive or infectious disease, the likelihood of pus is increased. Chills or chilliness, intermittent fever with exhaustive sweats, clubbed finger ends and progressive emaciation point to suppuration. The emaciation in empyema resembles that of phthisis. Leucocytosis indicates a suppuration. Edema of the chest wall not only betrays the presence of pus within, but that nature will endeavor to discharge it by perforation.

A neglected empyema may, if it be small or even large, possibly have its fluid portions absorbed and its more solid elements become a cretaceous mass. However, the possibility of this rare and not very desirable event is by no means to determine our course of treatment. The pleural pus collection may break through the chest wall at about the fourth or fifth intercostal space and discharge itself. It may break into a bronchus and be gradually emptied by coughing. It may burrow into the lung and form abscess there, possibly discharging thence into a bronchus. It may burrow through the diaphragm and cause peritonitis, or on the right side abscess of the liver, or it may track downward and appear as a lumbar abscess.

Treatment.—The medical treatment of pleurisy is well laid down in excellent text-books on medical pediatrics, and the physician may himself choose to aspirate for diagnostic or curative purposes, be the effusion serous or purulent. But the surgeon is frequently called in the purulent cases, or cases suspected of purulence, and must be familiar with the disease and the surgical measures advisable. I may be allowed to remark in passing that if physicians would more freely resort to the use of the aspirator in the serous effusions which are very large in quantity, without waiting many weeks, as is often done, while the lung is compressed, hoping by medicines alone to

produce a reabsorption of the fluid, their results would be far better. Probably three weeks is quite long enough to wait before resorting to mechanical means for the removal of fluid from the pleural cavity, and it would often be better to aspirate sooner. The effusion may be purulent from the first and require prompt removal; or even if it is only serous its presence not only embarrasses the respiration but damages the lung, more, the longer its compressing effect exists, while its removal by aspiration is a very simple process. (38)

Paracentesis Thoracis.—To Bowditch of Boston we are indebted for the use of suction to remove fluid from a cavity. Paracentesis thoracis for diagnostic purposes may be done with a hypodermic syringe fitted with a long needle, if no better instrument is available. But failing to draw fluid with such an instrument would not prove its absence, for very frequently the fluid would not run through so fine a needle. An exploring needle at least a millimetre in caliber fitted with a syringe holding an ounce or two is better suited for the work. But one prefers for either diagnostic or therapeutic use a trocar and canula as less likely to injure expanding lung and less apt to be obstructed by flakes of pus or fibrinous masses. To the canula should be attached the Dieulafoy or similar apparatus. Then one is prepared not only to find but to remove the fluid. If an aspirating syringe is used a few inches of rubber tubing should intervene between needle and syringe.

The instruments should be rendered aseptic by boiling. The patient should be held by nurse or parent so securely that he cannot interfere with the surgeon and that no sudden twist may snap the needle as it is introduced.

The needle or trocar may be introduced into almost any part of the chest, avoiding, of course, the heart and great vessels near it and near the roots of the lungs, the liver, and the vessels and nerves near the spinal column. The site of puncture should be where percussion reveals the greatest flatness. If the whole side is flat, the sixth space on the right and sixth or seventh on the left in mid-axillary or posterior axillary line are favorite sites for puncture. The skin should be carefully washed with soap and warm water and a piece of gauze, then with ether or alcohol, followed by bichloride solution (1:2000) and sterile water. No anesthetic is necessary, but ethyl-chloride spray or a piece of ice may be used. Avoiding the ribs, the needle is thrust in a distance of $1\frac{1}{2}$ to 3 centimetres ($\frac{1}{2}$ to $1\frac{1}{4}$ inches) unless fluid is encountered sooner. As soon as the needle has been introduced it is held loosely in the hand, which steadies itself against the thorax and follows any movement of the patient. If fluid is not encountered, the needle should not be pointed in this or that direction in search of it. Such maneuvers may wound the lung or break the needle. If the fluid does not flow or flows a

little and soon stops, it may be because it is too thick or the needle may be clogged with a flake of pus or fibrin. If trocar and canula have been used, the trocar or a blunt wire (previously sterilized) passed through the canula, may remove the obstruction. Or the needle or canula may impinge on expanding lung or rising diaphragm, which stops the flow, and a partial withdrawal may free it. The emptying of the distended pleura may embarrass the circulation and excite troublesome coughing. This may be relieved by stopping the flow for a half minute, or by drawing tighter a double-tailed bandage passed round the chest to control expansion. Persistent coughing is an indication to discontinue the aspiration. It is not advisable in all cases to draw off at one time the whole of a large effusion. Suction having stopped, the needle is withdrawn with one quick movement. The skin puncture is covered with iodoform collodion, or a bit of iodoform gauze held in place with a patch of adhesive plaster. A specimen of the fluid should be subjected to bacteriological examination.

Cases are on record in which a single tapping or repeated tappings, particularly if the pus contained only pneumococci, have cured empyema, but such a result is not to be waited for and does not alter the rule that if the collection is purulent no time should be lost in securing free drainage.

Drainage.—Methods of drainage depending on needles or canulæ thrust through the chest wall and left for hours or days in that position are hard to manage and unsatisfactory. Losing no time in effecting free drainage does not mean that an opening by incision must be made at the same sitting with the aspiration. Indeed, it may be advisable to wait some hours or even a few days, especially if there has been much tension within the thorax and the needle has removed a large amount of fluid, in order that expansion of the lung may take place gradually. But a free opening must not be long delayed.

Thoracotomy.—Thoracotomy having been decided upon, there is a choice between a simple incision through an intercostal space and excision of a portion of a rib. The simple incision has the advantage of being a slighter operation and more quickly performed, therefore producing less shock, and not always requiring general anesthesia. It has the disadvantage of not making an opening sufficiently large for easy exploration of the abscess cavity; that the margins of the ribs impinge upon the drainage tubes and interfere with free drainage; that the pressure of the tubes is apt to cause necrosis of rib; and that it is often difficult to prevent the incision from healing shut before the abscess cavity has been obliterated by expansion of the compressed lung and also of the sound lung, by depression of the chest wall and rising of the diaphragm.

Excision of a portion of rib has the advantage that it produces an opening into which an exploring finger may, if necessary, be introduced, in which the drainage tube rests easily, and remains patulous and is not so apt to produce rib necrosis; an opening through which fibrinous masses may be easily removed; an opening which remains open longer, although it has a constant tendency to close prematurely. It has the disadvantage of usually requiring general anesthesia during its performance of being more severe than simple incision—too severe for very young or greatly enfeebled patients; and that it produces greater scar, though it does not, as has been stated by some, produce chest deformity unless a considerable portion of a rib or of several ribs be excised. (Fig. 186.)

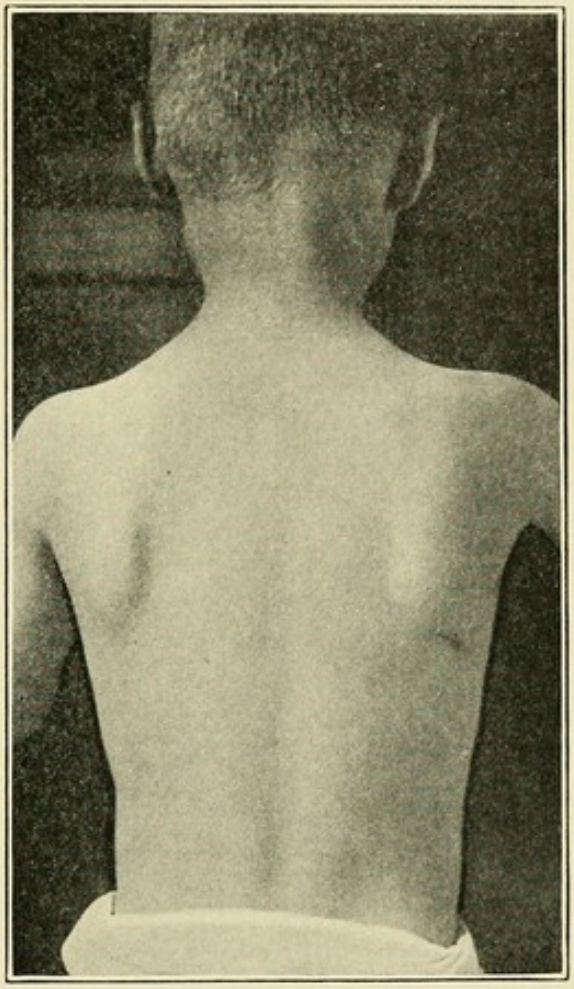


FIG. 186. WHOOPING COUGH, MEASLES, AND PLEURO-PNEUMONIA WITH EMPYEMA at the age of 6½ years. Drainage by excision. Pus showed pneumococci and tubercle bacilli. Photograph 2 years after, shows no deformity as some assert occurs after excision, and that recovery can follow pleurisy with tubercle bacilli present.

As a general rule simple incision is usually chosen for patients under eighteen months of age, and for those very greatly enfeebled or in whom a heart lesion or other complication forbids general anesthesia. It is only under readily be done with ethyl-chloride spray, or cocaine, the former being preferable, though general anesthesia is sometimes used. Excision is usually done under general anestehsia. It is only under exceptional conditions that it should be done with local anesthesia, although this when necessary is practicable.

The operation of thoracotomy for empyema is performed as follows: The side of the chest to be opened is cleansed with soap and warm water, followed by alcohol or ether, bichloride solution (1 to 2000), and finally sterile water.

It is generally advised to aspirate just before proceeding to cut into the chest, even though an aspiration had been made a few days previously. But if the aspiration had been made only a few hours or a day previously to the operation, there can be no advantage in using the needle again unless there be much tension. If the fluid in the chest is producing a great amount of pressure as evidenced by the respiration rate and the physical signs, there is an advantage in its *gradual* removal by the aspirator, even though aspiration is immediately followed by a free opening. By so doing there will be less coughing and embarrassment of respiration and circulation than if the tension is suddenly relieved by rapid escape of the pus through a larger opening. For the same reason the drainage tubes, sterilized, and also a pad of bichloride gauze and cotton should be ready at hand before the knife is used.

If a simple incision has been decided upon, it is situated in the intercostal space, is from an inch and a quarter to an inch and three-quarters long, and carried through skin, fascia and, perhaps, muscles. In cutting between the ribs, one should avoid injuring the periosteum of the rib below the incision and keep clear of the artery and nerve which run along the inferior edge of the rib above the incision. If preferred, after the skin and fascia have been incised, a grooved director may be thrust in, followed by a hemostat or a pair of round-pointed scissors closed, by spreading the blades of which the opening may be enlarged to admit the drainage tubes. It is generally not easy to introduce an exploring finger between the ribs unless the incision is larger than is really necessary for drainage.

If a portion of one rib is to be excised, one selects the site of operation by the same rule as that for aspiration or incision, going in at point of greatest dullness. With a large collection free in pleural cavity one chooses the mid-axillary or posterior axillary line just in front of the latissimus dorsi muscle, not lower than the sixth rib on the right and sixth or seventh on the left side. In small saccculated collections one usually takes the shortest route. In the case of a girl who had a circumscribed collection of pus behind the upper portion of the right mammary gland, I chose to make an opening in the fold beneath the gland, and, tearing through the adhesions in an upward direction, drained the pus cavity and avoided a more conspicuous scar. (Case operated for Dr. I. S. Bretz.)

The incision corresponds to the center of the rib and is carried down to and through the periosteum and an inch and a half or two inches long. One or two small vessels may need forceps. The periosteum is next separated from the bone, a dissector being most convenient for the edges and going beneath the bone, which is laid bare a distance of an inch or an inch and a half (25 to 38 mm.) (39). A piece of the rib of that length is then removed, the anterior cut

being made first. In using the ordinary bone forceps it will sometimes occur that the point beneath the rib will puncture the cavity prematurely. Therefore, if a gouge forceps or bone shears be used to make the section, the work is neater. The cut ends of bone should be freed of splinters or sharp corners, and the cavity entered in the middle of the exposed posterior layer of periosteum by a grooved director or pointed hemostat followed by finger. I am fond of making with the entering finger a hasty exploration as to the size and shape of the cavity and resilience of the lung adhesions, etc., but not necessarily to break up adhesions. If the child be much weakened this exploration should not be made. If there be found large fibrinous clots or masses obstructing the flow, and if the child's condition warrant the manipulation, they may be removed with forceps or finger. As a general practice irrigation is not advised. It may cause shock and has caused death. It is better reserved for fetid cases. In the usual case the tube or tubes should be immediately inserted into the opening, covered promptly with the pad and binder, the child turned upon his back and the binder pinned rather snugly.

Dressing will probably be required in eight or twelve hours, but after once or twice repeating at this interval it may go twenty-four hours. Sterile absorbent cotton between layers of gauze, or, better still, prepared oakum or jute covered with gauze constitute the dressing material. Irrigation at the time of the dressing is not generally necessary unless the pus is foul at the time of operation or become so later, which should be prevented by careful dressing. Irrigation in dressing may cause as much shock as operation. It sometimes produces a rise of temperature apparently brought about by increased absorption of toxines. As before stated, irrigation should be reserved for fetid cases, and this provided the opening is not sufficiently large that the cavity can be packed dry with iodoform and sterile gauze. (40)

Care should be taken that the drainage tubes are not too long, and especially that they do not impinge on the expanding lung. If the tube or tubes reach fairly within the pleural cavity it is sufficient. To find the tube displaced from the incision may indicate that it has been thrust out by the expanding lung. Neither should the outer end of the tube project far from the skin surface. Many ingenious contrivances have been made for drainage tubes in empyema; by wiring or suturing the rubber tubing to a flat rubber sheet through which it has been thrust, or to a split piece of similar tubing, and the like. But that most easily prepared is made by pinning together with a safety-pin two or three pieces of tubing of the caliber of a cedar pencil, one piece being fenestrated. When in place the pin lies across the wound and prevents the drains from slipping into the cavity. In dressing, a piece of folded gauze should

be placed beneath the ends of the pin. A better device is the eyelet-shaped drainage tube made of soft rubber. (See Fig. 187.) It is known as the Flint empyema tube. The wider flange is left outside. With this tube there is no chance of thrusting an end against expanding lung, and no pain incident to replacing a tube which has been let slip out. The only objection to it is that on final removal of the tube there is a certain amount of pain, and maybe some little bleeding from granulations. The tubes are made single or double and in various lengths, from half an inch to two inches.

The opening will continue to discharge very freely for days

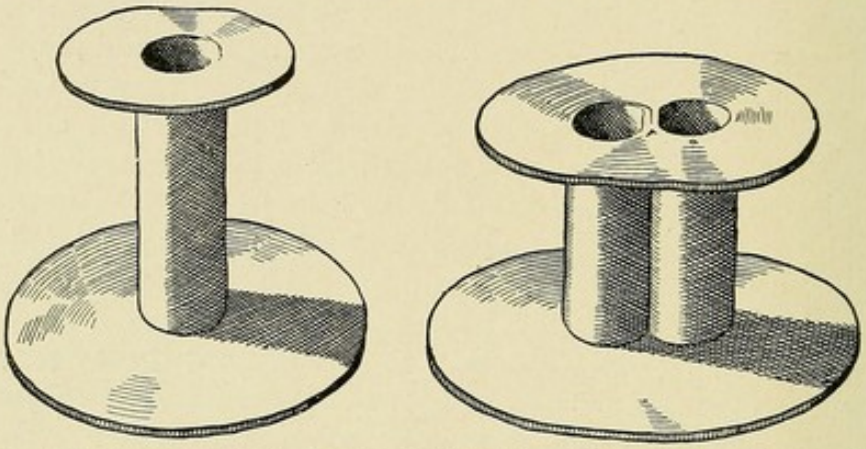


FIG. 187. FLINT EMPYEMA DRAINAGE TUBES. The wider flange is left outside the thoracic wall.

and less freely for several weeks, lessening gradually. A sudden stoppage of the flow by a plugged drainage tube will be promptly followed by a rise in temperature.

The expansion of lung that is the great desideratum may take place to a degree as soon as the chest is opened. But a failure to expand noticeably at that time or even in a few days subsequently should not be regarded as discouraging. Remarkable expansion may occur many days after the pressure is released, and sometimes it appears to come rather suddenly after long delay. Expansion should be promoted by breathing exercises, laughing, crying, singing, blowing soap bubbles, or wind instruments, or the apparatus devised by James with which the child is induced to blow colored fluid from one bottle into another. No class of patients more imperatively requires good ventilation, or, if possible, life out of doors in all but positively inclement weather. When the cavity has shrunk in its dimensions, the discharge has become serous and small in amount, one of the drainage tubes may be removed; and when the discharge is no greater than would be caused by the presence of the drainage tube, the latter may be removed entirely, the sinus being filled with antiseptic gauze at each dressing, until this also is crowded out by the healing process.

After several weeks, if the discharge has diminished to a very small amount, and the opening has lessened to a mere sinus, and such a sinus refuses to heal, and if no cavity within the chest is to be found by probing, it may be that a portion of the rib has necrosed. This may take place either following simple incision or excision of rib, more frequently the former. In incision cases it is the edge of a rib which becomes necrotic; in excision cases one of the cut ends. The sequestrum should be removed even though it may require, as it probably will, anesthesia and a dissection in order to do so.

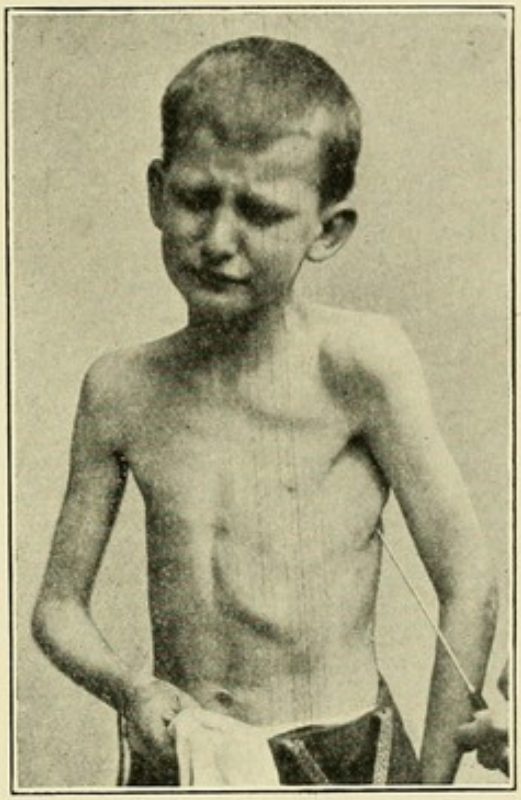


Fig. 188. Johnny F., aged 11 years. After excision of rib for drainage of empyema. The lung failing to expand sufficiently, a cavity and sinus persisted, requiring more extensive resection.

Thoracoplasty.—In cases in which a cavity remains, the fault lies not in the unhealthy condition of its lining. So that irrigation with a solution of bichloride of mercury, or carbolic acid, or boracic acid, or iodine, or permanganate of potash, or, worst of all, hydrogen peroxid, which have been used with the idea of promoting granulation, are useless or harmful. To close a cavity of any considerable size, the lung and chest wall must meet either by expansion of the former or collapse of the latter, together with expansion of the opposite lung and elevation of the diaphragm. Operations either to remove the adhesions binding down the lung or to collapse the chest wall are not to be undertaken without due consideration, and yet, as the alternative is a continued suppuration with hectic fever and exhaustion or lardaceous disease, they are to be urged and performed in all suitable cases. (See Fig. 188.)

When further expansion of lung is impossible by reason of its carnified condition or immovable adhesions, it is necessary to collapse the chest wall by excising portions of several ribs, usually the sixth and fifth, sometimes also the fourth, and, if necessary, from the third to the eighth or ninth inclusive, though this extensive resection is seldom required in children. The number of the ribs and the length of the pieces to be excised should be such as the surgeon judges sufficient to enable the chest wall to be depressed

inward far enough to meet the lung, and may vary from one to three inches, or may be from the cartilage to the tubercle of the rib or ribs removed. (See Fig. 189.) As a rule, the pieces of rib removed should be the greater part of an inch longer than the diameter of the cavity; and care should be taken to remove as much from the upper as from the lower ribs. The position of the cavity will also be considered in selecting the portions to be removed. Usually they are in the axillary line. The sinus locates the center of the first incision and a single rib is excised as above described. The extent of the cavity can then be ascertained and portions of other ribs be removed as necessary. If the first incision be through an intercostal space, two ribs can readily be excised through the same incision by reflecting the skin-flaps. If it is necessary to excise other ribs, a second incision can be made at right angles through the center of the first. Or an incision at each end of the first extended either upward or downward or both ways will permit adequate flaps to be raised or turned down and the ribs exposed.

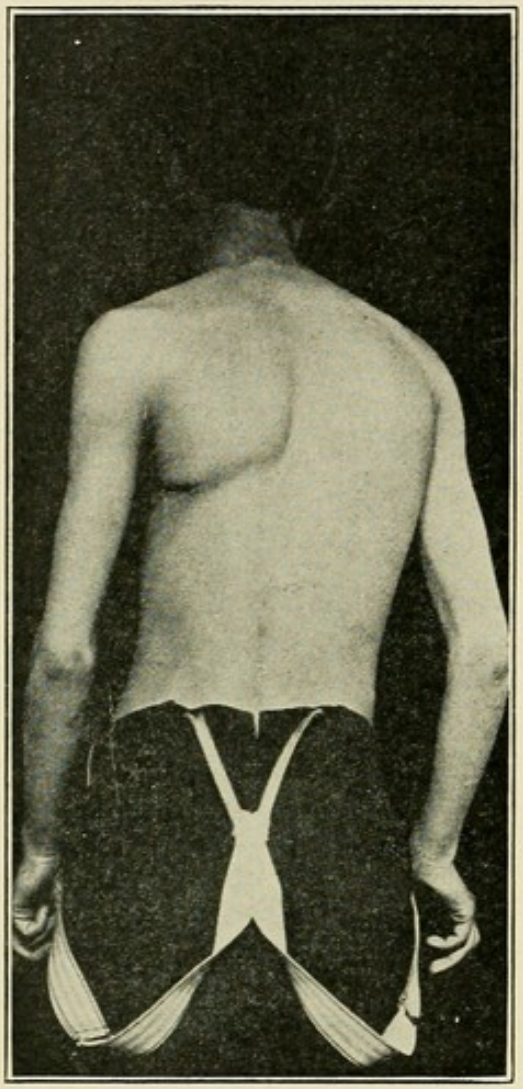


FIG. 189. Same case as 188, at the age of 18, seven years after resection of 15 inches of ribs. Retraction of thoracic wall and spinal curvature. Gymnastics rather than supporting apparatus are advised in such conditions.

Extensive excision of ribs for the cure of empyema is generally known as Estlander's operation, he having published a paper on the subject (in 1879), although it was previously done by De Cerenville (1876) and others. In this connection the following is of interest: "An idea has generally prevailed among surgeons that if the pleura costalis were divided in the living subject, the lung would immediately collapse, as it is usually found to do in the dead one. But M. Bremond[1] has shown by experiments that not only when

[1] Memoirs L'Acad. Des Sciences, 1739.

an opening is made into the cavity of the thorax, but even when some of the ribs are removed the lungs will occupy their natural situation, and are even thrust up into the opening during expiration. Mr. Norris [1] has also lately shown, by experiments undertaken for this purpose, as well as by observations upon the effects of accidents, that frequently the lungs do not collapse when the cavity of the chest is exposed in the living animal. And I have also had occasion to observe, on dividing the pleura costalis in a case of supposed hydrothorax (in which, however, no water was found), that the exposed lung did not collapse, a circumstance which, I think, ought to encourage us to a more frequent performance of such an operation. In other experiments, however, the lungs have been known to collapse, and the circumstances on which either of these effects depend are not perhaps well understood.[2] Estlander excised only the ribs, leaving the remainder of the chest wall, including, as it does in many cases, an immensely thickened costal pleura capable of doing a great deal to prevent collapse of the chest and healing of the cavity. While in some instances the periosteum will so quickly reproduce bone that the condition is much the same as before operation, the newly formed bone propping the chest wall before collapse is completed.

For use in these cases of long standing, where there is unexpanded lung, a cavity of considerable size with greatly thickened chest walls, Schede [3] devised and practiced an operation which since bears his name. Schede's operation differs from Estlander's in that not only the ribs but the periosteum and intercostal muscles and thickened costal pleura also are removed. The technique is as follows: The incision begins on the front of the chest at the level of the axilla, extends downward, curving backward to the lower limit of the pleural cavity, thence curving upward posteriorly to the level of the second rib between the scapula and the spine. The flap, consisting of all the soft parts down to the ribs and including the scapula, is then raised. Each rib is then divided in the center, each end caught with bone forceps and the rib broken out to the tubercle posteriorly and to the costal cartilage anteriorly, the remaining structures of the chest well sheared through and removed. The intercostal arteries are clamped and tied if necessary. The visceral pleura is then thoroughly curetted and the flap applied to its surface and sutured in place, all but the lowest point for drainage, and union by first intention is expected.

Keene practiced and published [4] in this country an operation

[1] Memoirs Med. Soc. of London, Vol. IV., p. 440.

[2] Surgical Works of John Abernethy, F. R. S., Vol. II., p. 181, London, 1822.

[3] Verhandl. d. Cong. Innere. Med. Wiesb., 1890, Vol. IX., p. 41.

[4] Annals of Surg., June, 1895.

practically the same as Schede's, without knowing of Schede's preceding publication. Keene's operation differs from Schede's in that he does not first excise the ribs and then the pleura, but divides the entire chest wall under the soft parts with a strong pair of bone pliers.

Many modifications of this operation have been made. The flap, instead of being horseshoe-shaped, may consist of a triangle or of two triangles, the incision having been shaped like a capital L or like an inverted T (⊥), with the transverse incision on the lowest rib to be resected, and the vertical incision in the axillary line. Or it may be H shaped, with two rectangular flaps. The ribs may be sawed (a needlessly slow process). The pleural cavity may be scraped, or be " peeled " with the aid of scissors.

All operators will probably agree with Gerster that this operation is one of great danger on account of shock and depression from the profuse hemorrhage. It is quite a bloody operation, especially when decortication is also done, although not always accompanied by the amount of hemorrhage one would expect from the normal size of the numerous vessels divided, as the previous inflammation may have occluded them, and, as Keene remarks, the crushing of the pliers may prevent the hemorrhage. An assistant diligent in the use of hot gauze pads or towels may prevent extensive hemorrhage from the large surfaces exposed and which cannot be clamped, while the operator proceeds rapidly to complete his work. The cavity, after its surface has been covered with iodoform gauze, is usually packed with sterile gauze. The skin flaps are placed over the dressing and all margins not needed for drainage are coapted and sutured. Healing by adhesion of granulating surfaces is more frequently obtained than by first intention.

Delorme [1] cut through the whole chest wall, including skin, muscles, ribs and costal pleura, and through this extensive door removed the thickened masses from the visceral pleura. The flap was then replaced and closure of the cavity by expansion of the lung was expected. If the lung then failed to expand, the result of the operation was a failure. This operation of decortication without sacrifice of a portion of the chest wall, or at least portions of the ribs, has not been found effective by many operators.

These extensive resections are only to be undertaken in obstinate cases and in older children, and after careful examination for amyloid changes and nephritis. They are very badly borne in young children, often proving fatal in those under two years of age. Fortunately, in infants, owing to their readily yielding chest walls, even Estlander's operation is very seldom required. If para-

[1] Gazette d. Hop. Par., 1894. LXVII., 94, 96. Nouveau Traitement des Empyemes Chroniques.

Jaboulay's operation, separating six or seven of the upper ribs from the sternum has not displaced Estlander's operation.

DOUBLE EMPYEMA may occur, and when it does it doubles the necessity of prompt surgical interference. Aspiration should be done first and may be performed upon both sides at the same sitting; a few days later a free incision or excision is made upon one side and an interval of some days should elapse before the other side is operated upon.

BISMUTH PASTE INJECTION [1] has gained recognition as a method of treating suppurating cavities and sinuses remaining in empyema, lung abscess; Pott's disease, and other fistulous tracts and abscess cavities, superior to previous methods of injecting hot vaseline, parafine, etc. Used promptly it may preclude thoracoplasty or it may successfully follow Estlander's, Schede's and other operations that fail to close the cavity. The paste ordinarily used is one part bismuth subnitrate or subcarbonate, to two parts sterile yellow vaseline; but it may be diluted as low as five parts bismuth to ninety-five parts vaseline. From a few drachms to several ounces of this paste, warmed to fluidity, are injected into the cavity with a piston syringe. Bronchial communication is no contra indication. The effect is, that the pus becomes sterile, suppuration ceases, cough, fever and wasting disappear, the patient gains weight, and, if there is no necrotic bone present, the sinus closes.

The paste is thought by Beck to act by chemotaxis. Possibly it acts also by pressure, and, slightly as chemical antiseptic. Reinjection is practiced only when the paste has discharged and microorganisms are still found in the pus. After injection a pad of sterile gauze is applied daily until the sinus closes. If fever rises to 101 F. or the patient complains of severe pressure the accumulated fluid should be drained off, and the sinus be allowed again to close. Possible symptoms of poisoning may appear. These are cyanosis, blue borders on the gums, albuminuria, dyspnea, diarrhoea, loosening of the teeth, rapid loss of weight, death unless relieved. A slight blue line along the gums only, is not regarded as alarming but should be closely watched. Poisoning is treated first by removal of the paste by injecting the cavity with warm sterile olive oil, and withdrawing the resulting emulsion by suction pump next day. Large quantities of water should be ingested, iodine administered internally, and elimination promoted. (41 and 58.)

CARDIOLYSIS OR PRÆCARDIAL THORACECTOMY

This, according to Berger (Semaine Medicale, Sept. 7, 1910), is practicable in adhesive mediastinal pericarditis with healthy myocardium. (58.)

[1] Instituted by Emil G. Beck, 1907. Jour. Am. Med. Assn., Mar. 14, 1908; Dec. 18, 1909. A. J. Ochsner, Ann. Surg., July, 1909, p. 151.

CHAPTER XX

THE ABDOMEN, ITS MALFORMATIONS AND DISEASES

Its Anatomy in Infancy and Childhood—Omphalitis—Arteritis and Phlebitis—Septic Peritonitis—Umbilical Hemorrhage—Paralysis of Abdominal Muscles—Acute Peritonitis — Appendicitis — Chronic (Non-tuberculous) Peritonitis—Tuberculous Peritonitis.

ITS ANATOMY IN INFANCY AND CHILDHOOD

In the infant and child the abdomen normally is large in proportion to the whole individual, and appears more so because of the small size of the thorax and pelvis. It contains not only the organs found in the adult, but the bladder and upper end of the rectum. In the new-born the liver is very large in proportion, being one-eighteenth of the whole body weight. In the adult it is one-thirty-sixth. If a line be drawn from a little below the lower margin of the thorax on the left side to a few centimetres above the crest of the ilium on the right, the liver will be found to occupy the space above it, which is nearly one-half the abdomen. In the other half are the intestines, the stomach, spleen, upper portion of rectum and the bladder. (Ribemont.) It is in order to accommodate this large liver and the bladder and rectum, which have not sufficient room in the diminutive pelvis, that the abdomen is so large. The large intestine occupies somewhat the same position that it does in the adult, but the cecum is apt to be a little higher and not uncommonly projects to the middle line or even to the left of it, and during the first two years of life may not have taken the position to the right side of the abdomen. The colon in its ascent from the cecum soon comes in contact with the liver; and sometimes instead of crossing transversely to the splenic flexure, it crosses to the left diagonally downward. The sigmoid, with its long meso-sigmoid, instead of occupying its usual adult position in the left hypogastrium, may lie across in the supra-pubic region or over to the right near the cecum, or it may hang down into the pelvis, and give rise to a variety of partial fecal impaction. (Jacobi.) The abdominal walls themselves, excepting the subcutaneous fat, are very thin. In the region of the kidneys the muscles are so slight as to offer but little protection to those organs. The omentum, which in the adult is often such a substan-

tial apron loaded with adipose tissue, in the infant, as Mr. Owen says, "but thinly shadows forth its future greatness." The umbilicus is placed relatively low. In the new-born it is at the central point or one to two centimetres below the central point, of the whole figure. It is low also with relation to the vertebræ. In the adult the umbilicus corresponds to the lower border of the third or upper border of the fourth lumbar vertebræ. In the infant it is level with the disc between the fourth and fifth lumbar vertebræ (Ballantyne), being therefore fully one vertebra lower, and but a little above the level of the iliac crests. With growth of the pelvis, lower abdomen, and of the lower extremities, the umbilicus becomes relatively higher up on the abdomen and the os pubis becomes the central point of the whole figure. Other anatomical peculiarities in the young subject will be pointed out in discussing the diseases of special organs.

Examination of the Abdomen.—The examination of the abdomen in infants and children is often extremely difficult. Through fear or restlessness or nervousness the position so constantly changes or the muscles are rendered tense that in some instances it may be impossible to make satisfactory examination without sleep, either natural or induced by an anesthetic. The abdomen may be found distended by gases, and this may be uniform, or confined to a certain portion if obstructed bowel prevents its distribution throughout the entire canal. Fluid free in the peritoneal cavity will cause uniform distension; but an enlarged viscus or a tumor will produce a localized swelling. Enlarged veins upon the surface of the abdomen are found with any enlargement which impedes the return circulation, whether this is due to chronic peritonitis with effusion, or tumor, malignant or innocent. The abdominal walls may be flattened or depressed, especially in acute brain or meningeal disease; or relaxed in collapse or early in intussusception. They may be so extremely wasted and transparent that the coils of the intestines and peristalsis may be readily observed by sight; and in cases of pyloric stenosis the reverse peristalic wave of the stomach may be seen.

Palpation of the abdomen by a warm and gentle hand is exceedingly valuable, but more difficult than inspection. The thin walls of the child's abdomen would offer but a slight barrier to the sense of touch if these were only relaxed and unresisting. If this condition can be secured by sleep or by distraction of the attention much valuable information may be obtained. The tumor of intussusception or of a new growth or of enlarged liver or spleen, or mesenteric glands, or fecal impaction, or distended bladder, or enlarged or displaced kidneys, or an abscess, or a sacculated ascites, may be palpated; and wave impulses sent through a collection of fluid. The most difficult points to establish are those we are often very anxious to ascertain, namely, whether there is muscular rigidity, and whether

there is pain or tenderness. Much tact, patience, and experience will all be necessary to success in this part of the examination.

Percussion will enable the examiner to determine whether an enlargement is gaseous or of more solid consistency. But it should be remembered the tension may be so great in gaseous distension that the percussion note almost simulates dullness; and that the proximity of a viscus distended with gas will often give a tympanitic note when percussing a solid body. A much lighter tap of the finger than would be necessary in the adult gives a truer note.

Malformation at the Linea Alba and the Umbilicus.—Sometimes there is a failure of the ventral laminæ to meet in the middle line, thus causing a hiatus of the abdominal wall. If this occurs in the region of the bladder the anterior wall of that viscus may be lacking—extroversion of the bladder, (*q. v.*). In less severe deformity, where only the recti muscles fail to meet, a ventral hernia may result. The protrusion may be a portion of the liver—hepatomphalos—or intestines or stomach. The condition is to be treated by the application of pad and binder or by operation bringing the muscular margins of the opening together and uniting them by suture.

The umbilical cord may retain its fetal condition, containing a coil of intestine or other organ enclosed in a more or less distended sac outside the plane of the abdominal wall—exomphalos. The cord may be so thin and transparent that its contents can be plainly discerned, or it may be so normal in external appearance and so little distended that a loop of intestine might be ligated within it and cut without suspicion on the part of the accoucheur. Or the structures of the cord may appear as though spread out to form a portion of the abdominal wall left incomplete by failure of the ventral laminæ to meet in the middle line, and on sloughing away leave the abdominal wall deficient. Closure by approximation of the margins and suture is indicated, and may succeed, but often fails. These deformities are analogous to hare-lip and cleft-palate, spina bifida, epispadias and hypospadias, and some forms of meningocele.

Meckel's diverticulum may open at the umbilicus, thus producing a fecal fistula. Wright ligated the protrusion and strapped the opening, procuring a closure. Owen advised emptying the bowel thoroughly by purgation and the subsequent use of opium to induce rest of the parts; in the meantime applying a dry pad and leaving it undisturbed. Wright thinks this treatment applicable rather to older children than to infants. For umbilical hernia, see Chapter on Hernia, and for patent urachus see the Chapter on Genito-urinary Organs.

OMPHALITIS

Infection by septic organisms may give rise to inflammation of the umbilicus and of the abdominal wall surrounding it. It usually

occurs in the first few weeks of life, often the second or third week, beginning before the umbilicus has healed, although it may apparently have done so. The cause may be any of the common pyogenic bacteria, either staphylococci or streptococci, or more rarely the gonococcus or pneumococcus. According to the virulence of the inflammation and the resistance of the tissues the disease remains local and superficial or it may involve the whole thickness of the abdominal wall and extend over a large area, or attack the umbilical vessels or the peritoneum; and may terminate in resolution in abscess or in gangrene.

Symptoms.—The symptoms are redness, swelling and infiltration; and sometimes ulceration, bleb formation and sloughing, with constitutional symptoms of septicemia.

Treatment.—(See Sections on Septic Peritonitis, Cellulitis, Septicemia.)

ARTERITIS AND PHLEBITIS

Infection conveyed by the lymphatics and involving the connective tissues may attack the blood vessels. Contrary to the prevailing belief, Runge considers arteritis very much more common than phlebitis, the vein being alone diseased in only about one-half of one per cent. of the whole number of cases. The disease of the vessels may follow omphalitis or there may be no external evidence of inflammation. The arteries as far as the bladder may be affected, becoming thrombotic, and containing pus, which sometimes oozes out at the umbilicus. Other septic foci also develop, in cellular tissues, joints, bones, periosteum, kidneys, spleen, the parotid glands, the meninges, or, most commonly, the lungs. Phlebitis may extend to the liver and give rise to hepatitis with multiple abscesses, and jaundice.

SEPTIC PERITONITIS

This usually originates in omphalitis, or in arteritis. It may extend generally over the abdomen or remain localized near the umbilicus or the liver. There is free exudation of plastic lymph with formation of adhesions, sometimes with abscesses pocketed among the adhesions.

Symptoms.—The symptoms are dorsal decubitus, rigid abdominal muscles, flexion of the thighs upon the abdomen, and thoracic breathing. General symptoms of sepsis accompany these infectious inflammations. (See Sections on Septicemia, on Erysipelas and on Cellulitis.)

Treatment.—The treatment of omphalitis or of any of its complications that can be exposed, is the same as the treatment of pyogenic inflammation elsewhere: thorough cleanliness; the use of antiseptic washes or wet compresses, with solution of salicylic acid (Runge), boric acid, mercuric bichloride and the like, of a

strength to meet the virulence of the infection and the stage of the inflammatory process. All accessible abscesses are to be evacuated and washed out and drained. Treatment of erysipelas and septic cellulitis will be found in appropriate sections. In pyemic abscesses of brain, liver, lung and peritoneum little can be done. All cases suffering with septic diseases need the best of nourishment and often the free use of stimulants.

UMBILICAL HEMORRHAGE

Hemorrhage may follow imperfect ligature of the cord or cutting of the cord by a thin ligature; or by slipping of the ligature; or by its becoming loose by shrinking of the cord after it is cut. A cord will not invariably bleed even if left untied. But bleeding occurs under certain conditions of asphyxia and of imperfect muscular action and in certain states of the blood. It may occur idiopathically or spontaneously as a symptom of hemophilia, or of syphilis or of hemorrhagic disease or of fatty degeneration of the new-born. In these children the coagulation time of the blood is slow; and it seems almost impossible in some instances to stop the flow. It is this form which, while more rare, is also more dangerous. It is apt to begin a few days after birth, either just before or just after the separation of the cord—very often about the fifth day. It may be accompanied by hemorrhage from stomach or bowels, or purpuric spots beneath the skin, or edema of extremities; or it may be the only manifestation of the hemorrhagic tendency. The child may have appeared quite healthy and doing well up to the beginning of the hemorrhage; or an apparently healthy baby may show some drowsiness, perhaps vomiting, cyanosis, or icterus or other disturbance before the bleeding begins. The hemorrhage takes place as a general oozing from the umbilical site or around the stump of the cord. No individual vessel can be seen either spurting or flowing. The peculiarity of the hemorrhage is its persistence. A fair example of such a case is one seen by me in consultation with Dr. Robert Bailey. On the first day of the babe's life a slight pin scratch on the babe's leg bled forty-eight hours. On the third day the umbilicus bled persistently. The cord was not yet detached, but at its point of attachment blood oozed continuously. Dr. Bailey had tried collodion covered by adhesive plaster, tannic acid, Monsell's solution, lead acetate, sulphate of copper, and other astringents. The extract of the adrenals was then unknown and calcium chloride not used. But the oozing continued. I finally transfixed the cord with two needles at a distance of an inch or more from the belly wall, and then wound the cord beneath the needles as if it were a spool, with woollen yarn. This stopped the bleeding. Albuminate of iron was prescribed. The baby recovered. In this case the cause

was probably hemophilia. The same mother had lost one infant of umbilical hemorrhage, and other infants had been lost from the same cause by her mother and other relatives. Among the remedies recommended are the actual cautery, galvano cautery, underpinning and ligaturing, adrenalin chloride locally and internally and calcium chloride internally. (See also Hemophilia.)

Umbilical Polypus is described in the Chapter on Tumors.

PARALYSIS OF ABDOMINAL MUSCLES

This may follow poliomyelitis anterior acuta and may be very puzzling unless its possibility be borne in mind.

ACUTE PERITONITIS

Acute peritonitis does not so very often come under the notice of the children's surgeon; yet whenever it does so it presents interesting and important conditions. No child is too young to have peritonitis, either acute or chronic. It may occur in the fetus; not, as was formerly supposed, always because of syphilis, but from the poisons of the exanthemata circulating in the mother's blood, or septic causes, or possibly trauma, or inexplicable causes. Doubtless fetal peritonitis accounts for some of the cases of malformations of abdominal viscera, and of adhesions between them, which occasionally give rise to serious symptoms later.

Acute peritonitis of the new-born has been alluded to in connection with inflammations of the umbilicus. After this period it is quite rare throughout infancy, but becomes more prevalent in childhood and youth. It is primary, or more often secondary. It may be due to accidental traumatism, blows, falls or burns, or to surgical traumatism, or possibly to exposure. When secondary it may arise in mechanical causes such as malformations, intussusception, strangulation of intestines, volvulus, or foreign bodies, or from extension of inflammation in adjacent structures, such as inflammation of the abdominal parietes, pleurisy, perinephric abscess, spinal caries, caries of pelvic bones. Or peritonitis may occur in the course of or following scarlet fever, influenza or penumonia, or other infectious disease. Or it may come from disease arising in the gastro-intestinal tract or its appendages. From this source appendicitis is a representative and one of the most frequent causes of peritonitis in the whole list. Perforation or extension from typhoid ulcer or other ulceration of the intestine, or from gastric ulcer is extremely rare in children.

Infections from the genito-urinary tract are comparatively rare, in marked contrast to the frequent uterine and tubal implications of the peritoneum in the adult. But gonorrheal vulvo-vaginitis in

girls may originate peritonitis. The microbic cause of peritonitis is most often the streptococcus in the septic infections of the newborn, the pneumococcus, and the bacterium coli communis.

Pathology.—The inflammation may be localized or general. In children there is a strong tendency for it to become general. It may present one of three forms: fibrinous, serous, or purulent; or according to the infection or re-infection it may merge from one of the slighter to a more severe type. In children the tendency is to become purulent. In the fibrinous form there is vascular injection and escape of plasma and corpuscles. The lining endothelium of the membrane becomes swollen and its cells desquamate. There is exudation of a small quantity of serous fluid and a larger amount of plastic lymph, most abundant where coils of intestine are in contact. Here the membrane is most reddened and swollen and covered with the yellowish-white fibrinous exudation. Adhesions are produced between any adjacent serous surfaces. These adhesions, soft and yielding at first, become tenacious after a time.

In the serous form the inflammation induces a free outpouring of serum, the lymph being in comparatively small quantity. The serous exudate frequently undergoes absorption. If adhesions occur in this form they are not as extensive.

In the purulent form the exudate may be only fibro-plastic or serous at first, and then rapidly become purulent; or it may become purulent from the beginning, depending on the nature and virulence of the infection. If the inflammation begin locally and fibro-plastic adhesions have taken place before pus formation, the result may be a localized peritoneal abscess. Or with rapid extension of the purulent inflammation the pus may be free in the peritoneal cavity. Or it may be contained in numerous pockets formed by adhesions between coils of intestines or other viscera. If the patient survives, such abscesses may discharge externally, either through the abdominal wall or by burrowing to the surface at a distance or by bursting into any of the hollow viscera. It is said the non-tubercular peritoneal abscess, the pneumococcic variety especially, tends to discharge at the umbilicus.

Symptoms and Diagnosis.—Sudden onset is the rule, with high fever, vomiting and pain. In some cases there is little fever. The patient prefers the dorsal decubitus with the thighs flexed. The abdomen soon becomes swollen, tympanitic, tender, with its muscles rigid. The respiratory movements of the diaphragm are restricted. The tongue is dry and red. Thirst is tormenting, but drink not retained. Pulse rapid and small and at first hard, later thready. Constipation is the rule, to which there are exceptions. The mind remains clear. Death occurs in the majority of cases, often with the Hippocratic face, a wet skin, a running pulse and collapse.

Infants may succumb on the third or fourth day. Older children survive a week or ten days. In some cases, hectic fever, chills and sweats indicate pus formation. Perhaps dullness and fluctuation can be made out at some location. The navel may protrude, become red, soften and open, discharging a quantity of pus; or the abscess may point in the hypogastrium or in the loin. The pus varies in character and consistency. In the pneumococcus infection it is apt to be creamy, greenish and ready to clot. With the bacillus coli there is a vile odor.

If peritonitis sets in after an abdominal operation, the pain which was present before, instead of disappearing or at least subsiding, grows worse. Vomiting, if absent before, now appears; or if present before persists and becomes more troublesome. The abdomen becomes tympanitic and tender. The face looks anxious and distressed. The patient prefers the dorsal decubitis and flexes his thighs as before described. Temperature and pulse may run up; but of still graver import is a falling temperature with a rising pulse.

Prognosis.—The prognosis is very serious indeed in all cases. Yet they vary somewhat according to cause, extent and location. The septic infections, especially those of the new-born, are usually fatal. In older children, as a rule, there is some hope. If the inflammation is localized the outlook is not so bad, even if suppuration ensue. In the fibrinous form there is hope even if the inflammation is general.

Treatment.—Treatment depends on the cause, and the stage of the inflammation. Opium is a drug which has in the past been almost invariably resorted to in peritonitis on account of the pain, which is often severe. If the pain is not beyond endurance opium should be withheld or very sparingly used, at least until the bowels are thoroughly emptied. For this purpose salines, citrate or sulphate of magnesia are the best if the stomach will tolerate them. The saline should be given in broken doses and well diluted. It is often well to give a few doses of calomel before the saline; and if the stomach rejects the saline the purgation is secured by calomel. After the bowels are thoroughly emptied it is not well to continue active purgation for any length of time for the sake of depletion. Rest is at that time of more value, and affords nature an opportunity to "wall off" the inflammatory focus. Copious irrigation of the bowels with normal saline solution at this time aids in emptying them. Later, if vomiting persists, saline injections are used to relieve thirst and furnish water to the circulation for purposes of the elimination of toxines by the natural emunctories. As much normal saline should be supplied to the bowels all through the illness after the early cleansing as they will absorb. As an external application

cold is of the greatest value. Children will object to the icebag if it is applied too near the skin, but usually not if a layer or a few layers of flannel are placed between the icebag and the skin. Young children are very easily affected by cold, and can be seriously depressed by it. The ice should be broken small and the icebag made comfortably flat, and only comfortably cold. Pain and tenderness can be greatly relieved by smearing the abdomen with ext. bellad. ℥i to glycerine ℥i, under oil silk.

Heat also relieves pain, but it does not check the acute inflammatory process. It should be used in the depressed cases with low temperature.

The tympanites can be relieved by turpentine stupes or by injections of milk of asafetida in water. If the invasion of the peritoneum results in suppuration, or is caused by intestinal perforation or the bursting of an abscess into the cavity, laparotomy is indicated. The perforation must be repaired or the abscess emptied and washed out, and the abdominal cavity thoroughly flushed with hot normal salt solution, drainage introduced into its lowest portion and the incision closed, to the drainage. The head of the bed should be raised, placing the patient in "Fowler's position," since the lower portion of the peritoneum is less active in the absorption of toxines than that nearer the diaphragm. If the stomach becomes quiet, stimulants, and food in the form of broths and peptones, can be swallowed. Otherwise they must be given per rectum. (42)

APPENDICITIS

Few diseases have been more fully discussed in recent years than this one. Its prevalence, causation, pathology, symptomatology, diagnosis and treatment, especially operative treatment, have each been considered in every phase. At the present time, although opinion is not quite unanimous upon every minor point, all are agreed that our knowledge of the disease and success in handling it have advanced remarkably, and upon the main features of the subject there can be no question. The disease many of us as medical students were taught as typhilitis and perityphlitis, and treated medically up to the stage of a pointing abscess, is now considered under the heading of appendicitis and is regarded as a surgical disease from the time the diagnosis can be made. Whether there is such a disease as perityphlitis occurring independently of the vermiform appendix is doubtful. It seems possible, considering the anatomy of the cecum and its liability to impaction; yet it is now known to be very rare, if it ever occurs, as compared with inflammation of the appendix.

Etiology.—The earlier theory that appendicitis is frequently caused by a foreign body has been abandoned, although no one doubts that foreign bodies are occasionally found in the appendix.

Quite frequently fecal concretions are found molded into the shape of fruit seeds or the like, and these may formerly have been regarded as foreign bodies. Their relation, if they have any, to appendical inflammation is uncertain. It seems probable that they may prove a source of irritation, or interfere with the circulation and cause pressure necrosis, or delay the expulsion of mucus and so form a nidus for bacteria. But some regard them rather as an effect of a low grade of inflammation, the mucus which results being mixed with fecal matter and forming the concretions.

As Morris Richardson remarks, "The worst thing that can get into the appendix is a bacterium." Many varieties of bacteria have been found associated with this disease, among which may be mentioned the bacillus coli communis, the staphylococcus pyogenes aureus, the streptococcus pyogenes, the proteus vulgaris, and the pneumococcus. The most common and the most active are the streptococci and the bacillus coli. The reasons why these organisms so frequently are able to attack the appendix are thought to be: Because it is a vestigeal organ undergoing a retrograde metamorphosis, and therefore its vitality is low; because of the anatomical peculiarities of the structure, shape and position of the appendix itself and of the mesentery; and of its imperfect drainage. Age, sex, food and condition of the digestive organs have some influence as well as the effects of typhoid fever. Holt considers appendicitis exceedingly rare in infancy, having never once been found in about 2000 autopsies, nearly all upon children under two years of age, in three institutions with which he was connected. But he has seen it once at nine and once at fourteen months; and quotes a case of Goyens in an infant only six weeks old, one of Shaw's and one of Demme's each at seven weeks, and Savage's at nine weeks old. D'Arcy Power quotes a case by Tordeus of perforation of the appendix, with a fatal result, in a babe of six months; and a similar case by Balzar in a babe of seven months. Deaver states that 15 per cent. of all cases occur under the fifteenth year, of which but few are under the fifth year. Whether this is because time is necessary for the formation of coproliths, which are, after all, predisposing causes, or how much change of diet and digestive disturbances of long standing, exposure, trauma, the lowering effects of various exanthemata, and the overgrowth of connective tissue, worms, oxyuris and lumbricoid, have to do as predisposing causes are still subjects of study.

The greater liability of the male sex to appendicitis is as conspicuous in childhood as in later life, the proportion of boys to girls being two to one (Manly). This is at least partly accounted for by the better circulation through the appendiculo-ovarian ligament.

The different types of cecum and of appendix, and the variations in the location of the former and the position and direction of the latter as they are found in the adult are all explained in works

on general surgery. All these are found with equal frequency in the child, which has, besides, peculiarities of its own. That type of adult cecum and appendix in which the cecum tapers to a funnel or conical shape as it merges into the appendix, known as the fetal type, is more apt to be met in the very young. While this shape would apparently favor the passage of material from cecum into appendix, the absence of constriction at the junction of cecum and appendix also favors emptying of the latter. The appendix is developed early in the embryo, while the intestines have not reached their full development at birth. They continue the process rapidly for a time after birth, the appendix not continuing to develop but changing its position and shape according to the transitional migration of the cecum and the control of the meso-appendix. When compared with the appendix of the adult, that of the infant is larger in proportion to the body, and is considerably larger in proportion to the size of the entire alimentary canal. The coats of the appendix, especially the sub-mucous coat, are more delicate in the young subject. (H. A. Kelly.) In many children the meso-appendix is very short, leaving that portion of the appendix which extends beyond it deficient in vascular supply. The primitive position of the cecum in the embryo is in the left of the middle line near the height of the umbilicus, from which position with development and growth it rotates, moves to the right and descends. A part of this relative change of position is due to the ascent of the umbilicus. (See the beginning of this chapter.) In many young subjects the location of the cecum, and with it the appendix, varies considerably from the adult type, where we look for it in the neighborhood of "McBurney's point," that is, on a line between the anterior superior spine of the right ilium and the umbilicus, at the outer border of the rectus muscle. Instead, it is often higher and farther toward the middle line, or even projecting beyond it, having not completed the usual change of position to the right and downward. (Young, Dwight, Ballantyne.) Or in unusual instances, as in one of my cases, the cecum and appendix may be found in an inguinal or scrotal hernia; or it may be up under the liver or near the spleen or kidney. The omentum in the young subject is both small and filmy and affords but a slight barrier between the general peritoneal cavity and a diseased appendix.

Pathology.—Appendicitis may be described as acute, and chronic or recurrent; and as catarrhal, suppurative or gangrenous. Ulceration and local perforation, which are sometimes classified as separate forms of the disease, are as well described as sub-varieties of the suppurative and gangrenous forms.

Catarrhal Appendicitis is an inflammation of the mucous membrane of the appendix with swelling of its follicles and round

cell infiltration. This leads to pouring out of mucus or muco-pus which distends the appendix. The follicular inflammation may result in ulcers which, however, do not extend deeper than the mucosa. The inflammation and infiltration may penetrate to the muscular and even to the serous coats, and the organ become swollen to many times its natural size, stiffened and edematous. This may entirely subside and complete recovery follow; or more likely there will remain some changes, such as partial or even complete closure of the lumen by cicatricial constriction; or adhesions to surrounding structures; or the inflammation may progress and merge into the suppurative form; or after subsiding for the time being, be followed by a chronic inflammation or by recurrent attacks.

Suppurative Appendicitis may begin as a primary, acute catarrhal inflammation, or it may come as a recurrence after a catarrhal attack; or it may be suppurative from the start. The mucous membrane and sub-mucosa, the muscular and the serous coats are extensively involved and the serous much more apt to be than with the catarrhal form. The rapidity of the inflammation and character of the pus formed varies with the infecting agent, but there is an accumulation of pus in the appendix with swelling and distension of the organ. This form may terminate in escape of the pus into the cecum, and subsidence of the inflammation, leaving considerable fibrosis of the walls of the tube and adhesions of the serous coat to adjacent structures. This fortunate course is not the usual one. It is more usual to have the collection of pus burst through the coats of the appendix either by a process of pressure necrosis or of ulceration. The subsequent history will depend upon circumstances. If inflammatory adhesions had formed which retain the pus, it constitutes a circumscribed peritoneal abscess, localized according to the location of the appendix and point of perforation. In children there is less tendency to the formation of protective adhesions than in adults; and the adhesions are more delicate and easily torn. Such an abscess may be post-cecal, between the layers of the ascending meso-colon, or immediately beneath the anterior parietal peritoneum confined by adhesions between cecum, coils of small intestines, omentum, the appendix, the masses of lymph; or in the pelvis (Deaver), or in any of the erratic positions which the appendix will occasionally occupy. And such an abscess may burrow to great distances. Or the abscess may, through adhesions, perforate the walls of an intestinal loop or the bladder or vagina, and so be discharged. General pyemia may occur; or secondary abscess in various organs. In the absence of retaining adhesions the pus escapes into the general peritoneal cavity, setting up general peritonitis.

Gangrenous Appendicitis is either localized upon one part

of the appendix, or it involves more or less of the entire thickness of the organ. When a gangrenous appendix ruptures there may result a local abscess walled off by adhesions as before described; but more frequently gangrenous perforation takes place before any such protective barriers have formed, and is promptly followed by septic general peritonitis. The tendency to rapid gangrene is very strong in children.

Chronic or Recurrent Appendicitis is a repetition of one or more attacks of catarrhal inflammation. It results in more or less narrowing of the lumen of the tube, either in portions or throughout its entire length, and in thickening or sometimes shrinking of the size of the appendix. Any attack is likely to take on the suppurative form.

Symptoms and Diagnosis.—There are three leading symptoms of appendicitis, viz., pain, tenderness, and muscular rigidity. To these should be added vomiting, tympanites and tumor. Constipation, increased pulse rate and temperature, restlessness, the urine, and leucocytosis must also be considered.

A typical, moderately severe case of catarrhal appendicitis begins with acute abdominal pain, referred to almost any part of the abdomen, vomiting, and localized tenderness at "McBurney's point" or at least somewhere along the outer margin of the right rectus muscle from the level of the umbilicus down. The abdominal wall in that region is in a state of continuous tonic contraction which upon the slightest touch is increased to a board-like rigidity. The bowels as a rule are constipated. The temperature elevated two or three degrees. Fever, vomiting, and pain gradually subside in from three or four days to a week, the tenderness on deep pressure remaining longer.

An attack may be either slighter or more severe than this. It may be so slight and indefinite that no diagnosis is made, and in some cases no diagnosis from an attack of acute indigestion could be made. On the other hand, without presenting any additional symptoms, it may be more severe, with more vomiting, pain, and higher fever.

With atypical suppurative appendicitis the disease will present the symptoms of a severe case of catarrhal inflammation to which are added a somewhat diffuse induration that in a few days becomes more circumscribed, but small, in the region of the appendix. In such a case plastic lymph has caused adhesions about the site of the inflammation and suppuration may not have passed the coats of the appendix, or if it does pass outside of the appendix it is still a localized abscess.

In another case with the same symptoms there may be found after two or three days a distinct mass which is very tender. Pain

and fever continue. Here an abscess has formed, outside of the appendix, but still a localized peritoneal abscess. Such a case may progress with increased tension and greater accumulation of pus until it bursts through into the general peritoneal cavity, or burrows, or perforates a viscus, as before described; or finds its way to the surface, probably in the loin. After the formation of a local abscess the symptoms will sometimes subside for a day or a few days and give the appearance of a turn toward recovery—and then return with increased severity and progress more rapidly and dangerously than ever. Such a localized abscess should be evacuated before it becomes large or escapes into the general cavity or its toxines are absorbed. In some cases the suppurative inflammation spreads by continuity and contiguity and rapidly becomes general; or a small abscess in the appendix perforates before plastic exudate has sealed off the diseased area and thus infects the general peritoneal cavity; or general suppurative peritonitis follows the bursting or burrowing of a localized peritoneal abscess into the general peritoneal cavity, as before described.

Gangrenous appendicitis begins like an ordinary catarrhal attack. On the second, third, and fourth day perforation occurs, with sudden severe abdominal pain, vomiting, symptoms of shock, or collapse, cold perspiration, with a weak, rapid, and low tension pulse, followed by subnormal temperature or a sudden rise to 105 or 106 degrees F. If reaction does not occur, and within a day, or sometimes within a few hours, there is profound prostration, with tympanites, continued vomiting which becomes stercoraceous, pinched features, leaky skin, running pulse, collapse and death. Reaction may occur, allowing the patient to survive a few days longer, during which septic symptoms develop. Fever continues, though not extremely high; the abdomen is painful, tympanitic, and extremely tender all over, with vomiting, sweating, stupor or dullness, or sometimes convulsions. Remission of the symptoms may occur, but they renew their force and the patient succumbs.

It is not to be supposed that the different pathological types of the disease can be always differentiated clinically, nor that cases often or usually present the definite group of symptoms here described. Even in the adult the symptoms and course are not always typical; and in children they are very often atypical and extremely difficult to determine. Pain may be present, but one may be entirely at a loss, from the child's words, looks, or actions, as to where the pain is located. If the patient himself knows where he feels the pain, it may have been reflected. Often the pain of appendicitis is reflected to the plexus of Meissner and Auerbach and felt in the neighborhood of the umbilicus. If pain is distinctly located near the umbilicus on the right side, and nowhere else, it is thought to be almost

pathognomonic. One is apt to think of pain resulting from inflammation as being constant, while a paroxysmal pain is of spasmodic origin. But the pain of inflammation of the appendix is paroxysmal, often leading to the error of considering it due to colic, either intestinal, hepatic, or renal, in children especially intestinal colic. But colic has no fever and no localized tenderness.

Tenderness in the region of the appendix is a valuable symptom. But the child fears a touch anywhere upon the abdomen, and does not discriminate between pain and tenderness.

Muscular rigidity—local rigidity of the abdominal muscles—is one of the most reliable symptoms of inflammation beneath. But in a child it will often require the greatest tact and skill in examining to detect it. The child dreads to be hurt and contracts the abdominal muscles as soon as or even before they are touched by the examiner's fingers. Unless his confidence is gained or his attention diverted it may be impossible to tell whether rigidity is present or absent from any or all of the abdominal muscles. With pain referred to the left side, and with abscess in the pelvis there will be muscular rigidity of both sides of the lower abdomen.

Vomiting is a common symptom, though in some cases it is absent altogether. It is apt to begin as early as the pain. Its cessation or continuation is some measure of the severity of the case; that is, in the favorable cases it does not usually persist. Yet I have known it to last at intervals for a week, and continue two days after the abscess was evacuated by operation, and the patient recovered. The vomitus consists simply of gastric contents early in the case; later it is mixed with bile, and, lastly, in cases progressing toward a fatal termination, it becomes stercoraceous.

Tympanites and constipation are generally present. The tympanites may result from the constipation, or it may be due to paralysis or sepsis, or obstruction by bands of adhesions. Deaver quotes Richardson's suggestion of differentiating by auscultation between a collection of gas from paralysis of the intestines. With the former, peristaltic movements may be heard, but not with the paralysis. A persistently distended abdomen and vomiting are a very unfavorable combination of symptoms.

Diarrhea is unusual, and generally turns one's thoughts toward gastro-enteritis; yet it may occur in appendicitis.

Tumor may be present in twenty-four or forty-eight hours, or later, or it may not be present at all, even in a severe case. It may be quite diffuse, or distinctly circumscribed. Two procedures valuable in the examination of obscure cases are frequently omitted. One is anesthesia and the other is rectal examination. In a fractious or nervous child it may be entirely impossible to form an idea whether tumor is present, until the patient is quieted by a few whiffs of

chloroform. Then the shallow abdominal cavity and thin abdominal walls afford conditions favorable for palpation and percussion. Rectal examination with or without anesthesia should never be omitted in any case of doubt. By this means tumefaction may be discovered, abscess sometimes recognized, or tenderness localized, when the same could not be accomplished through the abdominal walls. The finger reaches much farther, anatomically, in the rectum of a child. In all these examinations extreme caution and gentleness are necessary, remembering the liability of tearing adhesions or bursting softened tissues.

The temperature is not a reliable index to the condition of the patient. There may be a considerable amount of fever—102 or 103 degrees in a catarrhal case that will end favorably; and there may be gangrene without any alarming temperature. A sudden drop of temperature is unfavorable; and a more gradual decline does not always indicate that all is going well.

The pulse is of more importance as an index, if not of the progress of the disease, at least of the strength of the patient. But there is nothing reliable about pulse or temperature to aid in differential diagnosis.

Frequent micturition is a common symptom and is apt to suggest renal colic or other disease of the urinary organs as an explanation of the pain and other symptoms. It is due either to irritation of the nerves of the bladder when the inflamed appendix is in close proximity, or to irritation communicated through the sympathetic nervous system. The urine is generally diminished in total amount and sometimes contains indican and albumen.

Alteration of respiration is not regarded as of much importance in the adult. But in the infant and young child, in whom the type of respiration is abdominal, a fixation of the abdominal muscles and diaphragm and a change to costal respiration is more noticeable. It might be thought to indicate respiratory disease. Distension of the abdomen also may quicken the respiration rate and even cause a grunting expiration resembling that of pneumonia. The diagnosis of appendicitis from basal pneumonia, or diaphragmatic pleurisy is not always easy, but mistakes would occur less often if the possibility of appendicitis in children were borne in mind, and the muscular rigidity, tenderness, and tumescence searched for.

Restlessness is characteristic of childhood, but if a child with symptoms of appendicitis becomes extremely restless, it denotes the presence of pus. (Deaver.)

In children the so-called larvate form of appendicitis is rather common. If a child is not at the moment severely sick or weak or in pain, he wants to be up and about, and soon forgets or disregards minor symptoms. Within a few days of this writing I have operated

on a boy of five years, finding a foul-smelling appendical abscess extending over the brim into the pelvis. On the morning set for the operation he was up and clothed as usual and would have walked down stairs to take the street-cars for the hospital had he been allowed.

The diagnosis from acute indigestion and from acute obstruction is often very difficult early in the case. For example, in one of my cases, a girl of twelve years was attacked with cramps in the abdomen and vomiting. There was constipation and the entire abdomen was painful, tender, and tympanitic. Deep palpation was impossible. Fever rose promptly to 102.5 degrees F., pulse 124. She had eaten a quantity of raw prunes and also accidentally swallowed a prune stone. The use of copious enemata and of repeated small doses of calomel and broken doses of Rochelle salts started the bowels and they discharged scybalous masses and a quantity of prune skins. By the third day the illness, pain, and fever had subsided, and also the tympanites. The girl seemed better. But now induration could be felt in the right iliac region, and the tenderness which had seemed general localized here. Also muscular rigidity. Operation confirmed the revised diagnosis of appendical abscess.

Appendicitis is sometimes mistaken for typhoid fever and even for hip disease. Intussusception has some symptoms in common with appendicitis, and so also has hernia.

Leucocytosis is said to be invariably present in perforative appendicitis. But by the time it appears there are usually present unmistakable symptoms, which leucocytosis is not. In long-continued appendicitis hemoglobin is reduced to 60 or as low as 40 per cent., and the erythrocytes to two millions or three millions per c. c.

In chronic appendicitis there is often a history of one or more previous attacks, though these will often be attributed to indigestion or something else. Pain or discomfort or uneasiness is felt in the right iliac region. Pain may be referred to a point just at the right of the umbilicus. There is generally gaseous distension of the cecum, and constipation, which may alternate with diarrhea. There is frequently neurasthenia or "general debility," which in children takes the form of irritability or peevishness. There are frequent disturbances of digestion; and indiscretions in diet often bring on acute exacerbation of the inflammation. But the most valuable symptoms are tenderness localized in the region of the appendix; and pain excited by palpation at that point. Exercise may cause the pain. The appendix may sometimes be felt enlarged, though in other cases it undergoes contraction. A more diffuse chronic induration or the tumefaction of a chronic abscess may be felt.

Prognosis.—The prognosis depends so much upon early diagnosis and the line of treatment adopted that general prognosis is

impossible. Some writers claim that 95 per cent. of all cases will recover under medical treatment. But the men who have had most experience with the disease will not agree to this statement. Ribbert places the number of complete recoveries under medical treatment at 16 in 400. A somewhat larger number than this apparently recover. But according to Dorfer, of those who apparently recover without operation 30 per cent. have a recurrence. Catarrhal appendicitis may recover. But no one can be absolutely sure that it is only catarrhal appendicitis; nor that it will remain only catarrhal; nor if recovery occurs for the present, that the disease will not recur. Cases that recover with adhesions may have obstruction of the bowels from the adhesions. If, early in the attack, the bowels respond promptly to laxatives and are thoroughly emptied, the prognosis is thereby improved. A case operated early before there is perforation or peritonitis, or abscess, that is, while the disease is entirely within the appendix, will probably recover, unless it is quite a young child. The prognosis in all young children is uncertain. Older children do better, even better than adults. Cases operated when there is a localized abscess, and no symptoms of general peritonitis, general septicemia, or pyemia, generally recover. If either of the other conditions are present the prognosis is bad. Cases having general peritonitis at the time of the operation have recovered, but this is not the probable termination. More cases die of general peritonitis than from any other cause; but many end in pyemia. The virulence of the infection has a very important bearing on the result in cases treated medically. In cases treated surgically the prognosis is better the earlier the operation. If abscess has formed, the prognosis is not as good as if the operation were made before abscess formation. And if general peritonitis is present with a rapid compressible pulse and profuse perspiration, operation will most likely avail nothing; and to refrain from operating offers about as little hope.

Treatment.—From what has been said of the pathology, symptoms, and course, diagnosis, and prognosis, the line of treatment will readily be inferred. Medical treatment is to be followed only until a diagnosis can be made; then the treatment is surgical. Yet proper medical treatment can do a great deal of good, and what is equally important, can avoid a great deal of harm. Rest in bed is imperative, from the moment appendicitis is suspected. To empty the bowels is the first object. Pain and vomiting may be present, but these are often relieved better by emptying the intestinal tract than in any other way. To clear the bowels there is nothing better than castor-oil; but it is often not tolerated by the stomach. In the presence of vomiting, calomel and sodium bircarbonate are better, usually in small and quickly repeated doses, perhaps one-tenth of a grain at a dose every half-hour. After half a grain or a grain or

more has been taken it can be followed with castor-oil or with a saline laxative, such as citrate of magnesia, or Rochelle salts. In the meantime, however, the colon should have been cleared by enemata. Also an icebag should have been applied over the right iliac region, and a small mustard plaster over the epigastrium. The most important thing to refrain from doing is the giving of opiates in any form. Opiates lock up the intestines, and they also obscure the symptoms and give an appearance of safety that is completely opposite to the true condition. Pain and tenderness may be relieved without doing any harm by the use of the solid extract of belladonna one drachm, to glycerine one ounce. The tender area in the iliac region should be smeared (after thoroughly cleansing the skin) with this preparation, and covered with oil silk. The icebag can still be used outside of this dressing. The consensus of opinion among those who have closely studied this disease is, that in all patients, once the appendix is inflamed, there is no safety but in its removal; and the sooner this is done the better. In my opinion these principles are more especially true of children than of adults, and the younger the child the more urgent the necessity of prompt interference. The reasons have already been stated elsewhere, namely, their weaker resistance to the progress of the disease, less tendency to wall off the inflamed area with protecting adhesions, greater tendency to rapid perforation, and to general peritonitis. Also the fact that children, as compared with adults, bear deprivation of food badly, and this is a disease in which the amount of food must be cut low. The longer this continues the lower will be the state of the child's nutrition and recuperative power. The most favorable time for operation is early in the case while the disease is still confined to the appendix. If not seen or not diagnosed until later when tumescence betrays the presence of localized peritonitis around the appendix, the most favorable time for operation has been lost. There is a small number of cases in which a delay of a few hours or a day or two will allow more time for adhesions to form, and an operation can be made with greater safety, so far as local conditions are concerned. But some of these cases which apparently have subsided and admit of safe delay will suddenly become most violent and dangerously active. It is practically impossible to tell which cases can safely wait and which cannot, and so few of them will terminate in resolution that the risk of waiting is not justifiable. This brings us back to the rule that in children early operation in all cases is the safest line of treatment. If the parents will not give their consent to operation, or for any reason it is not done, and the case recovers for the time being, the probability of a recurrence should be explained, and operation in the interval, which is a more favorable time than during an attack, should be urged.

Operation.—There are four principal conditions under which operation for appendicitis is done. First, early in the attack when the disease is still confined to the appendix. Secondly, when abscess has formed but is limited by adhesions. Thirdly, in the presence of general peritonitis or where abscess has recently escaped into the peritoneal cavity. Fourthly, in the interval of the exacerbations of chronic or recurrent appendicitis.

All of these operations are done upon the strictest principles of antiseptic surgery. Even in cases thought to be purulent or septic, care is taken not to make matters worse by introducing new infective agents or by distributing further those already in the system. There are numerous methods of operating and many modifications of each method. I shall describe only such as, in my judgment and experience, are best adapted to meet the conditions in children.

The patient receives a bath of hot water and soap and a complete change of clothing and bed linen. The abdomen, groin, and right loin are thoroughly scrubbed with green soap or ethereal soap and hot water, applied with a piece of flannel or gauze, and thoroughly rinsed with sterile water. This is followed by ether or alcohol and bichloride, and then with a compress of gauze wet with bichloride solution 1 to 1000, which covers the parts during the adjustment of the sterile sheets and towels. This would be the preparation for an emergency operation. If there is time to spare, as in an interval operation, such preparation should be made on the previous day, and the bichloride compress, 1 to 2000, covered with cotton and a binder left on over night. Washing with alcohol, followed by bichloride solution and then sterile water, is repeated just before the operation. Care should be taken to protect the child from cold and shock by having the limbs wrapped in cotton and all parts not necessarily exposed well covered. After washing, the patient should not be allowed to lie upon a wet surface during the operation. Everything underneath should be dry and warm, and hot-water bottles should contribute their warmth. (43)

One uses either the McBurney or the simple incision. The McBurney incision is a little more difficult and takes a little more time (not merely to make the incision, but to work through it) than the simple incision, and unless the operator is quite familiar with it should be reserved for older children who are also in good condition for operation. It is not suited for pus cases. But it has the advantage of being very seldom followed by ventral hernia. In the McBurney operation the opening is made half way between the right linea semilunaris and the anterior iliac spine. The incision is curved, with the convexity outward. No muscle is cut, but only the fasciæ. Each muscle is divided by blunt dissection in the direction of its fibers. Thus the external oblique, and the internal oblique

and transversalis, are successively opened and held by retractors, thus exposing the transversalis fascia, which is divided in the same direction as the fibers of the internal oblique and transversalis. The incision in the peritoneum is transverse. The incision is now held open by one or two pairs of retractors. The anterior longitudinal muscular band of the cecum is traced downward, the appendix brought up into the wound and removed, the stump is invaginated. The peritoneum is closed with a continuous catgut suture, and the incision of the transversalis fascia also closed in the same manner. The separated fibers of the internal oblique and transversalis are allowed to come together and secured by a couple of sutures. The incision of the aponeurosis of the external oblique is closed by continuous sutures of catgut or kangaroo tendon, and the skin incision by continuous subcutaneous catgut suture. The wound is then sealed with iodoform collodion.

The simple incision is made in the direction of the right linea semilunaris, just at the outer margin of the rectus muscle. It has one-third of its length above a line drawn from the anterior superior spine of the ilium to the umbilicus. If, from the presence of tumor and the other symptoms, one is confident of finding a localized abscess, it is well to make the incision farther to the right, perhaps half way between the semilunar line and Poupart's ligament and parallel with the latter. This keeps the operation farther away from the adhesions which wall off the abscess, and perhaps affords better drainage. The length of incision usually advised in adults is three inches. Some operators think two inches is enough. Two inches certainly is enough in children in most cases and sometimes less will do. Their abdominal walls are comparatively thin and the cavity not deep. But if there are extensive adhesions of the appendix which cannot be reached or brought up into the wound, enlarge the incision as much as is necessary to do the work. All bleeding should be controlled with pressure forceps before the peritoneum is opened. Care should be taken lest distended or even adherent bowel be opened into immediately with the peritoneal incision. The peritoneum being picked up between two pairs of tissue forceps is incised a distance of one inch. The index finger carefully introduced now cautiously and gently explores. One has trembled to see a brawny pair of fingers plunged into a child's abdominal cavity and thrust hither and thither. If it is an interval case the cecum can now be picked up and traced down to the appendix, which can be brought out at the opening and amputated. This is done by first transfixing the meso-appendix at its base, tying it off with catgut and then removing it with scissors. In an older child in good condition for operation time may now be taken to form a cuff of the serous coat of the appendix. This is cut around the circumference

of the appendix a quarter of an inch from the wall of the cecum and dissected back to that viscus. The appendix is then ligated with silk and cut off. The mucous lining of the stump is then scraped with a small curette and touched with a solution of bichloride of mercury, 1 to 2000, and then with a solution of carbolic acid, 1 to 60. The cuff is then folded in by stitching with fine silk in a round needle. The stump is then invaginated into the end of the cecum, where it is held by continuous Lembert sutures. A simpler method, more quickly done, and therefore often useful with children, omits the formation of the cuff. The appendix is simply ligated and cut off. The mucous lining of the stump is curetted and touched with pure carbolic acid and the excess of acid wiped off. The cut ends of the stumps of the meso-appendix and of the appendix are united face to face by a few stitches, or sometimes, but not always, the appendical stump is invaginated by Lembert or a purse-string suture. If, however, abscess is present it is better to enlarge the peritoneal incision to the size of the external wound and introduce a wall of strips of sterile gauze along the inner side of the wound, shutting off access to the general peritoneal cavity, as one explores deeper and deeper. The finger finds the abscess, which wells up and flows or is mopped out with gauze sponges. At this point opinions of operators differ as to the next step. Some say the operation is not complete unless the appendix is removed, and they proceed to explore and find and then to remove it as if no pus were present. Others are content to introduce drainage and end the operation. If the appendix comes readily under the fingers and is easily brought into the wound, I remove it. But, whatever one may do in case of an adult, I consider it bad practice in a child to make any extended search for the appendix in a pus case. I realize that in one sense the operation is not complete. I realize, too, that many a surgeon is as anxious to add another appendix to his collection as an Indian is to hang another scalp at his girdle as a proof of his prowess; but the surgeon has no right to risk his patient's life for this purpose. If the appendix must be removed, which is not always the case, it can be better done at some future time. It is a very poor time to do it with pus separated from the peritoneal cavity by only weak and scanty adhesions, which may easily be parted in the manipulations necessary for the appendicectomy. Besides, no operation in a child should be prolonged when it can possibly be avoided. The abscess should be wiped out as clean as may be with gauze sponges; or if the child is very weak and bad, time should not be consumed even for this. An ordinary rubber drainage tube or preferably the rubber tissue drainage tube with a wick of iodoform gauze very lightly filling it should be passed to the bottom of the cavity wherever that may be. The incision may be partly closed, leaving space for the

drainage, and abundant moist gauze and dry cotton dressing should be applied.

If pus is free in the abdominal cavity it should be flooded out with hot sterile normal saline solution. If the patient is an older child and in fit condition to withstand further work, and the appendix can be reached and detached without too much delay and dissection, it may be removed, for in such a case manipulations do not endanger the spread of pus; it is only a question of shock. Ordinarily it is better, after flushing out, to introduce strips of gauze in various directions into the abdomen, their ends emerging at the wound; drainage to the location of the appendix; introduce sutures between the gauze strips, but leave most of them untied; and apply the dressings.

In closing the simple incision the peritoneum is united with continuous catgut suture, the muscular layers with simple or mattress suture of kangaroo tendon, chromicized catgut or silk, and the skin with subcutaneous or ordinary suture of silkworm gut. Moist bichloride gauze and dry cotton should be held securely in place with adhesive straps almost encircling the body. A binder covers all.

After Treatment is important. The child should be put to bed with hot-water bottles. The room should be quiet and he should be well watched. It is usually safer to restrain children by tying, or pinning clothing to mattress. They toss about. Some will pull at the dressings. I have had a boy, within a few hours after his operation, while the nurse was attending for a moment to another patient, jump out of bed, run out of the ward and down the hall in search of a drink of water. No harm came of it, but there might have.

Vomiting from the anesthetic should be avoided as much as possible. The use of oxygen with and after the anesthetic aids in this. Also free air in the room and an empty stomach for hours. A normal saline enema or a coffee saline on putting to bed relieves both shock and thirst. Hypodermoclysis of normal saline is useful but painful, and especially if any large quantity is used slowly; but a couple of ounces may be put under the skin, while still under the anesthetic. Use strychnia or camphor if necessary. No morphine should be used. The urine should be watched. The usual rule after anesthesia, of allowing nothing by the mouth for at least four hours, should be observed. Then bits of ice may be tried or a teaspoon of hot water. If the stomach continue irritable, nutrient enemata should be promptly resorted to, using peptonoids, pancreatized milk, and the like. For tympanites, rectal injections of emulsion of asafetida. In clean cases, that is, no pus, and the wound closed, if all goes well, without rise of temperature or pulse and no pain or tension, no dressing is necessary for at least five days. The wound may have closed perfectly and stitches may be removed. Or by this

time, unfortunately, pus may have developed and the case must be treated accordingly.

In drainage with a tube the tube should be kept free of any collection of fluid, and not withdrawn until nothing more collects. Gauze left for drainage or for walling off would best not be disturbed for two days; and then should be well soaked with warm boric solution and very cautiously removed. After irrigating the cavity without the least force or pressure it is again packed with iodoform gauze covered with moist boric or bichloride gauze, cotton, straps and binder and left for another two days. Drainage is withdrawn if pus formation ceases or the cavity closes from the bottom by granulation and approximation of its walls. Finally sutures or adhesive straps approximate the wound margins and hasten their closure.

CHRONIC (NON-TUBERCULAR) PERITONITIS

Chronic peritonitis, either fibrinous, serous, or suppurative, may follow the acute form. Chronic localized peritonitis may occur as a result of disease of any organ which the peritoneum covers, or from the growth of tumors in the abdomen. But there may occur in rare instances a form of chronic peritonitis that is not due to any of these causes nor sometimes to any known cause. Measles, exposure to cold and wet, rheumatism, and remote hereditary syphilis have been listed as causes. Some persist in the opinion that the disease is after all a result of tubercular infection in which the bacilli have disappeared. That some general cause is at work seems to be indicated by the occasional presence of chronic pleurisy in the same case.

Pathology.—The most obvious finding is a large amount of ascitic fluid, usually clear and slightly greenish. There may be flakes of fibrin and some adhesions. Disease of some of the abdominal organs covered by the peritoneum may be found or a tumor the presence of which has excited the peritoneal inflammation.

Symptoms.—There may be no symptoms whatever until the enlargement of the abdomen is noticed; or there may be a period of malassimilation and general debility. Occasionally a history of irregular slight abdominal pain and tenderness can be elicited, and sometimes irregularity of the bowels—either constipation or diarrhea, or these may alternate. On examination the abdomen is found to contain fluid, which gives the wave of fluctuation on percussion, and if the cavity is not too tensely filled with it, shifts its position when the position of the child is changed. If the distension is great it may be impossible to outline liver, or spleen, or any tumor; the umbilicus will be protuberant; and the abdomen remains dull with the patient changed to any position; and the superficial veins are

prominent over the abdomen. Sometimes the lower extremities are swollen from pressure upon the vena cava inferior.

Fever never runs high and may be nearly absent at times.

Diagnosis and Prognosis.—Ascites or general anasarca from disease of heart, liver, or kidneys should be carefully excluded, by the physical signs, testing the urine, et cetera. Without a tuberculin test it may be impossible to exclude tubercular peritonitis. However, after several weeks the simple form of peritonitis will usually gradually subside and recovery ensue; and no tubercular disease develop in the peritoneum or elsewhere in the body. In other cases the ascites increases and the patient declines to a fatal end, sometimes from the tumor or organic disease which gave rise to the peritonitis.

Treatment.—As in other forms of inflammation, the first indication is rest. This is best obtained by confining the patient to bed, although not necessarily to the house. The bed, couch, or Bradford frame can be carried out upon a porch or lawn. Tonics and sometimes alteratives are useful, such as syrup of the iodide of iron; or Basham's mixture, which combines a diuretic with the ferruginous tonic. If the fluid remains, or if it increases so that the distension interferes with the circulation and to some extent with the respiration, tapping is indicated. This may be done either with the trocar and canula or with the aspirating apparatus; but with either method strict antiseptic precautions should be employed. Repeated tappings may be necessary if the fluid reaccumulates; or laparotomy may be performed as described under tubercular peritonitis, with good prospects of a favorable result. (44)

TUBERCULAR PERITONITIS

This is almost synonymous with chronic peritonitis, for chronic peritonitis without tuberculosis, although it may occur, is infrequent, and by some is thought to be due to the presence of tubercle bacilli which are destroyed in the process. Yet not all tubercular peritonitis is chronic. It is by no means an uncommon disease, and prevails at all ages, though seldom in the first year. It may be primary, but in most cases it is one of the local manifestations of a general infection.

Several forms of tubercular peritonitis are described. First the acute miliary, second the ascitic, third the fibro-plastic, and fourth the ulcerative.

The Acute Miliary Form.—In the first form there are found miliary tubercles distributed over the peritoneum, and very little evidence of local inflammation. The peritoneal involvement seldom attracts attention during life, being overshadowed by the general infection which, as a rule, soon terminates the case in death.

THE ASCITIC FORM.—The second or ascitic form also presents miliary tubercles, but thickly placed over the peritoneum, the surface of the intestine and the mesenteries, the omentum and the serous coverings of all the viscera. There are evidences of inflammation, and of some plastic exudation, which is small in amount as compared with the ascitic fluid which is present. This fluid may be clear and serous, of a greenish-yellow color, if the infection is purely tubercular; or it may be sero-purulent when pyogenic organisms also have been present; or it may be stained with blood. The disease runs a subacute or chronic course of a few weeks, or more often of three or four or more months, with one or two degrees of fever, progressive weakness and moderate loss of weight.

Symptoms and Diagnosis.—The symptoms are indefinite until enlargement of the abdomen is noticed. There may have been some vomiting and slight abdominal pain, and bowel disturbance; but the permanent enlargement, and the presence of fluid characterize the disease as more than an ordinary digestive ailment. The abdomen becomes filled with the fluid. This may easily be demonstrated by the percussion wave. When the patient is placed in the dorsal decubitus the fluid gravitates into the flanks, where it gives a dull percussion note, while the intestines, floating near the umbilicus, are tympanitic. The distension may gradually increase to such a degree that the entire dome-shaped abdomen is dull, the skin is tense and shining, with large blue veins showing on the surface and the protruding umbilicus filled with fluid. Or the effusion may be sacculated by adhesions. The distension precludes the palpation of enlarged mesenteric nodes in most cases, and often makes it difficult to define the size of the liver. Hepatitis or perihepatitis may be present, but cirrhosis of the liver may generally be excluded in a young child, is much more chronic in its course, and usually presents jaundice. If evidence of syphilis can be obtained, cirrhosis is rendered probable. Some of the fluid may be withdrawn and examined for bacilli or injected into guinea-pigs or rabbits. Ordinarily there is no great difficulty in diagnosis, yet a case may be so complicated as to be very obscure, as illustrated by the following in a boy of three years. It was said that a year previously he had passed through measles, which left him with a chronic cough. Eight months after the measles the abdomen was noticed to be enlarging. When first examined in my clinic at the College of Physicians and Surgeons, the abdomen was so tensely filled with fluid that the liver could not be outlined. Breathing was difficult, cough almost constant; the loud mucous rales and the rapid action of the heart obscured its sounds, no valvular murmur being detected. The area of cardiac dullness was increased. He was tapped and eight and

one-half pints of fluid were withdrawn, enough to relieve the tension. The fluid was yellow with greenish tinge. On examination by Dr. R. G. Schnee, it presented the characteristics of ascitic fluid, and no bacilli were found. After tapping the liver could be outlined. Fig. 190 shows the lower margin of the liver marked by the dark line. Spleen not palpable. The stools were light colored, but showed some bile. The blood examination showed no leukemia. The symmetrical shape of the liver and the length of time elapsed eliminated endothelioma. Reaction from tuberculin (subcutaneously) was positive. There was low fever and wasting. A diagnosis of tubercular peritonitis was made and laparotomy or repeated tapping proposed, but the parents refused. He lived more than two months. At autopsy, a few tubercles were found upon peritoneum and mesentery, and a number of mesenteric and bronchial glands were cheesy. The important lesion was an adhesive pericarditis, to which more than to the tuberculosis, the condition of the respiration and hepatic enlargement and ascites were attributable.

Prognosis.—The prognosis is guarded. Most cases terminate in death by exhaustion. But it is not so very unusual to have a case recover, by reabsorption of the fluid, and a process of fibrosis. Or the lesions may break down and after forming many ulcerations and adhesions, terminate fatally by exhaustion, or by general or other local tuberculosis.

The Fibro-plastic Form.—There is usually serous effusion in this variety, but if so it is not as early or as marked a feature. This inflammation produces a plastic exudate which forms adhesions that become fibrous, joining intestines together, or to abdominal walls or to the viscera; or unites any of the serous surfaces in the abdomen that lie adjacent to each other. When ascitic fluid or pus is formed it is sacculated between adhesions. The disease begins insidiously with symptoms usually attributed to digestive disturbance, but there may be persistent low fever. Often nothing local is observed until the abdomen enlarges. The enlargement may be due to tympanites at first, but later to fluid. And it may be irregular in shape on account of the binding of adhesions, and fibrinous bands, which, if the walls are not too tense, can be felt as irregular masses in the abdomen. The disease runs a very chronic and irregular course, both as regards the symptoms of indigestion and loss of weight; and in respect to the enlargement of the abdomen, which may subside somewhat and increase again or change its position. Fever is of the hectic type and may register 1, 2, or 3 degrees. There may be pain and interference with peristalsis, or with blood or lymph circulation from the constriction of adhesions. There is nothing characteristic about the bowel movements. Diarrhea is not present unless there is ulceration of the intestinal mucous lining,

which is not as common a symptom as some suppose. There is not uncommonly edema of the lower extremities, in odd contrast with the general emaciation. This is produced by pressure on the ascending vena cava. Albuminuria may result from interference with the renal circulation. Most cases extend over a period of several months or a year and end fatally by exhaustion or perhaps by lung tuberculosis, or with lardaceous liver, kidneys, and spleen. An occasional case will improve after three or four months and make an apparent recovery.

The Ulcerative Form.—In this form, as its name implies, the tendency of the inflammation is toward ulceration. Fibro-plastic exudation takes place and abundant tuberculous deposits are formed, but these undergo cheesy degeneration and break down, forming tuberculous abscesses. In this form the abdominal walls and the intestines themselves are more apt to be inflamed and to contain abscesses, ulcers, and sinuses. Distinct masses and nodules may usually be felt. The general condition is more typical of tuberculosis than usually obtains with the other forms of tubercular peritonitis. Hectic is present and wasting is progressive. Almost invariably there is tuberculosis of other organs or regions, although it may be hard to demonstrate during life. Recovery from the ulcerative form need not be expected.

Diagnosis.—Concerning the diagnosis of all the forms of tubercular peritonitis it may be said that chronic ascites in a child from any other cause is very uncommon; and that if it is accompanied by hectic fever it is almost certainly tuberculous. If nodosities, such as enlarged mesenteric nodes, can be felt, or irregularities caused by adhesions or encysted collections of fluids in various parts of the abdomen; or if there is evidence of tuberculosis in other parts of the body with chronic abdominal enlargement and ascites, tubercular peritonitis may be presumed. Family history, if negative, does little to exclude it. Pain and tenderness are of uncertain value. The tuberculin test is of value for demonstrating the presence of tuberculosis in the system, but does nothing in regard to localizing it. Tapping is useful for diagnosis, if the bacilli can be found in the fluid, but their absence does not absolutely disprove the disease. Inoculation experiments are valuable. Tapping may also make palpation of the abdominal contents possible. Exploratory incision is justifiable, and if made, any enlarged lymphatic gland encountered should be removed for miscroscopic examination and inoculation test.

Treatment.—The general treatment of tuberculosis should be instituted and thoroughly and persistently carried out. Purgation or other irritation of the intestines should be avoided, but they should be regulated by diet, enemata, and, if necessary, by gentle laxatives.

It is doubtful if much may be accomplished by local applications to control a tubercular process. Yet the inflammation may be modified and perhaps the invasion of other infective agents prevented by drugs. The use of ointment of the yellow oxide of mercury, 20 grains to the ounce, with an equal quantity of the unguentum belladonnæ is recommended by Ashby and Wright. I have used the ordinary mercurial ointment, diluted with lanolin, with apparent benefit. Of more positive utility in this disease, though used only for the symptoms of pain and tenderness, is the extract of belladonna (solid) with glycerine, one drachm to the ounce. After cleansing the skin with soap and water and with alcohol, this should be smeared upon it and then covered with oil silk.

If life in the open air, rest, forced feeding, general hygienic management and medication do not produce the desired result, operative treatment is indicated in selected cases. It is not advisable to operate in the acute miliary nor in the ulcerative forms of the disease, nor in the so-called "dry" form, which is a variety of the fibro-plastic without ascites, nor in general tuberculosis that is rapidly progressive, nor in the presence of meningeal, or serious lung tuberculosis. If either tubercular ulceration of the intestines or tubercular nephritis be present, operation will be unavailing. All cases in which diagnosis has been impossible should be operated for exploration.

The second form described, that is, the ascitic, is the most favorable for operation. In the fibro-plastic form a natural effort at cure is in progress and need not be interfered with unless there is also ascites, or fibrous bands cause obstipation or painful tympanites, or a fluid collection even though small is purulent, or the patient is losing health and strength. In obstruction of the bowels or in severe pain which is exhausting the patient, there is no choice but to operate.

The operative treatment is simple laparotomy, with evacuation of fluid collections with or without irrigation; and either immediate closure or drainage. The patient should be prepared by thorough clearing of the intestinal tract, by castor-oil and by the use of antifermentative drugs such as salol, benzosol, calomel. The skin of the abdomen should be prepared in the usual careful manner for an abdominal section. If the case is one of the ascitic variety an incision is made in the linea-alba below the umbilicus, remembering that the bladder rises higher in the child than in the adult, and the younger the child the higher the bladder is likely to be located. The peritoneum should be opened with the usual care after raising it between two pairs of forceps, and incised at least to the width of two fingers. The next step will depend upon the conditions. If the fluid is free in the peritoneal cavity, all that is necessary is to allow

it to flow out and then close the incision. If sacs of fluid can be detected here and there, held by adhesions, they should be reached and evacuated. Otherwise the adhesions should be disturbed as little as possible. Some operators advise the removal of the omentum, if it be loaded with tubercles, but this is not advisable unless large masses appear about to soften. Its removal will prove more troublesome than might be anticipated on account of hemorrhage.

If, on the other hand, the fluid prove to be purulent, it is better to irrigate the abdomen either with sterile normal salt solution, flowing gently but freely through the nozzle of the irrigator at a temperature of 105 degrees F. Some would advise a solution of boracic acid, salicylic acid, or argyrol, which are all good. If there is a localized purulent collection in some part of the abdomen, the incision is made there instead of in the median line and the adhesions separated until the abscess is found, which may be a little troublesome to do. After evacuation the cavity is irrigated as before described. The non-purulent cases are closed without drainage; in the purulent a drainage tube or cigarette drain of rolled rubber tissue, or a flexible rubber-tissue tube with a wick of iodoform gauze, or simply the gauze wick drain may be used. The peritoneum is closed with continuous suture of catgut, the muscular wall with catgut or kangaroo tendon, and the skin with silkworm gut. A few operators use silver wire through the skin and muscular layer, with coaptation stitches of silkworm gut or horsehair between. In the drained cases the drainage is removed as soon as possible, usually in a few days or a week, and the track closes by granulation. The usual dressings of antiseptic gauze, cotton, adhesive strapping and binder are employed.

The rationale of this method of treatment is not well understood, or at least has no explanation that is generally accepted. It is an empirical method, often permanently successful. If relapse occurs the laparotomy may be repeated. (45)

CHAPTER XXI

THE ESOPHAGUS, STOMACH AND INTESTINES

MALFORMATION OF THE ESOPHAGUS—FOREIGN BODY IN ESOPHAGUS—STRICTURE OF THE ESOPHAGUS—PYLORIC STENOSIS—MALFORMATIONS OF THE SMALL INTESTINES AND COLON—INTUSSUSCEPTION—FOREIGN BODY IN STOMACH, INTESTINE OR RECTUM—FECAL IMPACTION—ENTEROLITES—VOLVULUS—INTERNAL STRANGULATION.

MALFORMATION OF THE ESOPHAGUS

THE esophagus develops independently of the pharynx and the stomach, both of which it opens into as its tube lengthens. Malformation may occur by failure of the esophagus to penetrate into the stomach below or less frequently into the stomadæum above. I have twice met malformation near the point where pharynx and esophagus join, which resulted in death. In one case, seen with Dr. H. T. Clapp, the esophagus and the larynx were connected by a slit-like orifice. In the other, seen with Dr. G. U. Bennett, the pharynx ended in a blind cul-de-sac behind the larynx, the esophagus having failed to reach and penetrate it. In some cases the connection between pharynx and esophagus is imperfect, leaving a partial stenosis.

FOREIGN BODY IN ESOPHAGUS

Most foreign bodies swallowed by children pass into the stomach, and their further adventures will be considered in another section. But every child supposed to have swallowed a foreign body should be examined. The symptoms will vary with the size and shape, position and substance of the foreign body. If a round, bulky body, like a marble, be lodged in the esophagus, there will be an obstruction to drink or food swallowed, and they will be regurgitated. A coin may allow them to pass; or may change its position so that neither food nor drink can pass. A substance that will swell by absorbing moisture may not cause obstruction at first, but later. A body not tightly wedged in the esophagus, nor entirely blocking it, may cause few symptoms and be overlooked at

first, but later inflammation rises and it becomes embedded, and ulceration, and probably extensive cellulitis, suppuration, pneumonia, and exhaustion follow.

Treatment.—If a body be lodged just below the gullet it may perhaps be seen by direct inspection, extending the head fully and using a tongue depressor well back. Or it may be touched, and possibly dislodged, with the index finger. If it be lodged lower its situation may sometimes be detected by listening at the chest while the child swallows a drink of water. In this class of cases the gastroscope, as devised and used by Jackson, of Pittsburg, is destined to fill an important place. Jackson has explored not only the esophagus, but the stomach of a babe not older than one year and two days. In the absence of special instruments and skill in their use, the bristle probang may be employed to either push the body on into the stomach or to withdraw it. The bristles of the instrument having been passed below the obstruction and spread into disc form by proper manipulation, the body may be swept upward as the instrument is withdrawn. The ingenious coin-catchers of the instrument makers occasionally work as they are intended, and as often do not. Emetics should not be used. Forceps are useful if the body is of suitable shape to be seized, is within reach, and the surgeon dextrous. Inversion of the patient and bimanual manipulation may be useful.

Failing in these endeavors, esophagatomy must be done, and that promptly. If done before inflammation and fever supervene, there is a good prospect of recovery. The impaction unrelieved will cause death. The operation is done as in the adult, upon the left side, and is difficult in proportion as the child is short-necked and fat. The external incision should be ample, in order that hemorrhage in the depth may be controlled, or, better, avoided by seizing vessels before they are cut. The recurrent laryngeal nerve, which passes between the esophagus and the trachea, should be avoided. The esophagus can be pushed into the wound by a curved sound passed per orem, and opened with scissors. The foreign body should then be removed with forceps. The esophagus is closed with Lembert sutures, unless it is badly inflamed, and the external wound closed with drainage. The patient is fed per rectum for several days, when stomach feeding by tube can be used. (See Section on Gavage.)

STRICTURE OF THE ESOPHAGUS

Stricture of the esophagus, from malformation has been alluded to in another section. A more common form is caused by cicatrices, following burns from swallowing corrosive substances, such as concentrated lye or ammonia, or from scalding.

Symptoms.—Symptoms may not appear until several weeks after the accident. The stenosis causes difficulty of swallowing and regurgitation, and in the absence of history might even be mistaken for foreign body. The child it often weak and emaciated from starvation.

Treatment.—Treatment with bougies, dilating the stricture, and gavage and rectal feeding improve most cases and cure some. The trouble is apt to recur and require persistent and careful attention. Some cases ultimately sink, on account of extensive damage of the stomach mucosa.

PYLORIC STENOSIS

Pyloric stenosis may be described as of four kinds, differing widely as to pathology. First, congenital stenosis of the pylorus; secondly, hypertrophic stenosis, or congenital hypertrophic stenosis; thirdly, spasmodic constriction, or spasm of the pylorus. The second and third kinds are the ones most often described under the title "pyloric stenosis of infants" and divided into two varieties, hypertrophic an spasmodic. Fourthly we have pyloric stenosis of older children.

Etiology and pathology.—Congenital stenosis, not marked by hypertrophy, occurs in rare instances at the pylorus as it does in other regions of the gastro-intestinal tract (notably at the site of the common bile-duct and in the ileum), the narrowing varying in degree even to atresia. It is a developmental failure, obscure in its ultimate etiology. The malformation is usually not confined to the pylorus.

Hypertrophic pyloric stenosis has been much discussed not only as to its etiology and pathology but as to its entity. Its entity is established. (Hirschsprung, Cautley and Dent, Ibrahim.) It is not the same as spasmodic stenosis, although there is no denying that it may be accompanied by spasm. And it is true that either hypertrophic or spasmodic stenosis may show redundance or catarrhal conditions of the mucous lining which aggravate the effects. Skillful feeders like Huebner are able to avoid or relieve many aggravated conditions, and in the mild grades of stenosis escape the fatal closure. But it cannot be concluded therefore that an organic stenosis never exists. Nor has Pfaundler's argument (that spasm of the pylorus persisting even after death, can produce a tumor resembling hypertrophic stenosis), been accepted as explaining away the organic tumor found by many other observers both before and after death, and before and after operation had removed all the other symptoms. This tumor is of the size of a hazelnut or a filbert, and the microscope reveals that its bulk is made up by an increase in the muscular fibres of the pylorus, the greater part of it being

due to hypertrophy of the circular muscular fibres. There is also increased connective tissue and redundance of mucous membrane, with narrowing of the lumen of the canal. When and how this hypertrophy takes place have been much disputed. One of the principal theories attributes it to faulty embryological development. And this condition has been found in various stages of fetal life. Another theory considers the increase of tissue a true hypertrophy, induced by spasmodic overaction of the muscle. The obvious objections to this view are well presented by Cautley who points out that spasm of the pylorus is not a disorder peculiar to the first few months of life. It may occur at any age. But there is no evidence to show that spasm produces hypertrophy at any other age, nor any reason why it should do so in infancy and not do so later. Cases of pyloric spasm have persisted to a fatal termination without producing hypertrophy. There is no analogous instance of hypertrophy produced by spasm in any other portion of the alimentary canal; for instance, anal spasm is common, but does not produce hypertrophy. If the hypertrophy is produced by spasm the longitudinal fibres should be increased in proportion to the circular. But this is not found to be true. Furthermore if the hypertrophy were due to spasm it should disappear after operation, the cause of the spasm and the other symptoms having been removed. But it has been demonstrated that the tumor persists after operation. (Scudder and others.)

In the present state of knowledge it is more reasonable to believe that the hypertrophy is present at birth and may show at once; but that when the narrowing is only of a mild degree it gives no symptoms until some irritation (such as indigestion or hyperacidity) produces spasm, and this (aided probably by a catarrhal thickening of the mucosa) sets up the obstruction. A high situation of the pylorus and consequent angulation also figure as possible etiological factors. Hereditary history of stomach troubles and neuroses bear an uncertain relationship to pyloric stenosis.

Spasm of the pylorus is an affection distinct from hypertrophic stenosis but showing no appreciable pathological anatomy. It occurs most often in infants of excitable or "nervous" type. Beyond this there is nothing definitely causative. Its nature will be further brought out in the symptomatology and diagnosis.

Pyloric stenosis of older children may be produced by causes acting from within, such as contraction of scars resulting from corrosive poison, from ulceration, or from a wound produced by a foreign body; or by plugging of the pylorus by a polypoid tumor. That common cause of pyloric obstruction in adults—carcinoma—is a possibility though extraordinarily rare in children. Or the cause

may act from without, as in constriction by bands or adhesions, pressure of a tumor, displacement of the stomach with angulation of the pylorus. There is a possibility that hypertrophic stenosis may persist to a degree into childhood or even later life.

Symptoms and diagnosis.—The symptoms of congenital stenosis are those of obstruction more or less complete. They are present from birth or at least from the earliest taking of food. The symptoms of hypertrophic stenosis and of spasm of the pylorus may be considered together. They are very similar, differing only in severity and mode of appearance. The clinical picture of spasm is familiar to all pediatrists, but should be distinguished from chronic gastric indigestion and habitual vomiting. Morse[1] states the symptoms well and briefly. The condition occurs most frequently in babies of the excitable, neurotic type, whether breast-fed or bottle-fed, but more often in the latter class. As a rule the symptoms do not begin immediately after birth, but develop in the first few weeks or months. The severity of the symptoms varies greatly in different cases according to the degree of spasm. The milder case is characterized by frequent vomiting which may or may not be explosive, and is usually accompanied by gastric pain and distress. The vomitus does not give marked evidence of indigestion, and in quantity amounts to no more than was taken at the last meal. Indigestion and hyperacidity, when present, favor a diagnosis of spasm rather than hypertrophic stenosis. While defecation is infrequent there is some stool, showing that a considerable amount of food does pass through the pylorus and intestines. Nutrition is not greatly disturbed. In the severe case, to these symptoms is added that of gastric peristalsis, and the stools are smaller and the disturbance of nutrition is greater. There may be a palpable small tumor at the pylorus in spasm.

The symptoms of hypertrophic stenosis are very similar to those of spasm. They commence from a few days to several weeks after birth. There is vomiting, which is apt to be explosive and forcible. It may be irregular at first, but tends to become more regular, following feeding, and to be persistent. There is pain and distress. The quantity of vomitus may indicate that some ingesta have been retained from feedings previous to the last. The vomitus is neither sour nor bile-stained. With all the vomiting the baby is eager for more food. Infrequent and scanty stools and loss of weight are quite marked. On inspection the abdomen appears pear-shaped, being distended above in the stomach region, and small in the region of the empty intestines—an exaggeration of the infant type of abdomen. Distinct dilatation of the stomach is rare

[1] Am. Jour. Dis. Child., May, 1911.

in pyloric spasm, and although not invariably present in hypertrophic stenosis, when found it favors a diagnosis of the latter condition. In hypertrophy visible gastric peristalsis is exaggerated. Distinct waves of contraction pass from left to right across the stomach region, beginning in the left hypochondrium and traveling to the pyloric end. These waves of course are not at all times visible. They are best seen after the babe has taken some food or drink, or may sometimes be excited by percussion or massage over the stomach. Tumor may be felt at the pylorus about the level of the first lumbar vertebra, to the right of the median line. The characteristic tumor is larger than in spasm, its size approximating that of a filbert, and it does not change so markedly in size and firmness during examination as in spasm. Tumor, although present, may not be palpable at all until operation; or may be found only by very careful search, which if necessary, should be made under various conditions, both after feeding and after the stomach is emptied by vomiting, and when the abdominal walls are relaxed by a few drops of chloroform. The finding of the firm palpable tumor, in the case of persistent vomiting and wasting which resists proper feeding and medical treatment, justifies a diagnosis of hypertrophic stenosis.

The symptoms of pyloric stenosis of older children have usually been preceded by a history of the swallowing of caustic or of a sharp foreign body, or of the presence of ulcer, or of a peritonitis capable of producing adhesions; or a tumor may be found in the region. Obstruction produces pain and distress, vomiting, wasting, absence of stool and sometimes dilatation of the stomach. The X-rays, after ingestion of bismuth, are a very valuable means in the hands of a skillful radiographer and interpreter of radiographs, in determining malpositions, contractions, adhesions, scars, ulcerations, dilatations and malpositions of the stomach and pylorus.

Treatment.—The treatment of congenital stenosis, briefly stated, consists in short-circuiting around the stenosis, unless accompanying malformations render this impracticable.

The treatment of pyloric spasm is directed toward feeding without irritation of the stomach, allaying spasm by drugs and by warmth over the abdomen, avoiding all general excitement; and keeping the babe completely at rest after feeding. Sometimes gastric lavage is useful. A few hints on food and drugs will be found in the Appendix (46).

If a faithful trial of medical means fails to bring success, operation should be performed the same as in hypertrophic stenosis. For it is well established that spasm without hypertrophy may cause a fatal ending.

The treatment of hypertrophic stenosis is surgical in all cases in which the narrowing exists to such a degree that the little patient, although properly fed and cared for, cannot maintain his nutrition and advance in weight, strength, and development. As soon as this condition of things has been demonstrated, no time should be lost in waiting and hoping. Delay only lessens his chances of life which are good if operation is resorted to before wasting and weakness are extreme. Without operation they are nil. One has the choice of stretching the pylorus and of several plastic operations. (For brief remarks on some of these see Appendix 46.)

Gastro-enterostomy is the one operation which is generally technically practicable and secures an adequate and permanent opening between stomach and small intestines. It interferes little if any with the metabolism of ingesta as shown by subsequent analyses of stomach contents and excreta, and by the condition of the patients who survive. The mortality at present is about fifty per cent. This will be greatly reduced when operation is resorted to as early as it should be. Various forms of gastro-enteric anastomosis have been tried, and we are indebted to many different men, probably to none more than Scudder of Boston, for study of the subject and improvement in the technique. Undoubtedly the best operation is posterior gastro-jejunostomy. Strict aseptic preparation is necessary, but no exposure for washing at the time of the operation. If the umbilicus has been inflamed it should after thorough cleansing be sealed up. The patient's extremities are swathed in cotton wool. Not only should the room be warm, but the table should be warmed and kept warm. The stomach should be empty or be washed out before the operation. The present fashion favors ether as the anesthetic, but whatever anesthetic is used the anesthetist should be one thoroughly skilled and watchful, and oxygen should be used in conjunction upon the slightest indication. Very small instruments, such as clamps and forceps should be used. The median incision, small at first for examination, may be carried somewhat low, going to the left of the umbilicus. If possible, the stomach and intestines are not to be delivered from the abdomen. The wound can be pulled to the left enough to come at the stomach. The colon being raised, the jejunum is thereby lifted into view and should be taken, and not other bowel used instead. Clamps are useful. If the stomach is dilated with gas, a catheter is passed by the esophagus to collapse it; or the work can be done without clamps. The Murphy button (or similar devices) is not available in these small patients. The Lembert line is made with fine linen thread. Some use silk. The incision for the stoma is an inch long. The inside stitching is done with zero chromacized gut. The anasto-

mosis completed, a catheter may be passed (per orem) through it, and a dose of water placed in the intestines before closing the abdomen,[1] or a hypodermic of camphor-oil, or saline solution subcutaneously or per rectum should be used. The after-care is important. He is removed to a warm bed, and after recovery from anesthesia he is placed in an almost sitting posture in a sling. Feeding with whey per orem, given with medicine dropper is tried early, and brandy as needed. A sharp reaction comes on after the operation—103, 105 or 106+ F. This soon subsides in favorable cases.

MALFORMATIONS OF THE SMALL INTESTINES AND COLON

Neither the small intestine nor the large is malformed so frequently as the rectum or its outlet. Yet malformation may occur in rare instances at any point. The whole or a part of the small intestine may be entirely absent, or be represented by a fibrous cord, nearly or quite impervious. Or the bowel may end in a cul-de-sac, its lumen being again resumed in a cul-de-sac, or showing no abnormality. Occasionally a diverticulum from the bowel will end in a cul-de-sac, or open upon the surface of the abdomen, the canal below being continuous with that above the diverticulum or separated from it, or undeveloped, as the case may be. The whole intestine may be abnormally shortened, but not lengthened. A point at which one of the more common diverticula is given off is the ileum a few feet above the ileo-cecal valve. Here a remnant of the omphalo-mesenteric duct may be found, and is known as Meckel's diverticulum. Its form varies. It may be flask-shaped or cylindrical, and may end in a blind extremity or open at a fistula in the abdominal wall above the umbilicus. Congenital atresia of the small intestine is most apt to occur in the duodenum about the situation of the bile duct and the pancreatic duct, or just where the duodenum passes under the transverse meso-colon to become the jejunum. Entero-cysts are not very uncommon. They are of several varieties, according to their origin; either springing from subperitoneal tissue or consisting in an irregular segmentation in the development of the intestine. The large intestine, although seldom malformed, may be so occasionally, in either cecum, colon, or sigmoid flexure. It may be rudimentary, or greatly diminished in its lumen, or its place supplied by a mere cord. In rare instances the cecum or the colon is double. Anomalous positions of the large intestine are common, the sigmoid flexure extending to the middle line or over on the right side, or the cecum occupying the middle line or extending on to the left side, or being situated where the hepatic flexure should be; or cecum and appendix being found

[1] Richter (suggested by Walls): Surg. Gynec. & Obstet., June, 1912.

in the sac of an inguinal or scrotal hernia. The causes of many of these malformations of the intestines are quite inexplicable. Some can be accounted for as failures in certain steps of the embryological development which are well understood, while fetal peritonitis and consequent adhesions explain a limited number. (47)

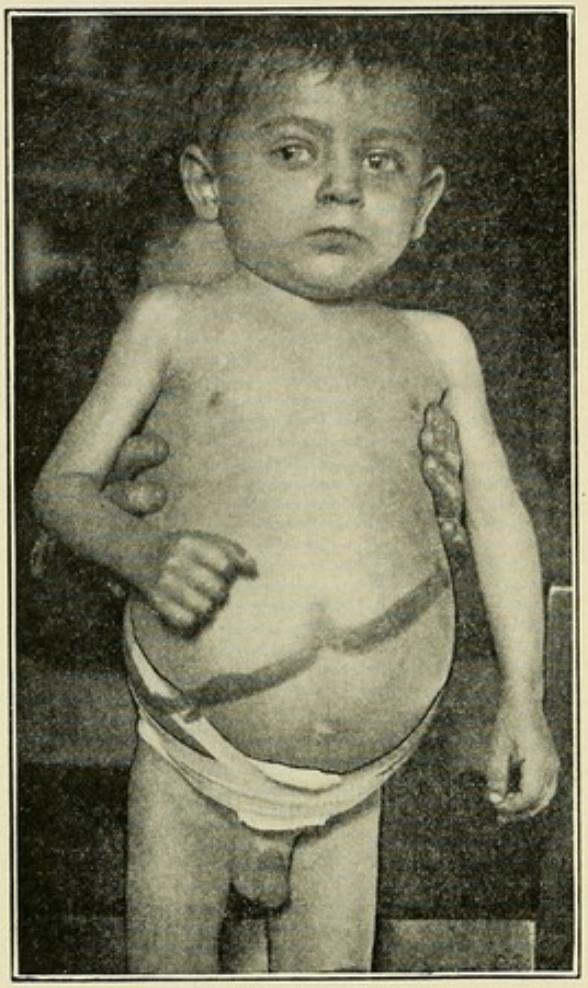


FIG. 190. TUBERCULOSIS AND BRONCHITIS FOLLOWING MEASLES. Ascites supervened, leading to diagnosis of tubercular peritonitis. Lower margin of liver shown by dark line. Autopsy showed death due to an old adhesive pericarditis. Boy aged 3 years.

Symptoms and Diagnosis.—The symptoms of congenital malformation of the intestine, large or small, vary with the nature and degree of the anomaly. The diverticula often give rise to no symptoms at all, and some with an external fistula only by leaking of intestinal contents. Judging by the location of a fecal fistula and the character of its discharge, and by probing through it, some idea of its point of connection with the intestine may often be formed. With atresia of intestine there are symptoms of obstruction more or less severe, according to the degree of the occlusion. Vomiting is a constant symptom, the vomited matters varying according to the seat of obstruction. If the atresia is high up in the intestinal tract, only whitish mucus will be ejected; but if the obstruction is in the ileum, or even in the jejunum, the vomitus will contain meconium. If the occlusion is complete, no defecation takes place. With obstruction high in the bowel, distension of the abdomen with meconium and feces or gases does not take place as it does with an obstruction low in the intestinal tract. In all cases it is important to explore the rectum to ascertain whether any mal-

formation can be detected in that situation, either by the finger or by a catheter or small rectal tube passed farther than the finger can reach. Injections of water may empty the bowel below an obstruction and help to demonstrate its situation. Palpation and percussion may reveal the presence of a tumor, which it may be inferred is an accumulation above the seat of the obstruction. Interference with the circulation, more marked upon one side than upon the other, may betray the location of a distended ampulla. The vomiting of whitish mucus alone might favor the probability of a high situation for the obstruction, but it does not prove it to a certainty. The vomiting of meconium indicates that the obstruction is below the duodenum, but it gives no clue as to whether it is in the small or large intestine. The absence of vomiting does not disprove an intestinal obstruction. Nor is the amount of urine of much value diagnostically. In the great majority of cases it is impossible to determine with any degree of accuracy the location of the malformation by the symptoms or physical signs.

Prognosis.—Complete occlusions are fatal unless relieved by surgical means. With partial occlusion a patient may survive. Occlusion low in the intestine, which finds an outlet through a fistula, is not incompatible with life. Quite a number of malformations could be remedied by operation if the condition could be determined and the operation performed early.

Treatment.—If a fecal fistula exist which prevents the promptly fatal effects of complete obstruction, or if, without fistula, the occlusion is evidently not complete, but allows the passage of liquid or soft feces, it may be advisable to wait until the infant is older and stronger before attempting operation for its relief. But if there is evidence of complete atresia or obstruction of such severe degree as to threaten life there is no choice but to make an exploratory incision. This may be located in accordance with the situation of a fecal fistula or of a definite tumor. In the absence of any guide of this kind, the incision will be made in the median line. The condition found must be dealt with according to its nature and location. If a bowel be occluded by a septum the bowel must be opened and the septum divided. If the interruption in the lumen of the gut be longer, it may be possible to bring the ends of the normal gut together and establish the continuity of the canal by end-to-end or lateral anastomosis. With hopeless atresia in the duodenum, or high in the jejunum, it may be possible to perform a gastro-jejunostomy, uniting the stomach to the jejunum below the obstruction. If the malformation is low in the intestinal tract an artificial anus, or what is more quickly executed, a fecal fistula, allowing the escape of intestinal contents from the lowest portion of the pervious gut to the outside of the abdominal wall, is the rational procedure.

These operations, although severe, are not necessarily fatal, and offer the only hope of escape from otherwise inevitable death.

INTUSSUSCEPTION

Intussusception is an invagination of one portion of bowel into another portion—sometimes described as "telescoping" of the bowel, or prolapse of one portion of intestine into another. It is not exclusively confined to infancy and childhood, yet more rarely occurs at any other time of life. It is far more frequent in infancy than in childhood, and is most frequent at about the fourth to the eighth month. It is the most frequent of all the causes of intestinal obstruction at this time of life.

Intussusceptions of the dying are in a class by themselves and have no clinical symptoms. They are found very frequently at autopsies in the small intestines, especially of infants. They are descending or ascending, easily reducible, having no swelling nor adhesions, and usually multiple. They are supposed to be caused by irregular peristalsis which takes place at the moment of dissolution. I see no reason for classifying them with pathological intussusceptions, and shall give them no further consideration.

Varieties.—The invagination is nearly always descending, but the ascending or retrograde variety is occasionally seen; also double and triple invagination at the same point. (See Figs. 191, 192 and 193.) Intussusception may occur in any part of the intestinal tract. Leichtenstern's classification is as follows: The ileum into the ileum, or ileo-ileac; the colon into the colon or colon intussusception; the ileum through the ileo-cecal valve, ileo colic; and the ileum into the colon without turning the valve; that is, the valve forms the head of the entering portion, ileo-cecal intussusception. As to course and duration, the clinical classification of Rafinesque, as given by Treves, is satisfactory: 1. The ultra acute, when the patient dies within the first twenty-four hours. 2. The acute, when the duration of the disease is between two and seven days. 3. The subacute, when it extends between seven and thirty days. 4. The chronic, when it lasts more than thirty days.

Etiology and Pathology.—In addition to age, which has been mentioned, sex, for some unknown reason, has an influence. Males are nearly twice as liable as females to intussusception. Other etiological factors usually mentioned are anatomical peculiarities, such as the thinness of the intestinal walls, the mobility of the ascending colon; and, in the ileo-cecal variety, the immobility of the cecum and its larger size, as compared with the mobility and activity of the lower end of the ileum, which is of small caliber. Then there is the frequency of other intestinal disorders at this period, such as indigestion, colic, diarrhea, constipation. But Treves, who has

studied the subject of intussusception closely and written upon it extensively, thinks that some attacks of colic may be the effect instead of the cause of temporary invaginations of the bowel. Indigestion often appears as a cause of these cases. Constipation is given as a cause, acting by inducing peristalsis, and also by the ad-

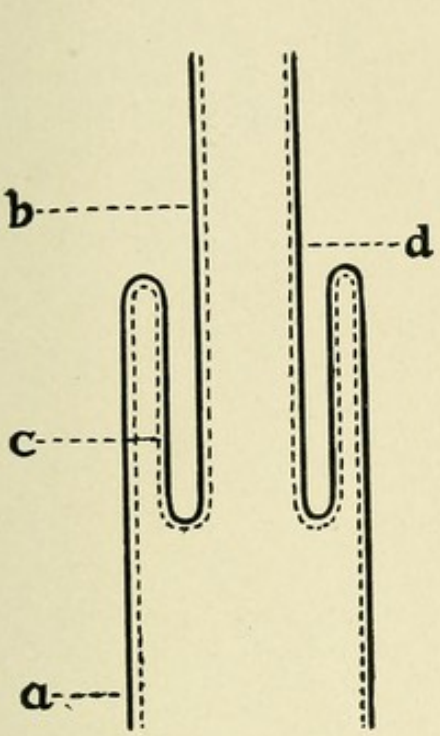


FIG. 191. VERTICAL SECTION OF AN INTUSSUSCEPTION. a. The sheath or intussuscipiens. b. the entering or inner layer. c. the returning or middle layer. b. and c. together constitute the intussusceptum. After Treves.

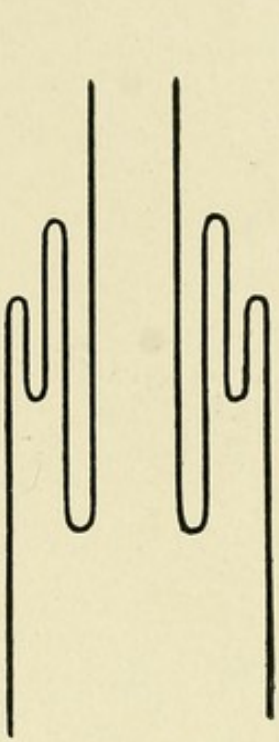


FIG. 192. DOUBLE INVAGINATION OF INTESTINE. After Treves. Instances of double invagination are not very uncommon. There are five layers of intestine.

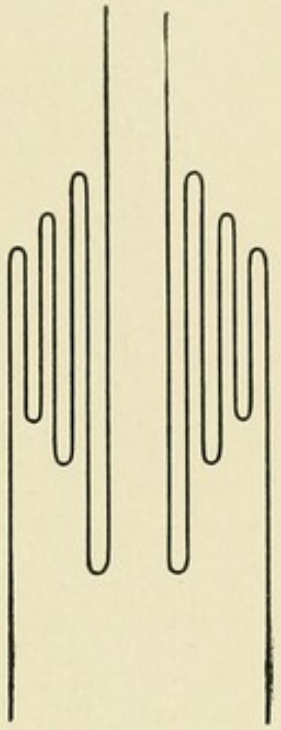


FIG. 193. TRIPLE INVAGINATION OF INTESTINE. After Treves. Cases of this variety are quite unusual. Seven layers of intestine are presented.

hesion of a scybalous mass to the intestinal wall, which is thereby drawn upon. Tumor or polypus of the intestinal wall is undoubtedly a cause. (See Fig. 194.) Tumors are not so very infrequent, and range in size from that of a cherry to that of an egg. Vegetations at the ileo-cecal valve or an inverted Meckel's diverticulum may act in the same way. Leichtenstern and other writers, as quoted by Treves, have remarked upon the effect of the ileo-cecal valve in producing intussusception. They compare the valve to the anus, and intussusception through it to prolapse of the rectum produced by tenesmus. A mass of undigested food has often brought on an intussusception. This trouble has, in a number of instances, followed injury to the abdomen externally. Sudden cold or chill, paralysis, and rarely stricture are among the causes. In

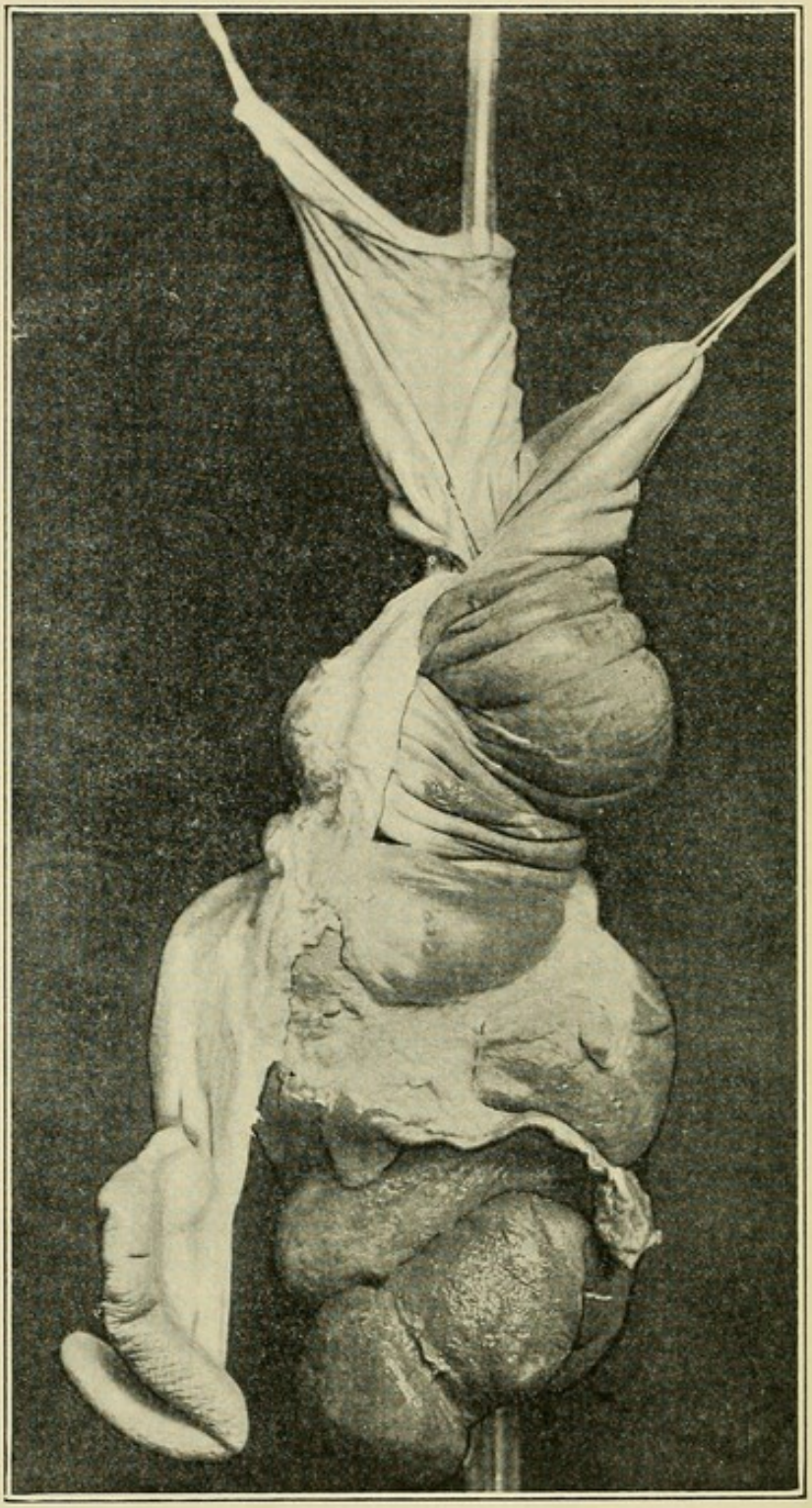


FIG. 194. SPECIMEN OF ILEO-COLIC INTUSSUSCEPTION removed post-mortem from a child of 3 years. Diagnosis easily made during life but operation refused. The glass tube is passed through the intussusception. A portion of the cecum forming the ensheathing layer is cut away below, to show the entering portion at the lower end of which is a tumor, which probably caused the invagination to occur.

my own cases I was struck with the frequency with which this accident followed promptly after the infant had been "dandled" or "tossed," or had a slight fall, or was simply frightened by nearly falling, and found, on consulting the literature, that Rilliet and Barthez had mentioned three or four such examples.

Intussusception is produced by irregular action of the muscular layers of the intestine. Anything that is capable of exciting the irregular action will act as an exciting cause. The sensation of falling, acting through the nervous system, seems to have that power. The vivisection experiments of Nothnagel, as quoted by Treves, furnish important data upon the subject of the formation of intussusceptions. The opinion is generally accepted that pathological intussusceptions are produced in the same manner as the experimental. For example, the intestines of a rabbit are exposed, and a segment of bowel stimulated by faradism applied through electrodes, so close together that a ring-like contraction is produced. As the current is increased the contraction extends a considerable distance upward (toward the stomach), but only to a slight extent downward. The gut at the point of irritation contracts to a hard, white cord, and this contraction, proceeding upward, either widens gradually to normal intestine or ends abruptly. In the latter case the wide tube of the normal gut above slides a short distance over the contracted portion below, thus forming an ascending or retrograde intussusception. Such invaginations never proceed far nor remain long. But at the lower end of the contracted portion a very different occurrence takes place. The point at which the electrode was applied remains a fixed point. The normal gut just below turns itself upward over this contracted portion and forms an intussusception of the descending variety. It was proven, also, by paralyzing a portion of bowel by crushing, that the entering portion of the intussusception takes no active part in its formation; and that either spasmodic contraction of a portion of intestine or paralysis of a portion may lead to the production of an intussusception. The active part in the process is taken by the receiving portion of the bowel (sometimes called sheath or intussuscipiens), which draws itself over the entering portion. The entering portion, together with the middle layer (that is, the layer which turns back from the apex of the entering portion to join the margin of the sheath), is called the intussusceptum. It will be observed that the serous coats of the entering and returning layers are in contact, while two mucous coats, that of the returning layer and that of the sheath lie face to face. If it were not for the mesentery the entering portion would be straight and occupy the middle of the sheath. But as it enters it draws the mesentery in with it, the latter lying between the inner layer and the sheath, and the dragging of the

mesentery curves the entering portion into the arc of a circle, with its concavity toward the mesenteric attachment, consequently toward the spine. To speak more correctly, in accordance with the accepted theory of the muscular action, the sheath or receiving portion engulfs or "swallows" the intussusceptum, mesentery and all, the latter being stretched to its utmost and also constricted in the sheath. As the invagination proceeds, more and more of the mesentery is gathered into the neck of the sheath, making it thicker at this part. The apex of the entering portion is drawn toward the side of the sheath, and thereby partly obstructed. This drawing upon one side of the intussusceptum causes the orifice at its apex to be slit-like. The degree of the curving of the intussusceptum varies considerably, according to the part of the intestine in which it takes place, as a rule being more marked in ileo-cecal invaginations, less constantly present in those of the middle of the ileum and of the colon, often absent in the rectal variety.

Invagination of the bowel does not invariably completely obstruct its lumen, nor cause serious strangulation of the intussusceptum. Yet obstruction and strangulation, to a degree, are always present, and cause most of the symptoms. The compression of the mesentery at the neck of the sheath and traction upon it interfere with its circulation, that of the veins being first affected. The venous return being impeded, the intussusceptum becomes engorged and edematous. Hemorrhage often occurs. If the strangulation is sufficiently severe, and especially if the arterial supply is prevented, gangrene results. If the strangulation is acute, gangrene occurs near the point of greatest pressure at the upper end of the intussusceptum, which is cast off in a mass. With chronic or slow strangulation, gangrene begins at the lower end of the intussusceptum, which sloughs away in pieces, or occasionally ends acutely by sloughing away in one continuous tube or *en masse*. The gangrenous portion coming away may be only a few inches of bowel or several feet. It may have the serous side out or if the inner layer becomes loosened first it may be passed with the serous side in. In the acute case, when sloughing of the entire invaginated portion occurs, it is generally in the second half of the second week. The fragmentary sloughing of the subacute or chronic case may extend over several weeks. The sheath, or receiving portion, does not show much effect comparatively. It usually is thrown into folds, and somewhat congested. It may be thickened. In exceptional cases it may show gangrene. A very important result of the invagination is the peritonitis that is set up, producing adhesion between the serous coats of the entering and the returning layers, sometimes involving the external coat near the neck of the sheath. Adhesions may be limited to the neck, where the entering portion

is most tightly constricted; or limited to the apex; or the whole of the serous surfaces of the entering and returning layers may be tightly glued together. The firmness of the adhesions varies greatly in different cases, often being very soft and easily separated and offering no obstacle to reduction. The time at which adhesions occur is a matter of the greatest interest. It is rare that they occur before the fourth day, and not infrequently it is the sixth or seventh day; while chronic intussusception may be present for weeks, or for months, without the formation of adhesions.

Symptoms.—In the typical acute form the symptoms are sudden pain, and vomiting of the stomach contents. The pain is paroxysmal, recurring every few minutes, and is very severe. There are symptoms of shock—feeble pulse, pallor, the abdominal and other muscles relaxed, mental apathy. The temperature may remain normal but is often subnormal. Tenesmus is a common symptom, usually said to occur in rectal intussusception; but in my experience something very like it occurs during the paroxysm of pain in the ileo-cecal, ileo-colic, and colic varieties. Soon defecation occurs. After the lower bowel has been emptied of fecal matter, blood is passed—blood and serum. A tumor may be felt, often in some part of the colon, or in the rectum. If the case does not die of shock within the first forty-eight hours, the abdomen, hitherto soft and relaxed, becomes tympanitic. The vomiting has continued and brings up bile-stained mucus, or is stercoraceous in older children, or is a mere empty retching. If the condition is not relieved, the prostration becomes extreme, the temperature rapidly rises to 102, 103, 105, or 106 degrees F., and the end comes with coma or collapse.

The subacute cases present the same symptoms, but the onset is not so sudden nor the symptoms so severe.

In the chronic cases the symptoms are very indefinite. There is usually some diarrhea, sometimes with straining, and irregular pains and discomfort. The child is worrisome and loses flesh. But there is no acute pain, vomiting, bloody stools nor collapse. Tumor may generally be found by palpation or rectal exploration.

Pain.—Pain is one of the most constant symptoms, being almost invariably present in the acute cases. It is extremely severe, causing the child to shriek with agony. After a momentary paroxysm it ceases, to return again after a few minutes, as in ordinary colic, but much more severe. The child's face wears a look of fear and anxiety as if in dread of the pain. Pain may become less severe after twenty-four or forty-eight hours, in some cases being less noticed after the first few hours, perhaps from the apathetic condition produced in the child. Children are generally unable to localize the pain. In some cases pain is not so prominent, its place being taken

by paroxysmal tenesmus. This is more apt to be the case in the subacute variety.

Vomiting is almost invariably present in acute cases, though it does not always begin early. When once begun it continues more or less throughout the attack. It is not as prominent nor as distressing a symptom as in other forms of intestinal obstruction. It varies somewhat according to the completeness of the obstruction. and is made worse when food is given by the stomach. It occurs with the obstruction at any part of the intestinal tract. It is not much affected by medication, but is not often violent. I have never considered it markedly projectile. In older children if vomiting persists several days it becomes stercoraceous. In a few cases it is bloody.

Tumor.—This is a very important symptom, because it is characteristic, and, fortunately, may usually be found readily if search be made within the first day or two, while the abdomen is relaxed and free from tympanites or tenderness. Tumor may be present within a few hours after the onset. In Holt's collection of 188 cases under ten years of age, one-half presented the tumor in the rectum or protuding from the anus. And this descent may take place in a very short time, even when beginning at the ileo-cecal valve. In one of his own cases it was felt in the rectum in less than twelve hours after the onset. This seems a surprisingly large proportion of cases to be first found as low as the rectum if they were all acute cases. It goes to show how long and loose the mesentery may be. Digital examination by the rectum may find the tumor there, or even protruding an inch, or two, or three, or more. It may present the ileo-cecal valve at its apex. Often the sphincter will be found relaxed if the tumor is low in the colon or rectum. One of my cases was a babe of ten months, which had been ill between five and six weeks. It began with pain, vomiting and purging, with bloody stools, but no physician had been called during the first two weeks. Then the doctor made eight visits and checked the symptoms, which, however, still recurred. During the last ten days or two weeks the mother had noticed a "lump" in the lower part of the baby's belly. Attacks of tenesmus were frequent, and each time the "bowel came out" a distance of two inches. The ready-made diagnosis was "dysentery," with prolapse of the rectum. Examination showed the projecting tumor an intussusception, of the usual purple color and opening at the apex like an os uteri. Apparently the entire colon from the cecum was invaginated. It was afterward reduced by water pressure and the babe recovered. If the tumor is not found in the rectum, search should be made by palpation over the course of the sigmoid, descending, transverse and ascending colon, and especially in the ileo-cecal region, where so many intussusceptions begin. The tumor may be small, of the size of a hickory-

nut, or several inches in length and "sausage shaped," that is, crescentic, with the concavity toward the mesenteric attachment at the spine. If taking its origin low in the colon or in the rectum, this curved shape is not noticeable. It is usually movable and may be felt to swell and become tense during manipulation or during a paroxysm of pain and tenesmus. It may be difficult to discover if under the margin of the liver; or if, after the first day or two of relaxation of the muscles, they become tense with the advent of peritonitis; or tenderness supervenes, leading to resistance from the patient; or the abdomen is tympanitic. An anesthetic may be necessary to discover the tumor.

Shock or Prostration.—This is a marked symptom in the acute cases. It would require a severe external injury or a serious operation to produce an equal degree of depression. Colic never produces such prostration. Strangulated hernia, some forms of poisoning, or cholera infantum might do so. The feeble pulse, cold, sometimes perspiring skin, subnormal temperature, relaxed musculature and the anxious countenance, and later apathy, are sufficient evidence that a grave accident has occurred.

The Stools.—Bloody stools are a very constant symptom. There are sometimes a few loose fecal stools first, but very soon, in the majority of cases, blood appears. Often there is quite a quantity; that is, enough to stain a diaper freely with watery blood. It is said that mucus is nearly always present. But in my cases this has not usually been present early in the case. Appreciable quantities of mucus come later in the acute cases, or in the subacute and chronic cases. In these latter it is a feature and lends some resemblance to dysentery. I have but a few times seen in colitis enough clear blood to resemble the stools of intussusception; and never in acute intussusception anything like the quantity of mucus ordinary in colitis. In intussusception the stools soon lose all fecal odor, and finally they may cease altogether, scarcely anything, not even gas, passing during the straining. In other cases there is a little blood or bloody mucus.

Temperature.—The most important thing about the temperature is the absence of fever early in the case. This or subnormal temperature are usual. If, later, temperature rises rapidly, it presages a promptly fatal termination.

Anuria.—The urine may be diminished, but the symptom is not marked and is of no value in indicating a high or lower seat of obstruction.

Thirst.—Thirst is not a symptom unless vomiting and bleeding are profuse—in marked contrast with many gastric disorders and diarrheas and some forms of strangulation bearing a resemblance to intussusception.

Loss of weight takes place in the subacute and chronic cases.

In the acute cases, although some loss takes place, it is not as much as indicated by appearances, which are rather due to the flaccid state of the muscles.

Course and Prognosis.—Treves gives the general mortality of intussusception as 70 per cent. Among acute cases alone the mortality is much higher, and the ultra-acute cases are all fatal. Most of the recoveries are among the subacute cases. The distinctly chronic cases have a high mortality. And in children under a year the mortality is high, as compared with cases at all ages. In over 80 per cent. of the cases death occurred before the seventh day. Holt gives the following figures: Of 198 cases under ten years, 155 were classed as acute, lasting less than seven days; 33 as subacute, lasting from one to four weeks; 10 were chronic, lasting over four weeks. Nearly all the cases occurring in infancy are acute. The duration of the disease in 92 fatal cases was as follows: Less than twenty-four hours, 2 cases; two to four days, 44 cases; five to seven days, 22 cases; one to two weeks, 18 cases; two to three weeks, 6 cases. Thus one-half the cases died on the third, fourth, or fifth day. Of 57 cases terminating in recovery, 66 per cent. were reduced on the first or second day.

In the acute cases the most frequent cause of death is shock. In the chronic cases it is usually exhaustion. Peritonitis, hemorrhage from separation of gangrenous gut, pyemia, and perforation are among the causes of death.

Spontaneous cure of intussusception may result, although these instances are so rare and uncertain they are never to be counted upon in the prognosis or treatment. Spontaneous cure may take place in one of two ways—reduction of the intussusception or elimination of the intussusceptum by gangrene, while adhesions at the neck of the sheath maintain the continuity of the intestinal tube. Treves and other observers have little doubt that spontaneous reduction occasionally takes place, perhaps oftener than has been supposed. In one case of my own, in a boy of three years, I carefully eliminated all other causes of the condition, which must have been an intestinal obstruction, and in all probability an intussusception, which righted itself under the prompt use of opium. Such cases are, of course, impossible of proof, yet to one familiar with children's attacks of vomiting, indigestion, colic, gastro-enteritis, ileo-colitis and the like, the clinical picture presented by intussusception, with its sudden onset in a well child, its acute pain, vomiting, tenesmus, collapse, even without tumor, is hardly to be mistaken. And to see this condition as suddenly righted admits of but one reasonable conclusion. There is every reason to suppose, from experiment and from recorded clinical cases, that spontaneous reduction takes place. As to cure by sloughing of the intussusceptum, there is abundant

evidence in the records and in the pathological museums. According to Leichtenstern, recovery by this method in the first year of life takes place in only 2 per cent. of the cases, between the second and fifth years in 6 per cent., and between the sixth and tenth years in 38 per cent. Of those who do recover from the immediate attack by elimination of the intussusception, over 40 per cent. die ultimately from the effects of the bowel lesion. (Leichtenstern, Treves.)

Diagnosis.—The diagnosis is made upon the sudden onset of paroxysmal pain, the vomiting, shock, bloody stools, tumor, and subnormal temperature. If the examination is made while the abdominal muscles are yet relaxed—that is, in the first day or two days—no anesthetic is necessary. But after tympanites occurs, or peritonitis or local tenderness at the site of the tumor appear, muscular rigidity or voluntary resistance or fear of being hurt will make general anesthesia necessary for satisfactory examination. In the chronic cases the presence and character of the tumor when discovered, together with the more indefinite symptoms, usually settle the diagnosis at once. Yet mistakes have occurred, even with the tumor projecting from the anus or plainly palpable in the rectum, it being mistaken for prolapse or polypus, or even for hemorrhoids or a cancerous growth. The opening at the apex should distinguish an intussusception from any tumor; and that one can sweep a finger all round it, there being no attachment at the anal margin, dispels any superficial appearance of prolapsus.

Treatment.—A few words are necessary concerning the opium treatment of intussusception. Treatment by opium has done incalculable harm; there is no other drug that has been so misused and has caused so many deaths from intussusception as opium (and its derivatives); and this notwithstanding that, if used wisely, it is a valuable medicine in this condition. If men would use opium as they would an anesthetic, understanding that it is only useful temporarily, in order thereby to accomplish something else that is positively remedial, its use would be justifiable. But the relief it affords from pain, sometimes from vomiting, from the appearance of shock, from tenesmus, and consequently from the bloody stools, this relief, I say, is so specious that it deceives the physician himself, blinds him to the real condition, and leads him to postpone active measures. It is sure to deceive the parents and cause them to oppose any mechanical solution of the difficulty. And so the time most favorable for reduction is allowed to pass by. There is no doubt whatever that in rare instances the prompt use of opium has checked the irregular action of the intestinal muscular coats, which had produced an intussusception, and with every recurring paroxysm was drawing it farther and tighter, and that

the entering bowel, released from the muscular grip of the receiving portion, has righted itself. But these instances are rare and are not to be counted upon as probable effects of opium. When they do occur it is promptly after the exhibition of the drug. They argue nothing for its repeated or continued use. It is true that opium will relieve shock, but that is no reason for allowing the cause of the shock to continue to act. Opium quiets the tenesmus and thus checks the increase of the intussusception.

Belladonna is a useful drug, used in connection with the opium. It aids in relieving the pain and in quieting irregular spasmodic peristalsis. One or both of these drugs may be used in suppository when the stomach is intolerant. This temporary staying of the progress of the intussusception should be utilized for making the necessary arrangements for permanent relief by reduction either without or with laparotomy, as may prove to be necessary.

Obstacles to Reduction.—Just at this point, before discussing the means of effecting reduction, it may be useful, at the risk of repetition, to refer again to the pathology of the condition, with an eye solely to its reducibility. Early in the case the greatest obstacle to reduction is the swelling of the intussusceptum, together with the spasmodic contraction of the sheath; other causes that may develop are the curved shape of the intussusceptum, together with the stiffness produced by the edema; gripping of the tumor by the sphincter-like ileo-cecal valve in the ileo-colic variety; twisting of the tumor; and adhesions between the serous coats of the entering and the returning layers. Adhesions never appear sooner than the third day, seldom before the fourth, and often not until the sixth or seventh. It is not uncommon for them to be absent for weeks in the subacute cases. In chronic cases there are apt to be adhesions. Occasionally there are adhesions only near the apex of the intussusception, so that when all is disinvaginated but the last inch perhaps, the adhesions prevent farther reduction, but this is unusual. New adhesions are soft and yielding, easily torn apart.

The Amount of Pressure borne by the intestine without rupture is stated by Forest, after experimental study of the subject, to be eight or nine pounds to the square inch in the infant and twelve to fifteen pounds in the adult. When rupture takes place it is usually in the transverse colon. Six pounds pressure was considered by him a safe amount to apply in a child during the first three days of the illness, and he advised the use of eight or nine pounds if necessary. In a subacute or chronic case the same amount would be safe any time within a week to perhaps three weeks.

Softening or Sloughing of the Bowel.—Another question of extreme importance bearing upon reduction is, When may sloughing of the affected intestine begin? According to Forest, in the

ultra-acute cases, sloughing may begin in twenty-four hours. In the ordinary acute cases, three days is the minimum time, while in the subacute and chronic cases a week or more will elapse before any change of that kind takes place.

Methods of Reduction.—The literature records many curious methods for reduction which are now obsolete; for example, the introduction of quantities of quicksilver into the bowel with the patient inverted; the use of bougies to push up the tumor and so effect reduction. Cures are recorded by all these methods. Also by introducing into the child's colon a sheep's colon and then inflating the latter with air.

Puncture of the intestine with the fine tube of an aspirator is a procedure not only useless in a curative way, but unsurgical and dangerous. It was used to prolong life by relieving gaseous distension while waiting for sloughing of the gut. I would not have mentioned it here but that I saw it alluded to without condemnation among the remedial measures in a recent book.

The lines of procedure which are worthy of discussion are abdominal taxis, reduction by the pressure of air or of gas introduced below the tumor; reduction by pressure of fluids; laparotomy with disinvagination; laparotomy with exsection of the intussusceptum or other entero-plastic operation; and combinations of these methods.

Abdominal taxis as nearly as possible after the manner of manipulating a hernia, but through the abdominal walls, was advocated by Mr. Jonathan Hutchinson. Cures are reported from this method alone, but it is better and usually combined with inflation or injection. (48)

In 1892 and at intervals subsequently I made some studies of the subject of intussusception, my conclusions being briefly stated in an article published later.[1] In this article I drew attention to the necessity of accurately measuring the pressure employed for reduction, and especially emphasized the fact that the element of time during which the pressure is kept up is of equal importance with the degree of the pressure, stating my opinion that a pressure of three to five pounds to the square inch applied for twenty-five or thirty minutes, or, if necessary, longer, is more efficient and safer than a pressure of seven to nine pounds for five or ten minutes. I criticised reporters of cases for indefiniteness upon these points, many writers saying "we used injections persistently," or "inflations," or "we inflated the bowels repeatedly," very seldom stating the amount of pressure used, and in no case recorded had I found mention made of the length of time during which the pressure should be maintained at a given degree. As stated in that article,

[1] Cleveland Medical Gazette, March, 1898.

and even yet to-day, our text-books are very indefinite on these points, especially as regards the element of time.

The condition is somewhat analogous to that of incarcerated hernia. No surgeon would think of seizing a hernial protrusion and at once by the exertion of force, even of a measured amount of force, thrusting it through its constricting ring into the abdomen. On the contrary, continuous and steady pressure is applied and kept up for a time sufficient in many instances to lessen the swelling and to tire out the spasmodically contracted muscular bands, while at the same time manipulation at the neck of the sac aids in the taxis. In the same manner the steady pressure of air, or gas or fluid within the bowel below the intussusception not only tends to push it back but lessens its congestion and edema and so its caliber while the ensheathing layer is also expanded and its spasmodic constriction forced to yield. I urged the use of normal saline solution at a temperature of 100 to 105, or of air followed by water. This was suggested as a means not only of preventing the escape of air, which is very difficult to keep in the colon under pressure, but of measuring the pressure of the air by the simple method of following it with water-pressure measured by the elevation of the fountain. I do not believe that, as one writer states, "the amount of air introduced should be left to the judgment of the physician," unless he has some means, more reliable than guessing, of estimating the tension produced. At the time of that writing I had not seen Forest's original paper,[1] and was not aware that he had alluded to the advantage of continuous pressure.

For inflation air may be used, or carbonic acid gas, or hydrogen gas. Ziemssen's method (or that of Libur or Jate) of using carbonic acid gas by injecting into the bowel first a solution of bicarbonate of soda and afterward a solution of tartaric acid, is only mentioned in order to condemn it. The use of a siphon of Vichy water as employed by Forest was afterward justly censured by the same writer because of the uncertainty as to the amount of force used. Hydrogen gas, after the method of Senn in wounds of intestines, could be used, but the apparatus is seldom at hand and possesses no advantage over common air.

Whatever agent is employed, the degree of force and the time it is kept in action should be accurately measured. The advantages of air are: The elasticity of its pressure within the bowel; and the fact that if reduction is effected pressure is relieved so promptly that it can be felt by the manipulating hand upon the abdomen; and most convenient of all, if the pressure is released the air recedes so readily that the tumor may be searched for at once. Air passes more readily than water, above the ileo-cecal valve into the small intestine.

[1] Am. Jour. of Obst., July, 1886.

Its disadvantages are: It is less manageable, that is, harder to confine within the sphincter, and hard to maintain at the desired pressure. This difficulty, however, has been overcome, as I mentioned, by first filling the bowel with air and then following with water at a measured pressure—which drives the air before it higher into the bowel

Of the fluids used for injection there are several—plain water, soapy water, normal saline solution, oil, milk, thin gruel, beef tea; not to mention decoction of tobacco or of chamomile and other fluids that have occasionally been used. Of these the best and most available is water that has been boiled and cooled to such a temperature that it will be delivered to the patient at 105 degrees to 100 degrees F., and it should have in solution common salt, a drachm to the pint. The advantages of such a solution are: It is quite manageable at a given pressure. It can be used hot or quite warm, thus aiding in overcoming shock; and doubtless some of it will absorbed from the intestine, stimulating the patient and supplying water for the circulation.

Its disadvantages are: It is not quite so readily apparent when the intussusception yields, as the tension does not alter so instantaneously; and if pressure is relaxed, the bowel is not at once emptied, so that one cannot immediately search for the tumor. It has been said to cause diarrhea. However, I have never seen diarrhea caused thus. In my own practice I use the hot normal saline, first filling the bowel with air from a bellows or an ordinary hand ball with a valve, such as is used with an atomizer, attached to a catheter.

It is usually directed that the patient's hips should be elevated, or that the patient should be inverted from time to time, in order "to get the assistance of traction of the intestine above upon the seat of the invagination," or that the "water in the intestine may assist by gravity." As matters of fact one may state that the traction of the weight of the intestine or of the water would be quite inconsiderable even if in the right direction; and that the force may be desired transversely in the transverse colon or toward the feet in the ascending colon. What inversion (as well as manipulation) might do is, to favor the passing of air or of fluid upward through the ileo-cecal valve, as Forest has shown, and as my own experiments corroborate. But, as before stated, it is extremely rare to have intussusception of the small intestine alone in children; and it is impossible to affect such an obstruction above the valve by air or water pressure without unsafe tension on the colon.

The simple device of Forest is quite as efficient as the elaborate apparatus of Mr. Lund. The nozzle of an ordinary Davidson syringe or a vaginal syringe should be wound with a roller bandage about an inch from its tip so as to make a shoulder an inch wide, which may be pressed against the buttocks to prevent the water from escaping.

This with a fountain syringe and some rubber tubing constitutes the hydrostatic machinery. I usually have twenty to twenty-five feet of rubber tubing, as a stairway to get the proper elevation may not be near. I have allowed two and one-half feet elevation to represent one pound pressure to the square inch.[1] Beginning at the height of the patient upon the table I mark the stairway, in an ascending scale, at intervals of two and one-half feet, numbering the marks, so that the person who holds the fountain can be directed verbally. An anesthetic is administered. The patient lies upon his back with thighs flexed and is held firmly, as one is obliged to press the shoulder of the injection tube strongly against the buttocks. Air is then pumped in and then the water allowed to flow. A case or two will illustrate. Baby M., aged four months, was well grown, breast-fed, and healthy, though the bowels were slightly loose. At eight o'clock one evening suddenly turned sick, cried with pain, vomited, and defecated. Vomited at intervals all night, the vomitus becoming green. After a few fecal stools the discharges became bloody serum. Paroxysms of pain and tenesmus. Refused the breast. Temperature normal; pulse very rapid; child apathetic; weak; pale; muscular system entirely relaxed. Abdomen flaccid. In the cecal region a movable tumor thicker than my thumb could not only be felt but seen. Palpation of tumor caused paroxysms of pain. Diagnosis intussusception, probably ileo-cecal. Gave a small opiate; and procured apparatus for reduction. Assisted by Drs. Bailey and Barger. Chloroform. Inflated with air followed by water to maintain and measure the pressure (normal saline T. 103 F.). Fountain at five feet four inches, giving a trifle over two pounds pressure per square inch. Kept this pressure fifteen minutes. Raised reservoir to six feet four inches, giving pressure nearly two and a half pounds and kept this up five minutes longer, making twenty minutes in all under pressure. There was not felt any perceptible giving way, but the respiration and circulation being impeded by the pressure it was now relaxed, and the water allowed to escape. It was then found that the tumor had disappeared. Infant vomited a few times after the reduction, then became quite easy and recovered.

Another illustrative case is Baby D., aged nine months. Seen with Dr. Nuss. While sitting on the floor he toppled over backward, which scared the infant without apparently hurting him. Soon after he cried with pain, and was much distressed. Vomiting ensued, and a bowel movement with much tenesmus. Could retain no food in the stomach. Was seen by me fifty-six hours later. He was restless, tossing and turning and kicking; apathetic; temperature

[1] Forest, in his paper of 1886, reckoned two and one-half feet; in his paper of 1889, two feet.

99⅗, pulse 158. Straining at intervals, passing small quantities of blood-stained mucus. No stool in past fifty-six hours. Would not nurse. Had had repeated injections by a midwife and by attending physician with no avail. Also calomel. Abdomen now somewhat distended but not very tense, excepting in region of ascending and transverse colon, especially from the hepatic flexure to the middle line. In the middle of the epigastrium or slightly to the right of it a tumor could be felt. Pressure upon it caused tenesmus and distress, not sharp pain. Diagnosis intussusception probably at the valve of Bauhin, extending as far as transverse colon. Used air and water pressure (normal saline at 100 degrees F.); under light chloroform anesthesia. In two minutes had carried pressure to three pounds. Kept this up three minutes more, then went up to four pounds. Kept this five minutes. Put pressure up to five pounds for two minutes. In all, the pressure was on twelve minutes. Pulse ran to 180+. Discontinued pressure. Manipulation of bowel is practically impossible after the pressure is on. As soon as anesthesia and the water had passed off babe appeared easy and comfortable. Tumor gone. He went to sleep, and on waking cried for the breast. No vomiting, straining nor pain. Nine hours after, fecal stools began. No return of symptoms.

Other examples could be cited, but these are sufficient to illustrate the method. I have not found it expedient, as Forest advised, to keep the pressure up for an hour, or anything near that. In feeble young children the pressure on the vena cava and on the diaphragm impedes the return circulation and the respiration markedly after fifteen to twenty minutes. Older children can stand higher pressure for a longer time. But I do not think it advisable to carry the pressure up to eight or nine pounds to the square inch, as Forest advises, if the invagination does not yield at a lower strain. Even if the colon does not actually rupture, I have found its serous coat cracked at seven pounds, and this in intestines not weakened by inflammation. It gives way opposite the folds which divide the saculi, the tendency of the pressure being to lengthen as well as widen the tube and obliterate the transverse folds. This it seems to me might be sufficient to set up peritonitis; or the distension might paralyze the gut.

Forest advocated a degree of pressure that risked rupture of the gut (provided it would not yield at a lesser), because he considered laparotomy for an intussusception irreducible by pressure as inevitably fatal. He quotes Treves' tables to show that the death rate after laparotomy, even though the invagination was easily reduced, was 43 per cent., whereas no case had been recorded where the patient died after the tumor was once reduced by inflation or injection. He says the statistics of Leichtenstern, Treves and

Schram show that the death rate in cases in which the invagination was reduced with difficulty or was irreducible was 100 per cent. Therefore he advises a pressure of six pounds to the square inch, and if this fails after lengthened trial to raise the pressure to seven or eight or nine pounds. This having failed, if the child is under two years, open the abdomen and resect the intestine. The child will probably die, but if left to nature the case is hopeless. If the patient is between two and five years and injections have failed, the chances of cure by sloughing or laparotomy are about equal, and the surgeon will be justified in following either course. Laparotomy will mean a resection or enterotomy. If the patient is over five years of age and the tumor has resisted eight or nine pounds it is irreducible; and he quotes statistics to prove that the operation of laparotomy shows a greater death rate than cure by sloughing. "Therefore nature's operation, nearly hopeless as it is, should be preferred to laparotomy."

Forest had perhaps given the subject more careful consideration than any other writer of his time, and one must admire his work in systematizing the reduction by water pressure and in drawing the attention of the profession to the necessity of precision in the application of the treatment, and the advantages of the certain and steady pressure of the fountain syringe as compared with the uncertain, intermittent, irritating effect of the Davidson syringe. But the status of abdominal surgery has changed so much since the time of his writing that the advice then given must be modified accordingly. He would now be considered ultra-conservative as regards laparotomy.

But now, if I am correct in my judgment, the pendulum has swung too far the other way. There are many crying, "Waste no time on injection methods, but perform laparotomy at once. Statistics could now be brought showing 100 per cent. of recoveries after laparotomy for intussusception." Why, then, is it not proven that laparotomy is the only correct treatment?

Because, for one reason, the cases showing 100 per cent. of recoveries are selected cases and do not include those most desperately in need of operative assistance. And because by laparotomy in every case the same results could not be obtained under all the circumstances in which intussusception must be met. They are the statistics of skilled operators in fully equipped hospitals upon selected cases, and they are not the measure of what can be done by the average operator and under unfavorable conditions. The acute intussusception is an emergency which must be promptly met. There is no comparison with elective work upon chronic cases in the hands of deliberately selected experts in a well-equipped hospital. Therefore the simple methods that are perfectly efficient in the

great majority of cases, and can be applied by any intelligent practitioner anywhere and under all conditions are to be advocated in the first instance, and emphasis should be laid upon early diagnosis, prompt resort to aëro-hydrostatic methods which should be accurately and thoroughly carried out; and in the few cases in which these will fail, early resort to laparotomy. And this with not so gloomy a prognosis as was probably justified when Forest wrote. No surgeon nowadays feels justified in abandoning to nature's methods a child over five years of age, with intussusception irreducible by pressure methods; and none would consider every case of the kind under two years as absolutely hopeless. It is my opinion that modern results indicate the rule that no case at any age should be laparotomized without a correct application of aëro-hydrostatic method of reduction; and, if this fails, that no case at any age but should be subjected to laparotomy within the hour.

Laparotomy.—With all the customary antiseptic preparation of the skin with the room at a temperature of 80 degrees F. or higher, and the patient laid upon a hot water bed or amply surrounded with artificial heat, the abdomen is opened in the middle or in one or the other semilunar lines. It should be foreseen that plastic work upon the intestines is likely to be necessary and the incision planned accordingly. In the majority of cases it will be made in the middle line or the right semilunar line near the cecum. Even with the abdomen open and the surgeon holding the tumor in his fingers it may not be easy to reduce the invagination. There should be no traction with the idea of pulling the infolded layers apart. One should gently press or squeeze the intussusceptum upwards out of the sheath. If reduction is effected the bowel should be examined as to its condition—whether gangrenous, or injured, and dealt with accordingly. If there appears a tendency for invagination to recur, or the mesentery is unduly long, a fold shortening the mesentery should be taken and secured with a few stitches, with care not to interfere with the blood supply of the bowel. The abdomen should then be closed.

If the intussusception is irreducible and the child is in too low a state for any prolongation of the operation, a fecal fistula may be formed, connecting the bowel immediately above the obstruction, with an incision through the abdominal wall. If the original incision is rightly placed for this purpose, a knuckle of the intestine is drawn out of the wound and closely sutured to the peritoneum, and then to the external parietes, the sutures passing only through the serous, muscular and submucous coats of the intestine. The gut is then or subsequently incised, thus establishing a fecal fistula, above the obstruction.

Ellsworth Eliot, Jr., (Binnie) suggests that the intestine near

the lower end of the intussusceptum be brought to the abdominal wound; a small incision through the gut wall be made near this lower end of the tumor, and a catheter be passed through this incision and through the canal of the intussusceptum into the gut above. The incision is to be sutured to the abdominal opening, making a fecal fistula below the obstruction, preventing increase of the intussusception, and providing drainage through the catheter. (Fig. 195.) I have never yet tried this method.

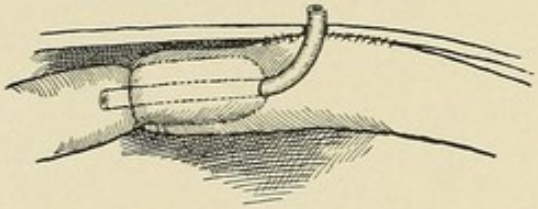


FIG. 195. ELIOT'S SUGGESTION FOR THE RELIEF OF INTUSSUSCEPTION. The gut just below the intussusception to be stitched to the abdominal wall, and opened, and a soft catheter to be passed through the opening of abdominal wall and gut, and upward through the canal of the intussusceptum into the gut above.

The following is a very ingenious and workmanlike method of excision of the intussusceptum. (Figs. 196, 197, 198.) If I am not mistaken it was originally Barker's operation. The entering portion of gut is sutured to the sheath all round just at the point of entrance. The gut over the intussusceptum is then opened (longitudinally) and the intussusceptum cut off and removed. The cut edges of the two layers are then united by continuous sutures, and the longitudinal incision in the gut is closed by Lembert sutures. Thus an end to end anastomosis is effected, and the strangulated gut removed. This entails less loss of tissue and less time than a regular enterectomy.

Enterectomy may be done, but it is badly borne by children. It will prove too much for a young child. If it must be done, the anastomosis should be made with the Murphy button. Circular enterorrhaphy or lateral anastomosis take too long.

FOREIGN BODY IN STOMACH, INTESTINE OR RECTUM

A foreign body in the stomach or intestines may be almost any imaginable object not too large for a child to swallow. Pins, needles, buttons, bullets, coins, fruit-stones or seeds, strings or threads are among the most ordinary. Almost any object that can be swallowed will find its way safely through the alimentary canal, yet some are of such a shape that by change of position they may lodge at the pylorus or ileo-cecal valve, while other objects may by moisture become swollen to such a size as cannot pass. Strings, fruit seeds, fibrous material and feces may collect in a large mass which cannot pass onward, causes an obstruction by its bulk or sets up an inflammation with consequent swelling, and so produces obstruction. There are well-authenticated cases of intestinal ob-

struction caused by masses of lumbricoid worms. Needles swallowed may work their way through the coats of stomach or intestines and appear in some distant part of the body. Foreign body may be found in the rectum. It may have been swallowed, or it may have been introduced per anum by the patient himself or by mischievous companions.

Symptoms of foreign body are sometimes very indefinite and puzzling. I recall the case of a child with symptoms of a mild gastric catarrh in which vomiting, though not frequent, was persistent for several days until, finally, a flat piece of beef-bone about three-fourths of an inch square was vomited up and the trouble ended.

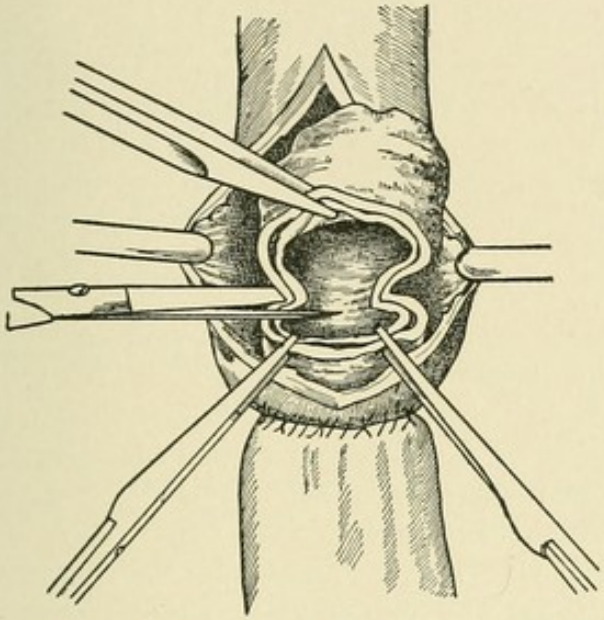


FIG. 196. EXCISION OF INTUSSUSCEPTUM. The entering portion is sutured to the intussuscipiens at the neck. The ensheathing layer is cut open longitudinally and the intussusceptum excised. After Guibe. See also Fig. 197.

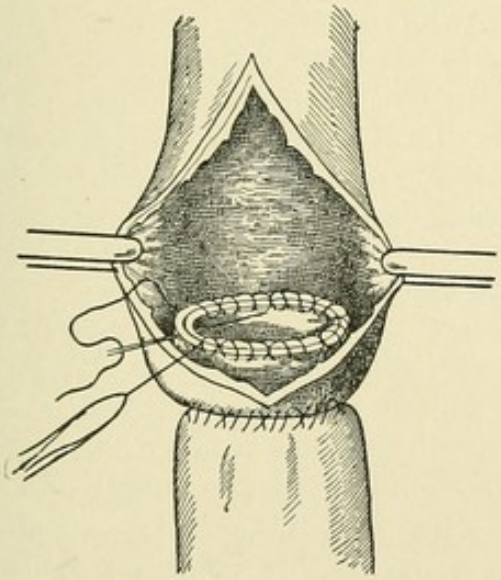


FIG. 197. EXCISION OF INTUSSUSCEPTUM. The intussusceptum is removed and its cut edges are united by suture. After Guibe. See also Fig. 198.

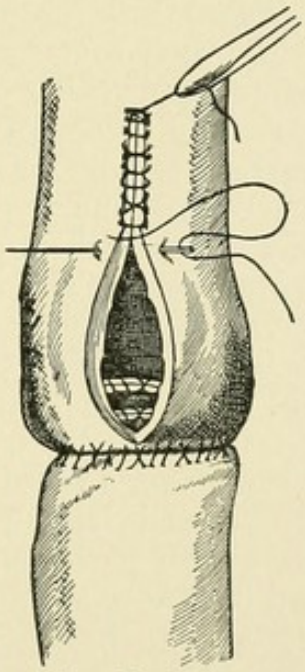


FIG. 198. EXCISION OF INTUSSUSCEPTUM. The incision in the ensheathing layer is carefully closed, by two rows, or preferably by Lembert sutures. After Guibe.

Occasionally there is only discomfort and distress in the abdomen with colicky pains and perhaps nausea as the foreign body is gradually worked along down the canal, lodging temporarily here and there. A foreign body may be days or weeks in traversing the alimentary canal. One case of a boy upon whom I operated for suppurative appendicitis failed to become quite comfortable, although the appendix was removed, the wound healed and to all appearances he should have been well. He was kept in hospital three weeks after operation on account of indefinite colicky pains and abdominal uneasiness for which I could discover no cause. Finally he developed tenesmus and pain in the rectum, and digital exploration revealed the presence there of a strong fish-bone curved somewhat in the shape of a fish-hook. It was removed and he was quite well. He had not eaten fish during his stay in the hospital, and his mother was quite sure he had eaten no fish for several weeks before he entered. If a foreign body becomes lodged, as it is most apt to do, just above the ileo-cecal valve, and causes inflammation, or is of a size and shape to mechanically obstruct the canal, vomiting, distension of the abdomen and peritonitis ensue. If not relieved, gangrene of the bowel and death will probably result.

Diagnosis.—The diagnosis may be difficult unless the history of swallowing a foreign body is definite. The very indefiniteness and shifting character of the symptoms should make one suspicious. Occasionally a foreign body can be felt if the abdomen is relaxed either with or without anesthesia. The Roentgen ray renders valuable service if the foreign body is impervious to it. Gastroscopy by the direct method, as described by Jackson, may discover it if in the stomach. The rectum should always be explored with the finger, which may detect and locate the foreign body there. Foreign body in the rectum may cause pain and tenesmus with passage of mucus and sometimes bloody stools. Suppuration or even abscess may result from the irritation or wound produced.

Treatment.—When a child is known to have swallowed a foreign body, almost invariably the mother or nurse gives a laxative and prides herself on her presence of mind in so doing. The laxative should have been withheld. Its administration is most unwise. To empty the bowel exposes its mucous lining to any rough or sharp surface upon the foreign body with which the active peristalsis, excited by the laxative, brings it in forcible contact. A better plan is to administer an abundance of bulky, constipating food, such as potatoes, rice, cornstarch, or bread, which forms large, firm masses likely to encase the foreign body, and distend the intestine as they are moved slowly and safely along. If the foreign body lodge and cause intestinal obstruction, laparotomy will be necessary. (See Section on Operation for Intestinal Obstruction.)

It is often necessary to anesthetize a patient to remove a foreign body from the rectum. Careful exploration with the finger will usually reveal the shape and situation of the offending article. A speculum or retractors may be necessary or the sphincter may have to be divulsed. The finger, or forceps or suitable instrument will then effect the removal. Ulcerations or granulations will then be touched with hydrogen peroxide or silver nitrate, and olive oil poured into the rectum. This dressing may have to be repeated. The rectum should be cleansed by irrigation daily. The diet should be regulated, and the patient kept quiet. As healing progresses watch should be kept for stricture, and if necessary the rectum dilated with the finger or bougies.

FECAL IMPACTION

It is not uncommon for impaction of feces to cause dangerous obstruction of the intestinal tract. The cecum, the sigmoid flexure, and especially the rectum are favorite sites for impaction. One has several times been obliged to remove piecemeal from the rectum quantities of scybalæ mixed with prune-stones or fruit seeds and skins and the like, packed together as hard as putty and immovable until broken up. The symptoms are those of obstruction coming on slowly, and sometimes with a demonstrable tumefaction of a doughy consistency and movable, in some part of the abdomen. I have seen it stated that the tumor of fecal impaction could be differentiated from that of intussusception by its usually being located in the right side, while intussusception is usually on the left side. This statement I consider misguiding, having felt fecal impaction on the left side or in the sigmoid region as well as on the right, and intussusception on the right side as well as on the left. The character of the tumefaction is of more diagnostic value than the situation. (See " Tumor " in the section on Intussusception.)

Treatment.—Fecal impaction can generally be overcome by repeated copious enemata aided by gentle massage, and careful use of laxatives, usually salines in broken doses. Purgatives are forbidden.

ENTEROLITES

Intestinal concretions, of a sufficiently stony character to be called enterolites, are certainly rare in this country. They are said to consist in some instances of phosphatic salts, together with cholesterin and mucus; or of chalk mixture, or magnesium carbonate, or the like used as medicine. They should be treated as just described for fecal impaction or foreign body.

VOLVULUS

Under this name are included three forms of obstruction or partial obstruction of the intestines. First, a loop of intestine may be twisted upon its mesentery as an axis. Secondly, a portion of intestine may be twisted upon itself as an axis so as to occlude its lumen. Thirdly, two separate loops of intestine are intertwined so as to obstruct the lumen of one or both loops.

Volvulus is not a common accident of early life. Treves mentions a case reported by Cripps of congenital volvulus of the ileum, and cases are on record of this condition in various portions of the small intestine, or in the cecum or colon, in infants and children. But volvulus more frequently occurs in the sigmoid flexure when its mesentery is long and loose.

Symptoms.—The symptoms are pain, paroxysmal at first, but becoming continuous with distension of the bowel. Peritonitis usually supervenes promptly. Tenderness is localized early in the case, but soon becomes general with the spread of the peritonitis. Distension of the intestines is apt to be irregular at first, upon one or the other portion of the abdomen, according to location of the twist. The abdominal walls are flaccid at first, until the distension of the bowels becomes general, and when peritonitis supervenes they become rigid. Vomiting is present, but is not so prompt or severe a symptom as in strangulation by bands. Fecal vomiting is unusual, but eructations are common. Constipation is the rule. The temperature is at or below normal and may remain so until the fatal termination. The pulse is rapid and small. Tenesmus is a frequent and distressing symptom in volvulus of the sigmoid flexure. Suppression of urine is not as marked a symptom as has been supposed, nor as marked as in obstruction by bands. When occurring it seems to depend somewhat on reflex causes, as the urine increases under the use of opium and relief of pain and tenesmus. There is no bloody stool nor tumor, as in intussusception.

Treatment.—Treatment consists in laparotomy, with untwisting or disentangling of the intestine. This is not always easily accomplished even after the abdomen is opened; and often there is a tendency for the twist to recur. This must be prevented by folding up the elongated mesentery and holding it in the shortened position with sutures, without interfering with its circulation. If gangrene threatens in the twisted loop of gut, enterectomy with anastomosis should be done. If the child is too young or too feeble to withstand so extensive and prolonged an operation the gangrenous portion of gut may perhaps be brought out at the incision and excised and an artificial anus established.

INTERNAL STRANGULATION

Like volvulus, internal strangulation is more often talked about than met with, yet it does occasionally occur, in one of its numerous varieties. It is caused by bands of adhesions resulting from previous peritonitis, or by omphalo-mesenteric vessels, by a Meckel's or other diverticulum, by an adherent or coiled appendix vermiformis, or by a hole in the mesentery or omentum. (See Hernia.)

Symptoms.—The symptoms are pain, which is usually referred to the umbilical region. The pain comes suddenly and is severe and continuous. Tenderness is not marked until after peritonitis supervenes. Vomiting is an early and marked symptom. It becomes stercoraceous after several days. Thirst is distressing. Suppression of urine is usually noted. Constipation is the rule after the intestinal contents below the obstruction have been discharged. Shock, and sometimes collapse, with subnormal temperature, follow the accident. Absence of fever does not negative peritonitis. The abdominal walls are at first relaxed, but afterward distended, and with peritonitis they become rigid.

Treatment is laparotomy with release of the strangulated gut, by disentangling or withdrawing it or by cutting bands after securing them doubly with ligatures.

Operation for Obstruction of the Bowels.—The operating room should be well lighted, and warmed to 80 degrees F. or a higher temperature. The patient should be laid upon a hot-water bed, or be well wrapped in cotton and surrounded with hot-water bottles. The vomiting and the abdominal distension can often be relieved by lavage of the stomach with warm sterile water. The bladder should be emptied by catheter. Chloroform or chloroform and oxygen are usually preferred as the anesthetic. The instruments required are scalpel and scissors, two pairs tissue forceps, half a dozen fine-pointed hemostats, two or three hemostats for sponge holders, a grooved director, two intestinal clamps, ordinary needles, round needles for the gut, needle holder, fine silk and fine catgut, medium catgut, and silkworm gut, one or two Murphy buttons. The instruments must be thoroughly sterilized by boiling and the sutures reliably aseptic. The hands of operator and assistants must be rendered aseptic by thorough scrubbing with green soap and hot water, the nails cleaned, then washed again, rinsed, and washed in bichloride solution, 1 to 2000, then covered with rubber gloves that have just been boiled. The skin of the entire abdomen should be prepared by scrubbing with green soap, hot water and gauze or flannel. This being rinsed off with sterile water is followed by ether or alcohol, and then with solution of mercuric bichloride 1 to 3000 or 1 to 4000. Sterile

towels, dry and warm, should be used beneath the patient and to surround the field of operation. If possible the situation of the obstruction should be ascertained by localizing the pain, tenderness, tympanites, tumefaction, dullness, or by the X-ray. If located, the incision may be made upon it. If its location is unknown one is directed to make the incision in the median line below the umbilicus. But in the young child the umbilicus is relatively nearer to the os pubis, and the bladder is apt to project higher than in the adult. Room is needed for the introduction of two fingers at least. It may be difficult to secure an incision of sufficient length between bladder and umbilicus, in which case it must be carried higher, usually to the left of the umbilicus. When the incision is carried down to the peritoneum the latter should be carefully lifted between two pairs of tissue forceps and cautiously incised, as the distended bowel generally presses closely beneath. The intestine should not be allowed to escape from the incision, but restrained by a large, flat gauze sponge wrung from hot water.

Finding the point of obstruction often proves to be no easy task, unless its whereabouts have been ascertained beforehand by locating tumor, dullness or irregular distension. We are usually directed to pass one or two fingers in through the incision and palpate the cecum or region of the ileo-cecal valve, which is frequently the point of obstruction. If the cecum be distended, feel along down the colon, as the obstruction must be lower down. But if the cecum be not distended the obstruction must be higher up, in the small intestine. We are now directed to find a loop of intestine that is not distended; examine its mesentery at its attachment to the spine to find which is its right layer, for the right layer is also the upper layer. That portion of the upper layer which goes to the left is the one leading toward the stomach, and if followed will lead to the obstruction. But these directions are not easily followed when the abdomen is tightly distended with intestines inflated with gas, and forcing themselves out through the incision. Exposure of the intestines outside the abdominal walls greatly increases the shock of the operation, especially in children. Extensive or prolonged manipulation of the intestines has the same effect. Mr. Greig Smith gives some advice covering this point which should always be tried in children, before ever a finger is passed into the abdominal cavity. He observes that the most distended coils always rise to the surface, and that as the greater number of coils of the intestines pass within three inches of the umbilicus, it is probable the most dilated coils will be or can be brought within sight at the incision. One should very gently move the distended coils from side to side and up and down, and select the most distended one which will at the same time prove to be

the most congested one. By following this coil in the direction of increasing distension and congestion one is led to the obstruction. If this method fail, Smith recommends to let the most distended coil escape from the belly. One end of the coil escapes less readily than the other and is most congested. This end leads toward the obstruction. (Greig Smith, Binnie.) In some cases it may be necessary to relieve the excessive distension by incising the intestine to allow the escape of its contents. To do this a badly distended loop is brought outside the abdomen, packed round with hot moist gauze sponges and a small incision made in a longitudinal direction at a point farthest from the mesentery. The contents having escaped, the incision is securely closed with Lembert sutures, the gut rinsed off clean with hot sterile normal salt water, and returned to the abdomen. To remove the rubber gloves and put on a fresh sterile pair at this point is advisable if it be done quickly. But if such incision and emptying of bowel can be avoided it is far better to do so. If the point of obstruction be found it should be dealt with according to its character, a volvulus should be untwisted or disentangled, strangulating bands should be ligated in two places and cut between the ligatures, a foreign body should be removed through a longitudinal incision in the intestine which is afterward closed with Lembert sutures. Before opening an intestine it should be brought outside the abdomen and packed round with moist hot gauze sponges. The special manner of dealing with intussusception will be found in the Section on that subject. If it be found that the cause of the obstruction cannot be removed or if the child is very much shocked or exhausted, one should not think of attempting any extensive operation, but rapidly make a fecal fistula above the obstruction, close the abdominal incision and apply heat and stimulants as directed to combat shock.

CHAPTER XXII

HERNIA

Its Causes, Frequency and Varieties—Irreducible Hernia—Strangulated Hernia—Diaphragmatic Hernia—Ventral Hernia—Umbilical Hernia—Inguinal Hernia—Femoral Hernia—Lumbar Hernia—Vaginal Hernia—Traumatic and Post-Operative and Relapsed Herniæ.

ITS CAUSES, FREQUENCY AND VARIETIES

Hernia may be due to a fault in development which leaves an opening or a very weak point in the muscular and aponeurotic layers that bound the abdominal cavity. Or the supporting walls in a feeble individual may be weak throughout, or be weakened by illness or malnutrition or faulty innervation. Added to one or more of these causes there may be the thinning and fraying out and paralyzing by overstretching that comes with continuous distension by overloaded stomach and intestines inflated with gases. The adipose tissue that should help to fill interstices and to cushion the visceral supports may have always been wanting or it may have been removed by wasting disease. Yet excessive obesity, or a sudden reduction of obesity, such as occasions hernia in adults, does not often obtain in children. Intra-abdominal tension may have been increased by the tenesmus of constipation or of diarrhea, of rectal polypus, or vesical calculus, or a narrow preputial or urethral orifice, or a cough either long continued or spasmodic and violent, or by persistent crying, or by the use of a tight bellyband, or a truss band worn for umbilical hernia. Taking all these facts into consideration it is not sufficient when one encounters a hernia to merely announce its name, or perhaps to go so far as to specify what variety it represents and then direct the parents to a truss dealer, or turn to the calendar for the next clinic day when it will be convenient to operate. There are a great many things to be considered about the hernia before the course of procedure is decided upon. For instance, what caused and what factors are perpetuating the hernia, its possible complications, and its probable results if treated by trussing, or by operation; also the type, the fitting and the management of the

truss, and the best time and method for the operation if such a procedure is necessary.

All the common varieties of herniæ found in the adult, named from their situation, are found in children—diaphragmatic, ventral, lumbar, umbilical, inguinal, femoral; and some sub-varieties belonging especially to children, such as the congenital, the funicular, the infantile, the encysted herniæ. But the relative frequency of such varieties is quite different in early when compared with adult life. Thus umbilical hernia is far more common in childhood, and femoral hernia comparatively rare. Obturator, perineal, and ischiatic herniæ are not found in children. The classification according to the organ or viscus protruding, as hepatocele, epiplocele, enterocele, cystocele, and the like, would show a different distribution in children; for it is comparatively seldom that the sac contains anything but intestine, the omentum being but slightly developed, and the bladder and vagina not yet having been subjected to causes that in later life produce relaxation and protrusion. However, not only small or large intestine, sigmoid, cecum, or appendix, but a portion of liver or of bladder, or an ovary or the uterus, or a testicle attached to a loop of intestine, may be found in the child's hernia. (See Fig. 213.) Naturally the proportion of the congenital variety is large and of the acquired is small in the child as compared with the adult.

IRREDUCIBLE HERNIA

Hernia in a child may be irreducible, due to the same causes as in the adult. But it is less common in the child, because the hernia has not existed sufficiently long to become adherent in the abnormal situation. But hernia may become obstructed or incarcerated by massing of its contents.

STRANGULATED HERNIA

Strangulation occurs seldom in children, in comparison with the whole number of herniæ. Yet it occurs sufficiently often to emphasize the necessity of never allowing a hernia to remain unreduced.

Symptoms of strangulation are nausea, vomiting, constipation, tenesmus, dragging sensations in the hypogastrium, local pain, tenderness, swelling, and tension in the hernia, fever and later subnormal temperature; pulse hard and quick, later wiry, small and weak and more rapid. The face is either flushed with fever or pallid as in shock, anxious and drawn. The constriction, if unrelieved, causes not only congestion and swelling, but inflammation and gangrene. If the constriction be absolute the whole of the

extruded gut will become gangrenous; but in less complete strangulation death of the tissue may occur only at the point of constriction. In either case perforation may occur and cause violent septic peritonitis.

Diagnosis.—The diagnosis is easy unless the hernia be of the diaphragmatic or vaginal varieties. Symptoms of obstruction of the bowels in the presence of a demonstrable hernia should lead to prompt treatment of the hernia as strangulated.

Treatment.—If the strangulation has not existed more than a few hours and the patient is in fair condition, an anesthetic should be administered and the patient placed in such a position as to relax the muscles at the hernial site, and secure the aid of gravity in drawing the hernia into the abdominal cavity. The taxis should then be tried with the utmost gentleness. The tumor is pressed upon slowly and persistently for some minutes so as to squeeze some of its fluid or gaseous contents into the abdominal cavity, or some of the swelling out of its tissues. An attempt is made to lift it away from the constriction as if drawing it out of the hernial opening. With the ends of the fingers of the other hand the neck of the sac is pushed from side to side and palpated. Perhaps the hernia will gurgle and slacken and slip away into the abdomen. If these maneuvers do not succeed in reducing it, preparation should at once be made for operation. If the symptoms of strangulation had been present twenty-four or forty-eight hours before the patient is first seen, or he be in a bad condition with a weakening pulse, a pinched face and a dry tongue, no time should be lost with the taxis; the operation is to be done at once. If the patient is first seen where no anesthetic is at hand, or if there must be delay before the operation can be performed, opium, or better, a hypodermic of morphia or of codeine phosphate should be given; the patient should be placed in the most favorable position for reduction and propped or suspended in that position, with an icebag, comfortably cold, pressing upon the hernia. If reduction does not take place while preparations are in progress the taxis or the operation can then be done. If the patient's temperature is subnormal, heat and stimulants should be used.

Operation for Strangulated Hernia.—No degree of urgency should induce one to neglect all the antiseptic precautions suitable in an abdominal operation. (See Section on Operations for Intestinal Obstruction for the preparation of the patient; and for the instruments and articles needed.) In former years herniotomy was expected only to relieve the strangulation, but usually nowadays the wound is closed in such a manner that the hernia cannot occur again, so that the incision is made with that end in view. Most frequently the constriction is in the ring and not in the

sac. In inguinal hernia it is generally the external ring that strangulates. Often the sac will be opened whether it was intended to open it or not, for it is very thin and closely blended with the fascia. When the sac is nicked and opened there is a fluid within, pale yellow, if the case is early and the bowel in good condition; dark brown if the case is more advanced, but one is not apprehensive if the fluid is clear. If the fluid is turbid and blackish one has fears, for the bowel will be found inflamed and edematous at least, purple and mottled, and perhaps worse. But if lymph flakes and pus and maybe blood clots flow out with the fluid from the sac, gangrene is near at hand. Perhaps already the intestine is dull and sodden, black or ashy and sloughing. If the intestine or other strangulated organ or viscus is sound, or if its circulation can be restored, the constriction is relieved and it is allowed to slip back into the abdomen. A great point is made by students to remember in which direction one should cut in relieving a hernial constriction. It is better to do no cutting at all in the dark. Sometimes merely lifting the constricting ring with a blunt dissector or nicking its edge if necessary will suffice. If cutting is necessary it is better to cut down with knife or scissors so as to see what is being cut. After the hernia is reduced the opening is securely closed as in the radical operation for hernia. If protruded gut is perforated or not viable one has the choice of resection or temporary artificial anus. An older child in good condition for operation might endure resection and anastomosis. A young or exhausted child would not; and it would be better to draw out the intestine until sound tissue appears, attach the open ends of the gut into the hernial opening and save the patient's life. The continuity of the intestinal lumen can be restored by one of various operations later when the patient is in condition.

DIAPHRAGMATIC HERNIA

This may be congenital, ordinary or traumatic. In either form it is extremely rare. In the congenital form the deficiency of the diaphragm is usually upon the left side. The opening may be small so that only a limited protrusion of abdominal contents occurs; or so large as to occupy nearly the entire chest cavity, and by preventing expansion or even development of the lungs, be incompatible with extra-uterine life. Such a case is illustrated in Figs. 199 and 200, drawn at the autopsy on a full-term seven-pound girl baby which cried twice after birth and died in twenty minutes. In the embryo the cavity of the body is not divided into thorax and abdomen until their organs, especially the liver, have attained a considerable degree of development. The internal layer of the blastoderm has closed up to form a gastro-intestinal canal. It assumes

a tubular form and then the upper end of the tube expands to form the stomach, which lies in the upper portion of the body cavity, near, but not connected with, the cavity which will become the

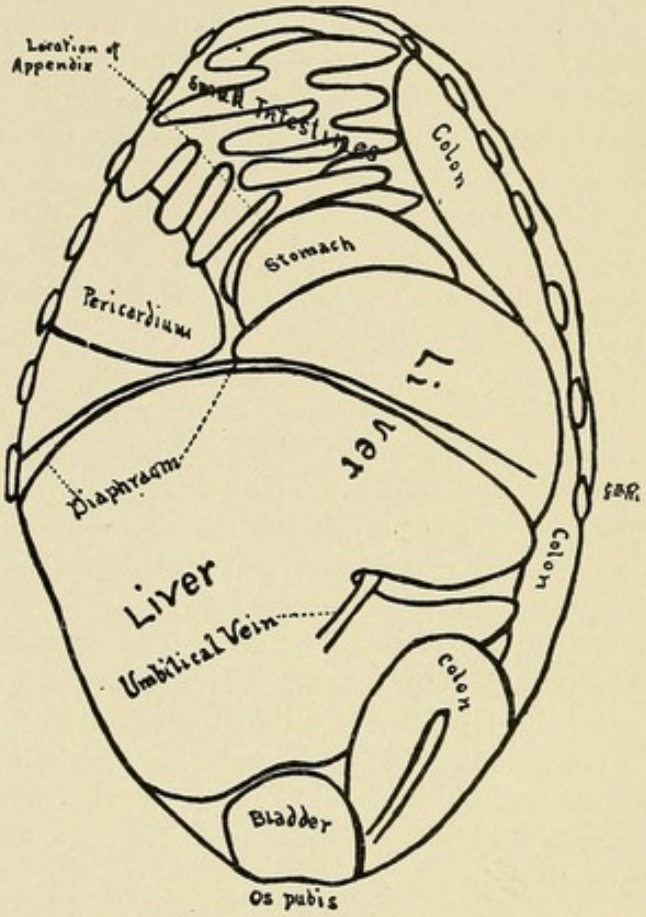


FIG. 199. CASE OF CONGENITAL DIAPHRAGMATIC HERNIA.

pharynx. The liver has budded out from the intestinal canal and at one month weighs one-quarter as much as the whole embryon and fills most of the entire cavity. The esophagus begins to appear as a short tube which by and by will open through into the stomach below and the pharynx above. The lungs bud out from the sides of the esophagus, which later partitions off a portion of its tube for the trachea. Still there is no division of the cavity of the body. Now the thorax should develop, the lungs grow and the esophagus lengthen, while the diaphragm, starting from its periphery, should close in toward the center, separating the abdomen and thorax with the organs which belong to each. But if that diaphragmatic development fails to take place properly, or is

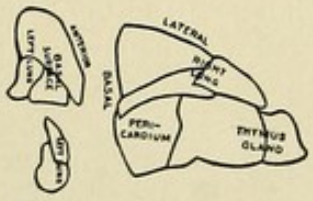


FIG. 200. LUNGS, PERICARDIUM AND THYMUS GLAND IN CASE OF DIAPHRAGMATIC HERNIA shown in Fig. 199, one-quarter actual size.

delayed until the organs are so large that the separation cannot take place, the consequence is a congenital diaphragmatic hernia.

In the ordinary forms of diaphragmatic hernia the abdominal viscera pass through one of the naturally weak points in the diaphragm, usually near the ensiform cartilage.

The traumatic form occurs from puncture, incision or tearing of the diaphragm.

Symptoms and Diagnosis.—The symptoms may be very obscure and difficult of interpretation. There are pain, dyspnea, and, upon auscultation, gurgling of intestinal or stomach contents in the chest cavity and perhaps a displaced heart. Strangulation may occur in the ordinary and traumatic varieties.

Treatment.—In the congenital variety nothing can usually be done. Most cases of ordinary diaphragmatic hernia are not diagnosed unless strangulated and operated. If a congenital diaphragmatic hernia is strangulated, and operation is undertaken, it may be found that the hernial mass is too large to be reduced into the abdomen, having been long resident in the thorax. In this case the constriction should be relieved and steps taken to prevent its recurrence, and no further attempt made to reduce or to close the hernial opening. The traumatic varieties should be operated if a diagnosis can be made. The thorax should be opened, the hernia reduced and the opening closed by suture. If there is evidence of injury also to abdominal organs the abdomen must be opened and the damage repaired. But the hernia is reduced and the opening closed best from the thoracic side.

VENTRAL HERNIA

Ventral hernia usually occurs through a hiatus in the linea alba. This has been referred to in the Section on The Abdomen and Its Malformations. It should be treated on the same general principles as umbilical hernia.

UMBILICAL HERNIA

Exomphalos has already been described as a malformation of the umbilicus. That form of hernia usually called umbilical occurs in two varieties. In one the protrusion really takes place through the umbilical aperture into the cord, or rather, the stump of the cord, being covered by the skin, superficial fascia, and peritoneum; while the other projects in the linea alba immediately above the umbilicus.

Diagnosis is easily made by the position and feel of the tumor. It is soft and elastic, and usually disappears with a gurgle when pressed upon. It reappears on the slightest straining, laughing or

crying. In some cases this frequent wedging out and in through the opening seems to be painful and make the child fretful. It is always unsightly.

Prognosis is good. It is very seldom that an umbilical hernia in a child becomes strangulated, or that it persists to adult life. Some are persistent and troublesome and would not close without treatment or operation.

Treatment.—Umbilical hernia is often treated domestically, and it is often treated by the physician with but little improvement over the methods of the mother or the mother's neighborly advisers. Sometimes a pad of muslin or cotton, or a coin, or a piece of sheet lead is bandaged on; and one has more than once seen an inguinal hernia produced by bandaging an umbilical hernia too tightly. Sometimes the coin or a disc of metal, either bare or covered with lint, or a cake or hemisphere of beeswax, with the convex side inward, is fastened upon the abdomen with a patch of adhesive plaster and maybe a cotton or flannel binder is pinned or sewn over all.

Another plan is to draw the skin in a fold across the rupture and fasten it thus with adhesive straps, changing the dressing every few days or a week. Also one can buy in the instrument stores hard rubber pads with elastic webbing attached to encircle the body. These pads usually have upon the bearing surface a conical or hemispherical projection intended to press the protruding viscus within the hernial opening. If the projection upon the truss is maintained constantly within the opening the tendency is to keep it open. Such is the effect of the hemisphere of beeswax, the pad with the conical projection, or any similar object when strapped upon the rupture. They do harm rather than good. However, the pads when applied with elastic webbing or a belt never stay in place at all, but slip about in any direction and effect nothing.

The best surface to prevent the rupture from projecting and at the same time not to prevent the opening from closing is a flat surface. Some slight cases in infants in arms, free from excessive coughing or straining, do perfectly well with a disc of thin board two and one-half or two and three-quarters inches in diameter placed in a pocket sewed to the bellyband. But under conditions less favorable the pad should be held accurately in place and kept there continuously for weeks or even months, until the opening closes. This fixation of the pad can only be maintained with adhesive plaster. But this is done with considerable inconvenience on the part of the doctor and the nurse, and sometimes with suffering on the part of the patient. The skin of the umbilicus underneath the pad becomes irritated or inflamed. Every little while one sees a child

with miliaria, dermatitis, eczema, or even with ulceration, developed under one kind or another of umbilical pad.

The same objection holds against the plan of drawing the skin in a fold across the rupture and holding it thus with adhesive straps. Fig. 201 illustrates a pad or plate made of any smooth,

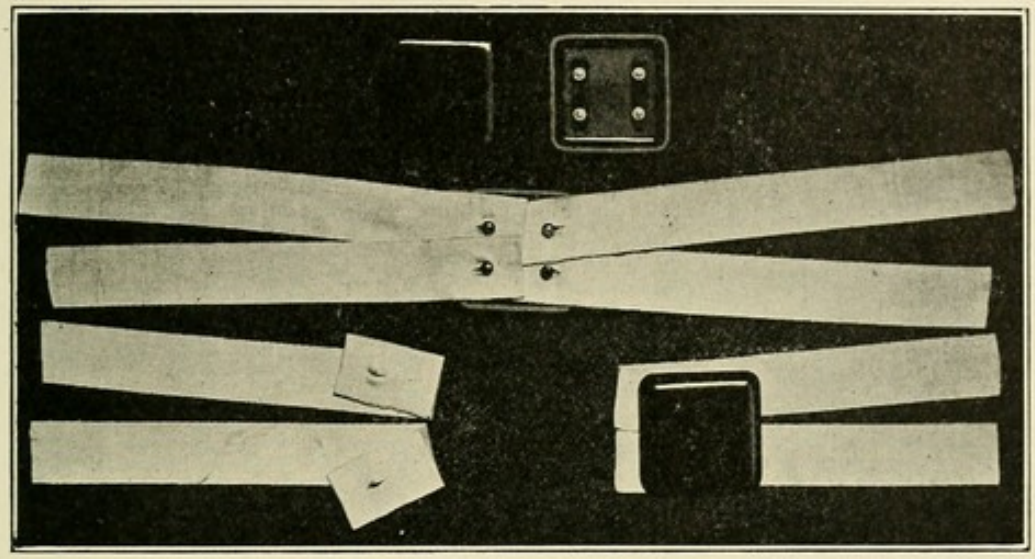


FIG. 201. AUTHOR'S TRUSS FOR UMBILICAL HERNIA. At the top of the illustration are shown both sides of the truss pad of hard rubber. Secondly, the pad with adhesive strap attached ready for application. Thirdly, the truss with one side unbuttoned and pad turned back as for cleansing or powdering the umbilicus.

impervious material; gutta percha is the best, with little buttons or pegs on the back of it to which are buttoned the ends of the adhesive straps. They can be made of any shape and of different sizes and the number of buttons or pegs is not an essential point. There should be at least two buttons and, if not more than two, they should be placed vertically with reference to the body. The square shape with rounded corners, and about two and one-quarter inches across, with four buttons, I find convenient. A couple of inches of one end of each adhesive strap is folded upon itself and this folded again so that there are three thicknesses of plaster strengthening the end. Through this a buttonhole a half inch from the end is cut with a penknife. The folded end prevents the plaster from adhering to the skin near the pad. The straps are buttoned on to the pad and adjusted round the body. When the abdominal muscles are weak, flabby or over-stretched the straps should be applied just tightly enough to support them. Fig. 202 shows the truss applied.

The straps can be unbuttoned and the pad removed at any time, the skin cleansed and powdered, and the pad washed and replaced with the greatest convenience and without removing the plaster from the skin. If one will take the precaution to wash

thoroughly and antiseptically all portions of the skin that are to be covered, either with pad or plaster, then pass the face of the plaster over the flame of an alcohol lamp before applying it, the strapping can be left on for weeks together and the mother or nurse can do the rest. In a few weeks or a few months the hernial opening is closed.

Operation for Umbilical Hernia.—It is only in extremely large or persistent umbilical herniæ that operation is necessary, as they are nearly always curable within a reasonable time by the use of a truss. Among 2000 operations at all ages for the radical cure of hernia at the Hospital for Ruptured and Crippled, New York, from 1890 to 1907, as reported by Bull and Coley, only thirteen were cases of umbilical hernia in patients under fourteen years of age. When the operation is deemed advisable the diet should be regulated, the bowels well emptied, and tympanites conquered, all the antiseptic precautions for an abdominal section be carried out. A modification of Ransohoff's operation is adapted to these cases. A vertical incision skirts the margin of the umbilicus. Expose the aponeurotic tissues at the side of the neck of the sac. Open the sac at its neck and reduce any hernial contents, ligating and removing any adherent omentum. Introduce a gauze sponge at the wound so as to hold down and protect abdominal contents and excise sac and margins of its opening, and close the peritoneal wound with running catgut sutures. In older children it is well to expose the inner margins of the recti muscles and unite them with kangaroo tendon sutures. Or the posterior layer of the rectus sheath, the edges of the muscles themselves, and the anterior layer of the sheath may each be united with a row of sutures; and finally the skin is closed. Often it will be sufficient, after closing the peritoneum, to strongly unite the aponeurotic layers, and then the skin. The abdominal walls should be strongly supported by strapping until the union is firm.

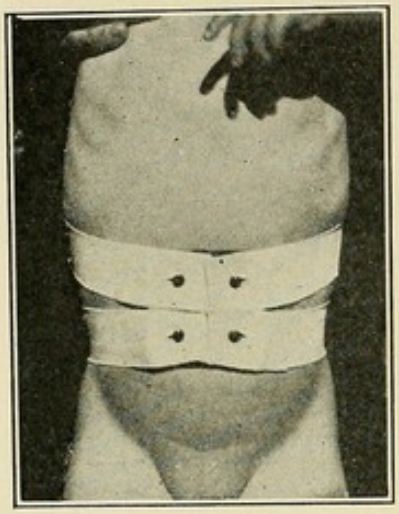


FIG. 202. AUTHOR'S TRUSS FOR UMBILICAL HERNIA, applied.

INGUINAL HERNIA

The inguinal canal in the child is not a very long canal. The internal and external rings are more nearly in a direct line from within outward than in the adult. It is only with development and widening of the pelvis, which in the infant is small and rudimentary,

that the internal ring assumes a position so much farther from the median line than the external ring that the space between them becomes lengthened into an oblique canal. In consequence of this conformation inguinal hernia in a child is almost always indirect or oblique, following the short canal easily rather than pushing directly through internally to the deep epigastric artery. By invaginating the scrotum on one's finger one can readily demonstrate in nearly every case in a young boy the shortness and straightness of the canal. Inguinal hernia in the child may be congenital, funicular, infantile, encysted, or acquired.

Congenital Hernia.—Any of the varieties, excepting the last,

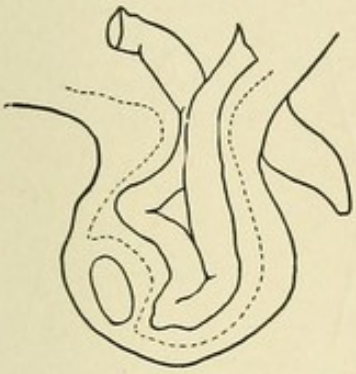


Fig. 203. Congenital inguinal hernia. Funicular process open into peritoneal cavity. Tunica vaginalis unseparated.

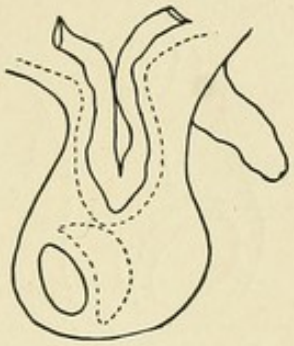


Fig. 204. Funicular hernia. Funicular process open. Tunica vaginalis separated from it.

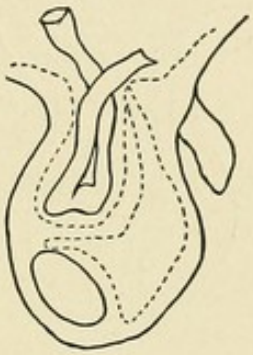


Fig. 205. Infantile hernia. Funicular process and tunica vaginalis one closed sac. Hernia behind it.

may be congenital in the sense of being present at birth. But the variety of inguinal hernia called congenital descends through an open funicular process which has failed to become separated from the peritoneal cavity or to form the tunica vaginalis. The loop of intestines descends into what should be the tunica vaginalis. Fig. 203 illustrates this condition diagrammatically. In congenital hernia in girls the hernia passes into the canal of Nuck. (Fig. 208.)

Funicular Hernia.—In funicular hernia (Fig. 204) the tunica vaginalis has become separated from the funicular process, but the latter has remained open and contains the prolapsed bowel.

Infantile Hernia.—In infantile hernia the funicular process has become closed at the abdominal end, but is still one with the tunica vaginalis. A hernia with a separate sac of peritoneum comes out through the rings and down behind the funicular process, as shown in Fig. 205. Thus there are three serous layers in front of the bowel.

Encysted Hernia.—This is sometimes described as a second variety of infantile hernia, or the two names are confounded. In this variety the same condition of the funicular process and tunica

vaginalis exists as in infantile hernia, but the hernial sac in its descent invaginates itself into the process below it. Thus the bowel has two serous layers in front of it. (Fig. 206.)

Acquired Hernia.—In acquired inguinal hernia (Fig. 207) the funicular process has become obliterated, leaving the tunica vaginalis in its normal situation in front of the testicle. The hernial sac is entirely independent of it, and may be incomplete or complete, that is, remain in the canal or emerge at the external ring. There is a growing belief that in many so-called acquired herniæ there is a preformed sac that is congenital, being a portion of the processus

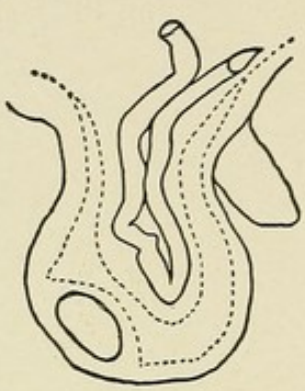


Fig. 206. Encysted hernia. Funicular process and tunica vaginalis one closed sac. Hernia within it.

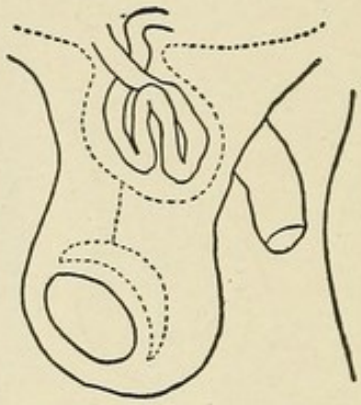


Fig. 207. Acquired inguinal hernia. Possibly the sac is after all a re-opened funicular process.

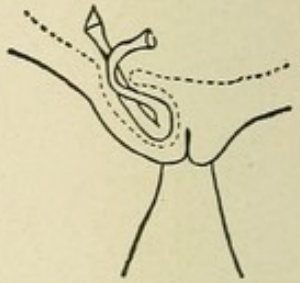


Fig. 208. Hernia in the canal of Nuck. This corresponds to congenital hernia of the male.

vaginalis that was never rightly closed; and only direct herniæ are really "acquired."

Diagnosis.—The diagnosis of hernia is made when one finds in the location where hernia usually occurs a rounded or oval tumor which gives an impulse when the child coughs, laughs heartily or cries, which is larger when the child stands and disappears or is easily pressed into the abdominal cavity when he lies down. The tumor usually contains intestine, is smooth, elastic, may be tympanitic, and is apt to gurgle when compressed or on reduction. It is usually, but not always, opaque or dark colored to transmitted light; when quite empty and distended with gas it may be translucent. An ovary in the hernial sac is small and firmer, has no tympany nor gurgling. The diagnosis must be made from several other swellings likely to be found in the inguinal and scrotal region. One of the most common is encysted hydrocele of the cord, or congenital hydrocele; or hydrocele of the tunica vaginalis and funicular process, infantile hydrocele or funicular hydrocele; or encysted hydrocele of the canal of Nuck; or cyst of the hydatid of Morgagni, which much resembles hydrocele. Time and again has one seen children wearing trusses on one or another variety of hydrocele. Hydrocele

has a different feel from hernia. If reducible, it disappears gradually and not in a mass, and it reappears in the same manner, has no tympany nor gurgling. It is translucent.

An undescended or a wandering testis may be found in the inguinal canal or in the groin or the perineal region. It is usually firm and irreducible, and its normal place is empty.

Hernia and undescended testicle in combination deserves special mention. The straying loop of intestine and the laggard testis may have adhered together, with the peritoneum between, and as the testis tries to descend it pulls the bowel with it, and when one reduces the hernia, the testis also disappears into the canal. Hematocele would show ecchymosis or give other evidence of traumatism, if not a history of it. Varicocele is not found in children. Tumor of the testicle may occur, but usually does not involve the cord, is opaque and irreducible, apt to be hard, perhaps nodular.

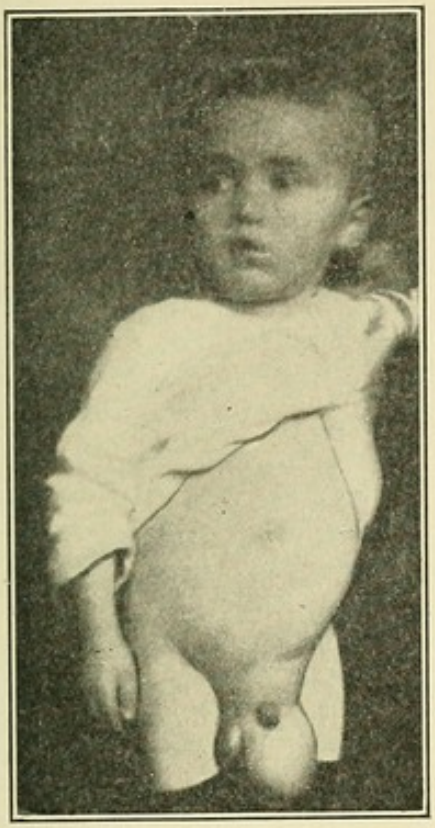


FIG. 209. DOUBLE SCROTAL HERNIA. Congenital. Note position of testicles. The right is best seen. The left is at the same height. Compare with the funicular hernia shown in Fig. 211. Boy 2½ years old.

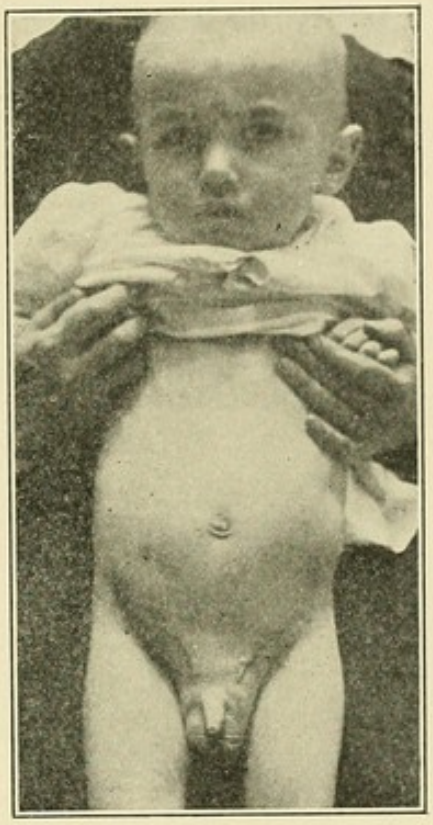


FIG. 210. Same case as 209, after operation. One does not like to make the radical operation for hernia on a patient under 4 years of age. Yet under urgent circumstances it may be done, with good hope of success.

Diagnosis of the Different Varieties of Inguinal Hernia.—A congenital, funicular, infantile or encysted hernia is suspected when

a hernia appears suddenly in a young subject, promptly attaining size greater than would occur with gradual formation of a sac. It is often taught that the varieties are distinguished only either after death or upon operation, the operator dividing one serous layer if it is a congenital hernia or a funicular hernia, whereas he divides

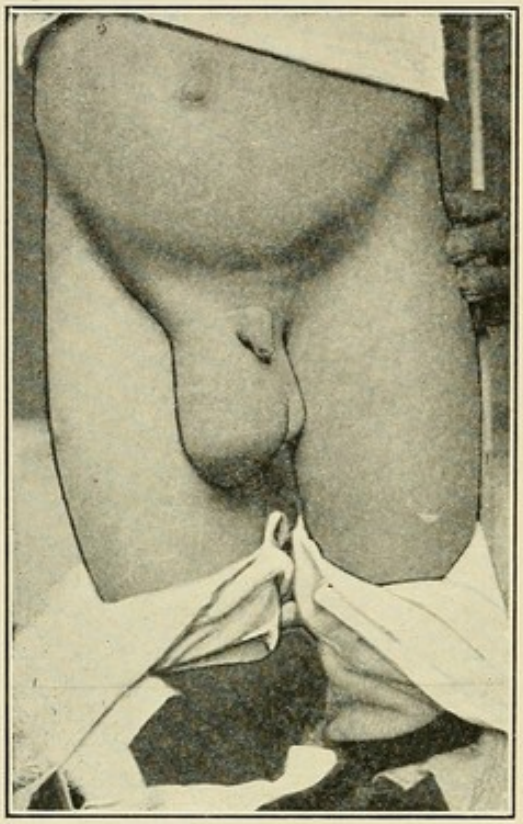


FIG. 211. INDIRECT INGUINAL HERNIA OF THE FUNICULAR VARIETY Observe the prominence begins at the internal ring; and the lower end of the scrotum is conical, containing the testicle below the hernia which is globular. Boy 5 years old.

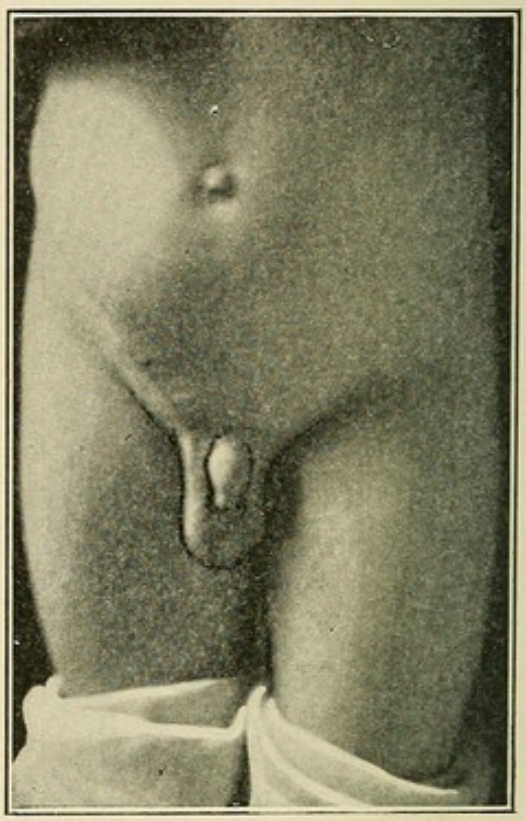


FIG. 212. Same case as Fig. 211. After operation. At 5 or 6 years is a better age for operation than earlier. The Bassini method is used, sometimes modified by not transplanting the cord. In children the results are good without transplantation.

three serous layers if it is an infantile hernia (or as some indiscriminately call it an encysted hernia), or two layers if it is an encysted hernia as herein described. But as a matter of fact one can often be reasonably certain which of three varieties he has to deal with upon examination. Ordinary acquired hernia appears late and increases slowly, and if it descends into the scrotum it remains separate from the testicle. The congenital variety appears early, descends suddenly, and often promptly takes a position lower than the testicle. The funicular hernia is probably far more common than either the infantile or the encysted forms. In this, the hernia appears

early, descends rapidly, but usually keeps the testicle below it. These points can sometimes be detected even upon inspection. Fig. 209 shows a boy of 2 9-12 years with double congenital hernia. The globular shape of the lower end of the hernial tumor is well seen at the bottom of the tunica vaginalis upon either side. The outline of the right testicle is plainly shown at the side of the tumor. The left cannot be seen in the picture, but it was at the same level. Fig. 211 shows a case of funicular hernia of the right side in a boy of five years. The lower end of the scrotum is conical, containing the testicle below the hernia, which is more globular. One may observe

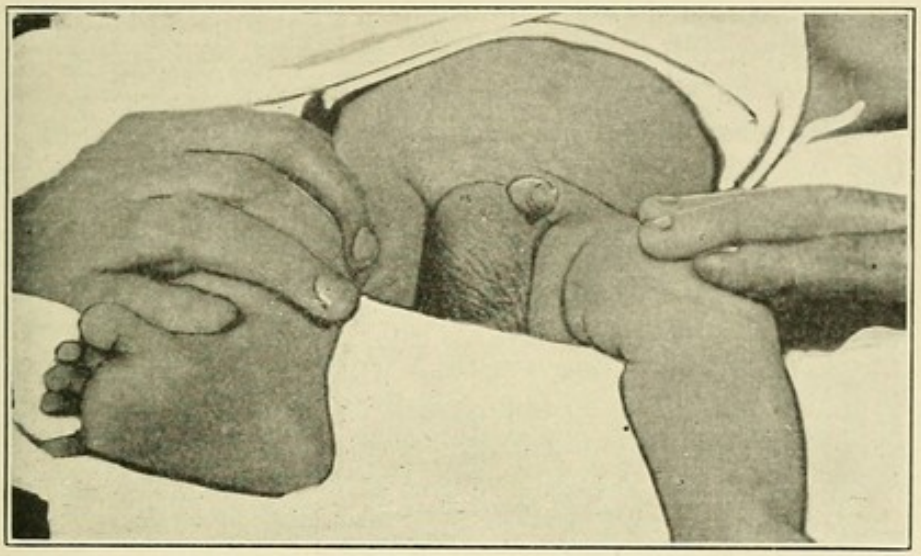


FIG. 213. TRAUMATIC ORCHITIS AND STRANGULATED INGUINAL HERNIA. On operation part of the cecum with the appendix found in the sac. Babe two months old. Case referred by Dr. Robert Tarr.

also that the prominence above begins at the internal ring, showing that the hernia is oblique or indirect. Figs. 210 and 212 show the same cases after operation.

Prognosis.—The prognosis in inguinal hernia in infants and children is good. In most cases removal of the exciting cause with proper trussing will effect a cure. In the remainder, operation will in all probability successfully and permanently close the hernial opening.

Treatment.—In every case of hernia the first point to be considered in the treatment is removal of the cause, be it cough, constipation, phimosis, calculus, frequent crying, malnutrition with emaciation, or whatever it may be. In some instances this, with keeping the child in a horizontal position for a time, will end the trouble.

In other cases in addition to this, some form of supporting apparatus or truss must be used. The form and varieties of these

appliances are numerous. Some of them are good, some are useless, and some are harmful. Again, a good appliance may be badly applied and poorly cared for, and do damage. The essential points are that the truss shall hold the hernia, that it shall do so without more pressure than is necessary under the customary strain, that it shall maintain its position no matter what attitude the child may assume or what exercise it may perform, that it shall not irritate the skin and that it shall be easily kept clean. The pad should be of a shape and size to cover the entire inguinal opening without boring into either ring, and should be hard and smooth in addition. If the truss is of such material or so constructed that the surgeon can easily alter or adjust it with precision to the patient, and is not too expensive, there is little more to be desired. A well-fitting inguinal truss usually does not require any perineal band. When one is necessary I have long been in the habit of using a piece of rubber tubing instead of a leathern strap. This is round and does not cut into the skin; nor does it stiffen and roughen by becoming wet or soiled. Many years ago I attempted to introduce the skein truss, as long and extensively used for infants in the children's clinics in England. (According to D'Arcy Power it was first published by Mr. William Coates of Wrington, Somerset, who learnt it from a gudewife in his neighborhood.) It consists of a skein of lamb's-wool which encircles the pelvis, one end being passed through the other and knotted just upon the inguinal ring, the loose end being carried between the thighs and tied behind to the encircling portion. This was changed morning and evening after the baths. But I could not induce people to persist in its use. It was voted too much trouble. There was a disadvantage in the daily changing, the hernia being likely, in unskillful hands, to escape. To be sure, the skein truss had only its cheapness to recommend it. For a spring truss, especially if covered with celluloid or with hard rubber, has everything in its favor. No child or infant is too small to be fitted with a truss. It is a rare hernia that cannot be held with a truss. Some cases can be permanently cured in a few months. Most cases can be cured with a truss within two years. Once the truss is applied the hernia should never be allowed to escape during the whole period of treatment. The truss is to be worn day and night and every moment. When it is necessary to change the truss or wash it the hernia must be carefully held in by the fingers of the mother or nurse. The skin beneath the truss should be kept scrupulously clean and dry. The mother or nurse should be clearly instructed that if the rupture comes out while the truss is on, the truss is to be immediately taken off, the hernia reduced and the truss reapplied; and the child is to be brought to the surgeon and the occurrence reported. The hernia may be considered permanently cured when the pillars are felt to be

of normal strength and properly approximated; and there is no tendency for the rupture to come down, and no impulse during continuous coughing or straining; and this condition has been maintained for several weeks after leaving off the truss. As a rule, cases which cannot be held with a truss applied by skillful hands, and cases in which trussing has been properly tried for a period of two years without a cure, should, if the child has reached four years of age, be subjected to operation. In selected cases under four years of age which could be trussed, or in children over that age who have not been trussed, but for whom it is impossible to get home care or supervision, the surgeon should in the interest of the patient exercise his discretion upon the question of operation. At five or six years is a better time to operate than at four years, if the patient can be safely carried along till that time. If he is past four years he is not so likely to be cured by a truss, but he can be, in some families, safely carried along to five or six years with advantage, and then operated. Cases have been operated upon at the age of a few months or even a few weeks, not only with a successful result at the time, but with a cure that has lasted for many years and bids fair to last a lifetime. In many cases in puny infants and very young and rickety children, the pillars are so filmy, so badly developed or stretched out, that it is better to use a truss for a time, as there is very little tissue from which to erect a barrier and the condition is not fit for an operation of election. Many such cases, if they can be carefully treated by truss, will in time be cured, whereas if subjected to operation the result will be a failure. The risk from strangulation during the truss treatment is so small that it need not enter into the calculation. The complication of hernia with undescended testicle argues in favor of rather than against operation.

Choice of Operation for the Cure of Inguinal Hernia.—After an immense amount of study and experimentation upon methods of operation and upon every step and point in the technique, the majority of the surgeons of the world to-day prefer the Bassini operation or some slight modification of it in almost all of their work upon inguinal hernia, in children as well as in adults. It has been claimed by some that almost any kind of an operation would be successful in a child; but this opinion has never been held by men of experience with children, nor by general surgeons who operate upon very many cases of hernia at all ages. It is distinctly denied by Bull and Coley, who give their percentage of relapses prior to the Bassini method at 40 per cent. within the first year, whereas, with the Bassini (sometimes modified by not transplanting the cord), it is about 1.4 per cent. It has also been shown by the same operators, and others, that in children, at least, it makes very little difference in the results whether the step of transplanting the cord is performed or not. It

need not be done as a routine step excepting in direct herniæ (which are extremely rare in children), and should not be done in cases of undescended testicle, as the cord is longer without transplanting.

Preparation for and Technique of the Operation.—It is essential that the child's digestive organs be in good order and that the intestines be nearly empty and free from gas. The diet should be carefully regulated for some days previous to the operation and for twenty-four or thirty-six hours previously should consist only of easily digested or predigested liquids which will leave little residue and not be likely to ferment. During this preparatory dieting or at least for a couple of days, the child should be kept in bed to accustom him to being quiet. Each day he should have a bath with warm water and soap. Twenty-four hours before the time set for the operation, the abdomen, pubes, loins and thighs should be scrubbed with warm water and green soap, using a sponge of gauze or flannel for rubbing, followed after thorough rinsing with alcohol and a solution of mercuric bichloride 1 to 2000. A compress wrung from bichloride solution, 1 to 5000, should be applied, covered with dry cotton and a bandage. When placed upon the table the parts are again cleansed in the same manner. The extremities are covered with dry cotton bandaged on, or with woolen drawers with feet, and the patient surrounded with hot-water bottles during the operation. The most scrupulous preparation of instruments and hands is essential, and rubber gloves should be worn by operator and assistants.

The incision is made parallel to Poupart's ligament, upon the inguinal canal. This exposes the aponeurosis of the external oblique. A grooved director is introduced into the canal, which is slit up by a series of two or three little snips, the director being readjusted between each snip. The wound should be kept very dry by the use of hemostats, lest the tissues, becoming blood-stained, be hard to distinguish. The sac is recognized by its white color and its structure. The sac is lifted up and dissected from the tissues beneath. This is more readily done by beginning on the inner side and circling round it before working upward or downward. Unnecessary injury to the cremasteric fibers should be avoided. If the lower end of the sac does not go down to the testicle, that is, if it is an acquired, a funicular, infantile, or encysted hernia, the sac may be dissected out completely at its lower end. In congenital hernia enough of the sac should be left at its lower end to make a tunica vaginalis. In the other forms of hernia it is not essential that the entire lower end of the sac should be removed, but in all it is essential that the floor of the sac, that is, the posterior part, should be dissected up and separated from the cord. The cord should be handled very gently and

not compressed. The complete neck of the sac should be lifted up and opened and the margins of the opening caught with hemostats and spread so that the surgeon can see that the sac is empty. The sac is drawn out, transfixed and tied with medium sized chromicized catgut as high above its neck as possible, cut off, and the stump allowed to disappear into the wound. If the cord is to be transplanted it is held up out of the way by a loop of sterile gauze or tape or a blunt hook, while the sutures are being passed and tied. For this purpose a needle armed with twenty- or thirty-day chromicized kangaroo tendon is passed through the edges of the transversalis fascia, the transversalis and the internal oblique and the rectus on the internal side of the canal, and the same excepting the rectus in the external pillar, and they are brought together and tied underneath the cord. Either mattress or ordinary sutures will answer. My own preference is for the mattress. From two to four pairs are passed below the cord, the upper one just touching it, attaching the internal pillar to Poupart's ligament. One suture is placed above the cord, care being taken not to compress either the vas deferens or its vessels. At the lower end of the canal, after passing the needle through the internal oblique, Coley passes it through the fascia of the muscle just where it reflects back, and this drawn across to Poupart's ligament, strengthens the closure at the lower angle just above the pelvic brim, where recurrence is apt to take place. In passing the needle one should be cautious not to wound the viscera or the iliac vessels. Pointing the needle obliquely as it passes under the edge of the wound and guarding it with the finger-tip lessens this danger. This suture line forms the posterior wall of the new canal. Upon this the cord is laid, and the divided aponeurosis of the external oblique is drawn over it and held with a continuous suture of catgut, thus making the anterior wall of the new canal. As before stated, it is not always necessary to transplant the cord. If this is not to be done, after tying and removing the sac the cord is replaced in its old position and the canal closed. The wound should be dry, and the skin incision is now closed without drainage, with silkworm gut or catgut sutures. In former years silk was used for tying the sac, and silver wire or silk for closing the canal. I have formerly used both, especially silk, with satisfaction. But nowadays hardly anyone uses non-absorbable material for buried sutures. Chromicized kangaroo tendon for the canal, chromicized catgut for the sac and ordinary sterilized catgut for the vessels and muscles are probably the choice of the majority of surgeons. The wound is dressed with gauze, adhesive strapped on, cotton, a spica bandage, and a plaster of Paris bandage going from the knee to the thorax. In some clinics the plaster of Paris bandage is carried no higher than the navel, on the theory that more room is given for possible disten-

sion of intestines away from the wound and less at the wound by so doing. Some use no plaster of Paris at all, in order that wetting the dressing may be more easily detected. But I think it safer in most cases in children to use plaster, and if the plaster is not carried up on the thorax, other means should be taken to prevent the child from raising up or twisting about during the first few days, as strain may be put upon the wound by so doing. In young children who wet and soil themselves it is safer to seal the wound with iodoform gauze and collodion, and outside of the dry sterile gauze to place rubber tissue so disposed as to keep the wound clean and dry. With bedwetters all precautions should be taken to prevent soiling of dressings, as the results of the most skillfully performed operation may easily be ruined. (49)

At the end of a week ordinarily the plaster is removed and the first dressing made, the skin sutures being removed, and usually the patient can be allowed to sit up in a reclining chair.

FEMORAL HERNIA

In children the pelvis is comparatively small and narrow, and the pelvis of the girl is much like that of the boy. The crural ring is small. Ligament and pelvis are close together, and the iliacus and psoas muscles and the femoral vessels fill the space so completely there is small chance for a hernia to wedge through. Congenital femoral hernia never occurs. It is always of the acquired form and is rare under puberty. When it does occur it is like that of the adult, an elastic swelling in the groin appearing first over the saphenous opening, but curving up over the groin. Under pressure it gurgles and disappears like other herniæ. But on account of its rarity in children, and the frequency of spinal or sacral caries and resulting abscess appearing in this region, the latter should be carefully excluded. Enlarged glands bear a resemblance, but they are often multiple, have no impulse on straining and cannot be reduced, and there is often an obvious cause. Varix of the saphena should be excluded. Femoral hernia is extremely liable to strangulation. It can usually be retained by a truss, but there is no hope of a cure by trussing. Therefore it is useless to wait if a patient is fit for operation. Bassini's operation is probably the best. The incision is made over the center of the tumor, parallel to Poupart's ligament. The sac is separated by blunt dissection, then transfixed and ligated as high up as possible. The excess is removed; or at this point a step from McEwen's operation may be introduced if desired; that is, the sac may be used to form a pad drawn up into the opening before closing the canal. The canal is closed by two lines of interrupted sutures of kangaroo tendon or silk. The first line unites the pectineal fascia and Poupart's ligament; and the second line connects the

cribiform fascia and Poupart's ligament and the fascia above the saphenous opening. The first sutures close the opening from the abdomen into the canal. The second sutures close the canal itself. The skin and superficial fascia are then sutured without drainage.

LUMBAR HERNIA

Hernia occasionally occurs just above the iliac crest in Petit's triangle. It may be congenital or traumatic, or result from weakening of the wall by abscess. It presents the usual signs of hernia, and should be treated like a ventral or umbilical hernia with a pad held in place by adhesive straps, or if there is no tendency to close by this means, a radical operation should be done. This was first resorted to by Edmund Owen, who dissected down to what appeared to be the transversalis fascia, thrust the sac and its contents into the abdomen, and united the margins of the external oblique and lattisimus dorsi with sutures, effecting a complete cure. Such herniæ, like ventral herniæ, seldom present a distinct neck. If they do it should be ligated.

VAGINAL HERNIA

Vaginal hernia is mentioned as a rare but possible condition even in infancy or childhood. T. Holmes records a case in a girl of three years in whom the tumor protuded behind the labia minora, between the urethra and vagina, being evidently an extension of the vesico-vaginal pouch of the peritoneum. It contained intestine, which was easily reduced, leaving a distinct hiatus or ring where it had protruded. As the tumor was increasing in size he reduced the hernia, dissected flaps off either side of the vagina and united them around the ring by numerous sutures. Cicatrization by granulation followed and the contraction closed the ring.

TRAUMATIC, POST-OPERATIVE, RELAPSED HERNIÆ

These are not so frequently met in children as in adults, yet they occur occasionally, from accidental injury or following abdominal sections for appendicitis, for drainage of peritonitis, for tumors, failure of radical operation for hernia, et cetera. These herniæ may often be retained by a pad and belt or some form of truss, but they show no tendency to improve under treatment by trussing. On the contrary the trouble increases by stretching of the scar tissue, and they should be treated on the same principle as laid down for hernia in the linea alba or intractable umbilical hernia. The scar tissue should be removed and the aponeurotic and muscular layers united in anatomical order by sutures of catgut and kangaroo tendon. In operating on relapsed hernia it is best to start the dissection for the canal a little higher up to avoid the scar tissue, and after distinguishing the structures to work downward.

CHAPTER XXIII

THE RECTUM AND ANUS

Anatomy—Examination and Pathology—Congenital Smallness of the Anus—Hypertrophy of the Sphincter Ani—Malformations of the Rectum and Imperforate Anus—Prolapsus of the Rectum—Nevus of the Rectum—Polypus of the Rectum—Bilharzia Adenomata of the Rectum—Proctitis—Syphilis of the Rectum and Anus—Vegetations or Warts about the Anus—Fistula in Ano—Fissure of the Anus—Hemorrhoids—Ischio-Rectal Abscess — Marginal Abscess — Foreign Bodies and Impactions—Inefficiency of the Sphincter Ani.

ANATOMY

The rectum in the infant and young child may be described as in the adult, as following the anterior outline of the sacrum and coccyx and being in contact with them in the first and second portions, then turning backward in its downward course in the third portion. But the sacrum and especially the coccyx are but slightly curved in the young. They are almost straight; and the curves of the rectum, both the antero-posterior and the lateral curves, are only rudimentary. The rectum is almost a straight tube, placed more vertically in the long axis of the body than in the adult. The lowest curve downward and backward to the anus does exist to a degree, and should not be forgotten when introducing a thermometer or instruments into the rectum. In the infant and young child the gluteal muscles are not much developed, so that the anus does not lie in such a deep fold between the nates, and it seems rather behind than beneath the body, by comparison with the adult. The rectum is relatively larger than in the adult. Its thick mucous membrane has a very loose attachment to the muscular coats beneath. The peritoneum covers the front of the rectum to about the level of the fourth sacral vertebra. This point corresponds to about the middle of the symphysis pubis. There is a meso-rectum for the upper portion of the rectum. This descends as low as the third sacral vertebra. In the infant as in the adult there is no anatomical line of division between the rectum and the sigmoid flexure at the level of the sacral promontory.

EXAMINATION AND PATHOLOGY

The disorders of the rectum and anus in infants and children constitute a field rather neglected in practice. Careful examination

should be more frequently and promptly resorted to when symptoms point toward this region. It is astonishing to find that even in the hands of average practitioners serious malformations and diseases that are perfectly obvious upon examination, often escape detection for days, weeks, months or years, for want of proper investigation. Doubtless the great frequency of digestive and intestinal disorders often leads to hasty diagnosis of functional trouble higher up in the tract. It is true that in infants and children the small size of the parts, and in children fear and lack of control, render examination more difficult than in adults, but these obstacles are to be overcome in many departments of our work.

In even the new-born baby one's fourth finger, well oiled and having the nail trimmed short and smoothly can be readily passed for exploration. In most infants and all children normally formed, a slender index finger, lubricated, passes readily and safely without overdilating the sphincter. For inspection the ordinary types of rectal specula of small size can be used in older children, and in infants, urethral specula. Not only inspection of the lower rectum, and digital exploration, but complete proctoscopy and sigmoidoscopy are practicable even in cases of acute inflammation and in children seriously ill.[1]

But most of the diseases of this region are found within an inch and a half of the anus. Imperforation is most frequently superficial. Congenital smallness of the anus, hypertrophy of the sphincter, paralysis and over relaxation of the sphincter, fissure, abscess, fistula, hæmorrhoids, nevus, syphilis, prolapsus of the rectum, are easily within reach. Proctitis, rectal impaction, foreign bodies, polypi and other tumors, ulcers, strictures, worms, may be encountered low in the rectum or higher. Moreover, by this route of examination other ailments than ano-rectal may often be detected or better defined. Such are deformities of the pelvis, sigmoid disease, intussusception, caries of pelvic bones, disease of hip joint or sacro-iliac joint, tubercular glands, vesical tumor or calculus, malformations and diseases of the vagina, uterus, ovaries, and tubes, intra-pelvic testicles, sacral and cocygeal tumors. So that the surgeon should familiarize himself with methods of examination *per rectum* and their findings palpable and visible.

CONGENITAL SMALLNESS OF THE ANUS

In this the structure of the anus is complete but of size smaller than normal. This produces difficult defecation and leads to distressing secondary symptoms of constipation and its results. Almost always the remedy is found in gradual dilatation; but if this

[1] Bowditch: Arch. Ped., Jan., 1911.

fails, section posteriorly in the median line is resorted to with success.

HYPERTROPHY OF THE SPHINCTER ANI

It is not always clear whether this condition is congenital or acquired. Nor is it always easy to distinguish whether there is actual hypertrophy of the sphincter muscle, or only hyper-activity, brought about by morbidly excitable reflexes or local irritation or both. But it sometimes occurs where no local or other source of reflex irritation can be found. The sphincter appears too strong and too actively contractile for the expulsive powers. Treatment is by dilatation, divulsion, or division of the sphincter muscle.

MALFORMATIONS OF RECTUM AND IMPERFORATE ANUS

These constitute a class of cases most interesting, not only to the pathologist but to the practical surgeon. Without an understanding of embryology they would be incomprehensible; and without intelligent, prompt and courageous surgery they would be all miserably hopeless. On the other hand, their etiology is beautifully explained in the mutations of the embryo; and nature's errors of this kind often afford a field for brilliant and beneficent surgical achievement. A brief review of the development of the rectum and anus will explain the production of some of these deformities. The intestinal and urinary canals are at first all in one, which consists only of an open gutter formed from the epiblast in front of the spinal column. This gutter, later, becomes enclosed as a tube or sac, and its lower portion, when partitioned off from the intestine or mesenteron, becomes the bladder. As the cloacal opening between bladder and mesenteron closes, a special opening, the urethra, connects the bladder with the surface. While the lower end of the mesenteron as a blind pouch extends downward in the situation of the rectum, a depression, called the proctodeum, from the epiblast at the base of the embryo opens inward to meet the mesenteron, thus forming the anus. If the perineal septum fails to separate the mesenteron from the urinary tract, one of those deformities is produced in which there is a communication between the rectum and the bladder or urethra. If the mesenteron fails to descend or the proctodeum to dimple in far enough, the two do not meet, and there is produced imperforate anus, one of the forms of malformation of the rectum about to be described more in detail. It is stated by some writers that ano-rectal imperforation is apt to be accompanied by other deformity, especially by contracted pelvis, extroversion of the bladder, spina bifida or naso-pharyngeal obstruction; but in none of the cases that I have seen was such malformation present. (59.)

Ano-rectal imperforation occurs perhaps once in five thousand or six thousand births.

Classification.—The classification of the congenital malformations of the rectum and anus as adopted and modified by Bodenhamer in 1860 still is, as that author remarked, "if not perfect, . . . sufficiently plain, comprehensive and correct for all practical purposes." Slightly modified in wording it is as follows:

I. Preternatural narrowing of the anus or rectum without complete occlusion.

II. Complete occlusion of the anus by a simple, membranous diaphragm or by integument.

III. The anus is absent, the rectum ends in a cul-de-sac at a greater or less distance above its natural outlet, without any communication whatever, externally or internally.

IV. The anus is normal externally, but ends in a cul-de-sac; and the rectum ends in a blind pouch at a greater or less distance above, the two being separated by a septum.

V. The anus is absent. The rectum is prolonged in the form of a fistulous sinus and terminates by an abnormal anus at the glans penis, the labia pudenda, or at any point about the perineum or sacrum.

VI. The anus is absent. The rectum terminates in the bladder, urethra, or vagina; or into a cloaca in the perineum with the urethra and vagina.

VII. The anus and rectum are normal, but the ureters, the vagina or the uterus open into the rectal cavity.

VIII. The rectum is entirely absent.

IX. The rectum and colon are both absent, and there is usually an abnormal sinus situated in some extraordinary part of the body.

Of each of these species there are several varieties. Some of these have been illustrated here by original diagrammatic drawings after the descriptions of standard authors but based upon infantile anatomy. (See Figs. 214 to 222.) All these malformations present some symptoms in common; and much that could be said upon diagnosis and treatment applies to all of them; yet it is obvious that each species has peculiarities which will require its separate consideration, either on account of symptoms, diagnosis or treatment.

Species I.—In this species the narrowing may be so slight as to occasion very little inconvenience further than some straining when the feces are too firm in consistency; or so extreme as to scarcely admit a catheter or a probe, and to cause severe straining with the escape of very little feces which accumulate and distend the abdomen, occasioning pain. (See Fig. 214.)

Diagnosis.—The diagnosis is readily made by examination of the rectum. The only difficulty likely to arise is in ascertaining the length of the narrow portion when it extends high up.

Prognosis.—The prognosis is usually good.

Treatment.—The treatment of this variety is by gradual dilatation. If the opening is too small or the narrowed portion too long for a well-oiled finger to pass, the dilatation may be done with grad-

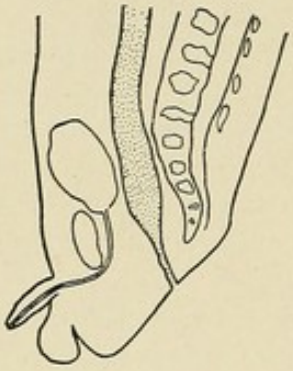


Fig. 214.

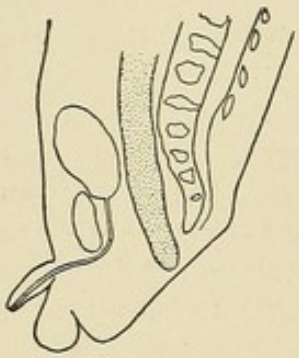


Fig. 215.

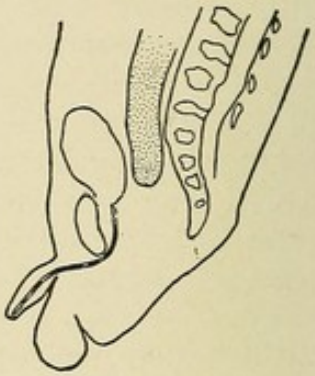


Fig. 216.

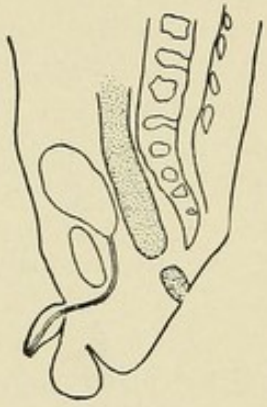


Fig. 217.

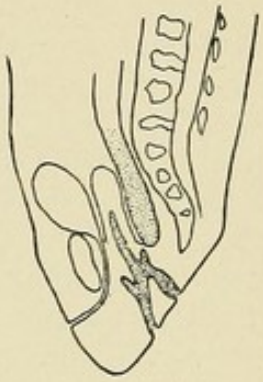


Fig. 218.

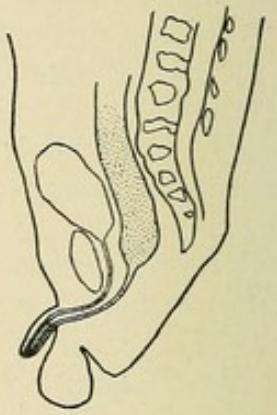


Fig. 219.

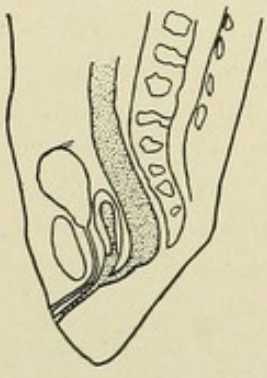


Fig. 220.

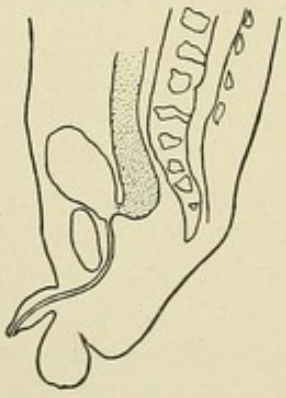


Fig. 221.

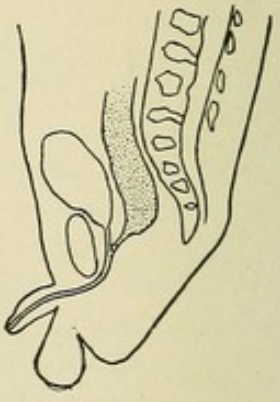


Fig. 222.

FIGS. 214, 215, 216, 217, 218, 219, 220, 221, and 222, ILLUSTRATING MALFORMATIONS OF THE RECTUM AND IMPERFORATE ANUS.

uated bougies. I have sometimes found small wax, tallow or stearine candles answer the purpose very well. Sometimes the little finger and later the index finger of the nurse or mother, well smeared with vaseline and passed daily, will accomplish all that is necessary. Care

should be taken not to irritate or excoriate the mucous lining; nor to overstretch the tissues by dilating too rapidly. Obstructing bands or folds may need dividing. The process of dilation may have to be kept up very patiently for weeks and months and even years. Attention should be directed to the diet and digestion in order that the stools may be of the right consistency.

Species II.—In cases of occlusion of the anus by a simple mem-

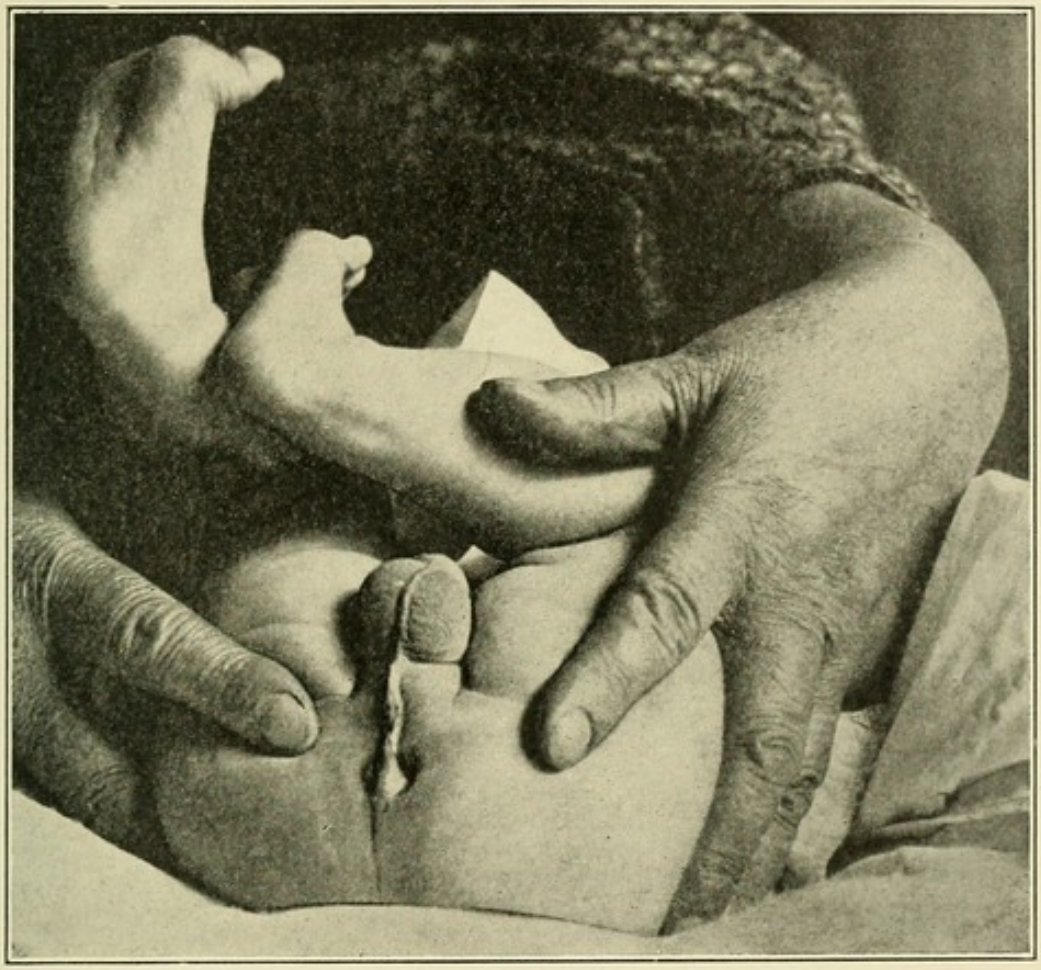


Fig. 223. Imperforate anus with a tapering tail-like ridge extending forward from the region of the coccyx, dividing the cup-like cavity of the proctodeum into lateral halves.

branous diaphragm or by integument (Fig. 215), the site where it should be may be quite smooth like ordinary skin, or it may have the papillary arrangement of the raphe of the scrotum or perineum, without either elevation or depression from the surface, or there may be a dimple or a slight groove at the anal site. More rarely there is a depression or cupping at the situation of the anus—with a bridge of skin extending antero-posteriorly across it. Again there occurs, rarely, the condition shown in Fig. 223, in which a tapering process like a tail extends forward from the coccygeal region across the anal site, dividing the cup-like cavity of the proctodeum into

lateral halves. This seems to contradict the usually accepted view that the ectodermal layer simply dimples in until it meets the terminus of the enteron. It rather confirms the description of Tourneux, that there is a definite anal membrane or specialized cellular mass thicker in the middle line than at the sides, forming the anterior wall of an internal cloaca or rectal ampulla; and that this cellular body is absorbed away, the greatest absorption taking place at each side of the central line, where the thicker portion remains the last to be absorbed, and in such malformations as this fails to be absorbed.

This description of external appearances applies not only to species II., but to all the nine species of Bodenhamer's classification in which the anus is absent. The occluding septum may be quite thin and membranous or resemble ordinary skin or be considerably thicker or firmer. The sphincters are often normally developed.

Symptoms and Diagnosis.—Restlessness and distress with refusal to take the breast are symptoms usually present, and should attract attention, but often do not. Distension of the abdomen and straining without defecation supervene and are noticed sooner or later. Examination reveals the imperforation. Often there is bulging of the septum during the straining.

Treatment.—The treatment of this species of malformation is quite simple and satisfactory. A crucial incision of the membrane or skin is first made and the small flaps trimmed off if they project. After evacuation the opening is plugged with a small roll of well-oiled gauze and kept dilated daily until healing takes place and all tendency to contraction is past.

Species III.—In the third species the rectum may be well formed and may descend into the pelvis almost far enough to place the case in species II., or the interval between may be one, two or several centimetres; or the rectum, or at least the pouch at the end of the intestine may terminate at or above the pelvic brim. (Fig. 216.) The space between the pouch and the perineum may be filled with cellular tissue, and there may or may not be a fibrous cord extending between the two in the situation where the rectum should be. My own experience would lead me to believe that the "distinct fibrous cord" often described is absent in the majority of cases, or at least is not sufficiently distinct to be noticeable as a guide in the search for the rectal pouch. In some cases the pelvic space is narrow, and the tuberischii can be demonstrated as closer together than normal. In other cases this is not perceptible, and cellular tissue fills the space between the sacrum and coccyx, and the bladder and urethra, or uterus and vagina, as the sex may be.

Symptoms.—The symptoms are uneasiness, distress, refusal to

take the breast, straining, distension of the abdomen, the absence of defecation, and in some cases vomiting. It seems strange that vomiting is not invariably present in these cases, although there is complete obstruction of the intestinal tract. It is always a feature of those rare cases which have survived more than seven or eight days, even during several weeks. They have had periodical fecal vomiting. In the ordinary case vomiting is unusual.

If steps are not taken to relieve the condition, in the course of a few days the abdominal distension may become extreme. The child grunts with distress. The diaphragm is pressed upward, interfering with respiration. The surface of the body becomes purple from interference with the venous return, this stasis being most marked over the abdomen and lower extremities. The straining may be severe or very moderate and at long intervals and only excited by manipulation of the abdomen. The infant may die of exhaustion; or in the meantime may develop paralysis of the bowel from extreme distension of feces and gases; or gangrene of a portion of gut; rupture of the colon; jaundice; or stercoremia from absorption of toxines, and absence of elimination. It becomes apathetic and comatose and sinks away.

Diagnosis.—The diagnosis of an ano-rectal malformation is so easily made upon slight examination that it seems strange so many cases are overlooked. It would seem that every physician and every nurse must recognize the serious nature of such malformation, and yet it is a fact that the majority of the cases do not come to the surgeon until several days after birth, when there is distressing distension and exhaustion, the meconium has become septic, and perhaps peritonitis or other complication has arisen, or even gangrene or perforation has taken place. One must conclude that no examination has been made on account of the earlier symptoms, or the condition would certainly have been discovered. As to the diagnosis of the exact location and shape of the rectal ampulla, that is quite a different and difficult matter. It may be possible in some instances to locate a distended pouch by palpation and percussion over the abdomen. But usually the abdomen is so distended, at least if not seen early, that little if any difference on the two sides can be detected. One can by no means be certain that the colon terminates anywhere in its usual course on the left side, and one has seen a case in which, with the terminal pouch on the left side, the external distension was greater on the right. One has observed, however, a greater degree of venous stasis in the lower extremity upon the side corresponding to the distended fecal pouch, and it may be this symptom is of some value. I have never found the sound introduced into vagina, urethra or bladder to be of any use in determining the location of a distended pouch, and yet it should be tried in

all cases. The passing of feces with urine should be carefully inquired into; and search made for any fistulous opening anywhere about the pelvic region or at the umbilicus. Bulging during straining may be felt over the perineum if the rectal pouch is at all near by. Yet it is very difficult to determine by this means its distance from the surface. Unless it is sufficiently low in the pelvis to cause an impulse or bulging on straining perceptible to the finger (or perhaps to a probe in vagina or urethra), I regard it as impossible in these cases of imperforate anus without external sinus to ascertain before operation the degree of development of the rectum or the location of the enteric termination.

Prognosis.—The prognosis is necessarily very serious. Without surgical interference the infant will almost certainly perish miserably within a few days or a week. A few cases are on record, for example one by Cripps, in which the infant survived several weeks. But these cases are so rare as to count nothing in the prognosis. The course and mode of death have been mentioned under symptoms. The prognosis that can be offered in case of operation, while uncertain, is by no means hopeless. It must vary with the time at which operation is undertaken, the condition of the patient, the degree of the malformation and the success of the operator in establishing an opening for the escape of intestinal contents. The later the operation is postponed the greater the danger. Some of the complications already mentioned are necessarily fatal. Numerous cases are on record of patients operated upon sufficiently early living to adult life with as great comfort and happiness as if they had been born without malformation. The surgeon has no alternative but to urge operation in any case in which there is either a possibility of a successful result or in which death can be averted for the time being, and the patient thus be given a chance for his life, even though further surgical attention may be necessary at some later period. The parents have no right to decide that the child must die rather than live with an anus in an unusual position. Neither can operation be looked upon as a farther infliction of suffering upon the infant, for it affords the most intense relief imaginable, as all who have handled such cases can testify.

Treatment.—The only treatment is by surgical operation to reach and empty the rectal pouch. If this can be done so as to establish a permanent opening in or near its normal situation, so much the better. And if the opening have sphincter control the result will be ideal. Operation should be undertaken without delay. Delay inevitably puts the patient in worse condition. Exhaustion, stercoremia, and distension increase; the meconium, at first sterile, becomes septic and the results or complications previously mentioned are likely at any time to supervene. There is no possibility of

gaining anything by more delay than is necessary to get the patient to a hospital or to prepare for an aseptic operation.

To discuss in its entirety the development of surgical procedures in these cases with all the reasons for the numerous modifications that have brought about the present status of opinion and practice would transcend our present object. There are numerous elaborate articles upon the subject.[1]

Of the older methods I shall mention but one at this point, and that in order to condemn it. Puncture or attempt at puncture of the rectal pouch, with trocar and canula or aspirating needle introduced through the perineum, suggests itself to the practitioner on account of its apparent simplicity and its bloodlessness. But its use is uncertain, unsafe and unsatisfactory. One cannot be sure what he is doing, is liable to injure important structures, to penetrate the peritoneum, to infect pelvis or peritoneum, and at the best can only temporarily empty the pouch if it is found. The records of past experiences condemn this procedure in unmistakable terms.

Infra-pelvic Operations.—The operation of choice with the patient in fair condition is perineal proctoplasty by incision in the middle line of the perineum. (Amussat, 1835.) Anesthesia is not necessary with the patient in good condition, or at most a few whiffs of chloroform for the skin incision. Anesthesia is a positive disadvantage, since it stops the straining which enables one to feel by the increased tension during the expulsive effort, when he is in proximity to the distended ampulla. Pressure of the hand over the hypogastrium will imitate straining, but, the diaphragm not being fixed, is not so effectual. Moreover, in bad cases seen late, with tympanites interfering with the respiration, with stercoremia and approaching exhaustion, anesthesia increases the danger.

The position of the patient during operation is an exaggerated lithotomy position. (Matas.) The incision should begin as far forward as the scrotum or vulvar commissure will allow, and keeping strictly in the middle line should extend backward to the tip of the coccyx. This incision will go deep enough to enable the index finger to pass through the muscles of the pelvic floor, when it may encounter the rectal pouch or feel its proximity during straining. If the pouch is not found here the dissection should be carried further up, still keeping in the middle line, and near the sacrum and pausing every moment to explore with the finger. If the rectum is found it should be loosened by careful dissection from its surroundings and pulled down into the opening and stretched to the margins of the incision and opened. Some operators advise opening the pouch before attempting to dissect it loose. But it

[1] Notably admirable contributions by Matas among recent writers.

will be found easier to distinguish by touch between the pouch and its surrounding tissues before it is opened than afterward. Besides, the efforts at straining tend to drive the distended pouch down into the opening. However, when it has been loosened as much as possible and does not reach the margins of the incision, it may be opened and pulled down. It may now be found to reach. If the intestinal tissue is still too short, it will be necessary to carry the external incision farther back through the middle line of the coccyx. The coccyx can easily be divided by knife or scissors, as it is cartilaginous. By thus placing the external opening higher up and dragging the rectum down the latter may be securely sutured to the outer margins of the wound from which the integument has been removed in a narrow circle. But if the operator has not been able to reach the ampulla through the perineal incision, what shall be done? If the patient is a fairly strong child and still in good condition, he should be turned upon his face and the perineal incision carried backward in the median line through the coccyx (median coccygotomy), and the dissection carried upward, in front of the sacrum, as far as can be by sight and touch, from this opening. If it proves necessary to explore still higher, the incision can be extended through the sacrum to the level of the lower border of the third sacral foramen (median sacro-coccygotomy, Vincent, 1887). The lower border of the third sacral foramen is situated one and a quarter centimetres above the sacro-coccygeal joint (Matas). One might venture to carry a median incision one centimetre higher than this point, but not to make a cross section of the sacrum at a level higher than the lower border of the third sacral foramen for fear of leaving open the sacral canal and of injuring the nerve supply to the bladder. Through such a median incision, the sides of which are held open with retractors, the exploration can be continued. If more room is necessary for the exploration, or if the ampulla is found and more freedom is needed for its dissection, the sacrum can be cut across by a transverse incision at right angles to the original median incision and at the level before stated as the limit of safety. (T section, Morestin, 1894.) Two triangular flaps can then be pulled outward, making an opening that is ample for whatever is to be done. The rectal pouch having been loosened, should be brought into the opening, as low as it will reach, and there secured by sutures as before described, making an artificial anus. If possible, this anus should be located below the level of the levator muscles to secure control of the evacuations. But if it must be located higher than the levators, Gersuny's procedure should be resorted to; that is, the rectum should be rotated axially before it is sutured to the margins of the incision. The amount of twisting required is usually

from 120 degrees to 270 degrees. The open extremity of the gut should simply be twisted upon itself until the finger when introduced feels a sphincter-like resistance. The edges of the gut should then be secured to the edges of the skin wound by two rows of sutures, the muscular as well as the mucous coats being held in the sutures, which should be firm enough to prevent the bowel freeing itself or untwisting.

Abdominal Operations.—Abdominal section is not the first choice in a case of ano-rectal imperforation without sinus. But it would be resorted to under certain conditions, namely: If the patient were in such extreme jeopardy from abdominal distension and exhaustion that prompt relief must be afforded with the least possible operative traumatism and shock; or if the infra-pelvic route had been tried with no success in locating the enteron; then one should proceed to form a fecal fistula. Unless there were some good reason for a different location for this fistula, such as a distinct bulging or fluctuation at a certain point upon the abdomen, one would select the site about two finger breadths (of the patient) above the middle and parallel with Poupart's ligament on the left side. A small incision is made and the nearest distended coil of intestine is rapidly sewed through its serous and muscular coats into the wound with running sutures of catgut, all round the margins of the incision, a row of sutures to the peritoneum and another row to the fascia and skin. The gut is then opened and its contents discharged. The bowel opened may fortunately prove to be the rectal pouch or the colon (inguinal colostomy, Littre, McCormac), or a small intestine (enterostomy, Nelaton). If the child survive and become sufficiently vigorous, at some future time operation may again be undertaken. This operation will be planned according to the nature of the malformation. If the fecal fistula previously made communicates with the colon a perineal anus may be formed by introducing a sound at the fistula and pressing the sac down toward an incision made in the infra-pelvic region. (Chassaignac, 1856.) The fistulous opening in the groin may then be closed. But if the fecal fistula connect with a small intestine a subsequent laparotomy will be made to determine the deformity and either bring the terminal end of the intestine to the perineal region, or to form a permanent artificial anus in the groin. The question of a primary exploratory laparotomy has been much discussed, but the weight of evidence is in favor of the perineo-sacro-coccygeal route if the patient is in fit condition. (Matas.) If, however, for the sake of quick and certain relief, the abdominal route is chosen for the primary operation, it is advised by some operators, instead of immediately making a colostomy in the groin, to open the abdomen in the left semilunar line and if possible ascertain the relations of the rectal pouch, so

as to determine whether a fecal fistula or a permanent artificial anus upon the abdomen should be produced. The operator is warned, however, that in the distended and tympanitic state of the abdomen such an exploration is likely to be very unsatisfactory without greater exposure and manipulation of the intestines than the infant is able to endure. My own preference is for the infra-pelvic as the primary operation, if necessary making the sacro-coccygotomy. If the rectal pouch cannot be found by subperitoneal search, the peritoneum should be opened through the pelvis and the pouch sought higher up. (Stromeyer, 1844.) If found, the pouch is to be drawn into the sacro-coccygeal wound and there secured. If not, there remains the plan of opening the abdomen either in the median line or laterally and bringing down the pouch into the perineal or sacral opening. (McLeod, 1879.) But I here repeat the advice that if either before beginning any operative procedure, or during the performance of one of the more radical operations for permanent relief from the malformation, it be observed that the patient is not in condition to withstand any considerable shock, a fecal fistula should be rapidly produced in the inguinal region for temporary relief, and the permanent correction postponed to a more favorable time. There remains only to be mentioned in this connection drainage of the cecum in the right inguinal region when the rectum and colon are entirely absent. (Pillore.)

When the operator has, by any of these routes or methods, succeeded in reaching and emptying the distended intestinal pouch, the babe shows evidence of the greatest possible relief and satisfaction. The straining ceases, the distress gives way to quiet rest, the infant takes the breast or drink eagerly and sleeps peacefully.

Species IV.—In the fourth species (Fig. 217) the septum may be thin or thick, or its place may be taken by an impervious cord-like structure substituting a portion of the rectum, or the rectal pouch may be located at a distance, or the anus may open into the vagina posteriorly. (Fig. 218.)

Symptoms.—The symptoms are the same as have been described under Species III.

Diagnosis.—The external appearances of this form are so deceptive that the condition is likely to go undiscovered by mother or nurse. When the symptoms have led to examination by the surgeon's finger or probe the condition is revealed.

Treatment.—The line of treatment is the same as that described for Species III, with the exception that the lining of the anal thimble should be removed when the gut is brought down to be sutured to the margin of the anus. It is not satisfactory in these cases, even if there is only a septum at a distance within the anus, to merely divide the septum and dilate. Recontraction will persistently take place.

The gut should be brought down, as before described, so that the whole canal is, to the anal margin, furnished with a mucous lining.

Species V. (See Fig. 219.)—Fig. 224 also shows a case of the fifth species. The infant was otherwise well formed, weighed $7\frac{1}{4}$ pounds, and measured $21\frac{1}{2}$ inches in length. The anus was absent, its place being occupied by a slight groove. A median cleft partly separated the scrotum into lateral halves with a testicle in each. At the bottom of this cleft, half an inch posterior to the peno-scrotal junction, were two small orifices. One of these extended only skin

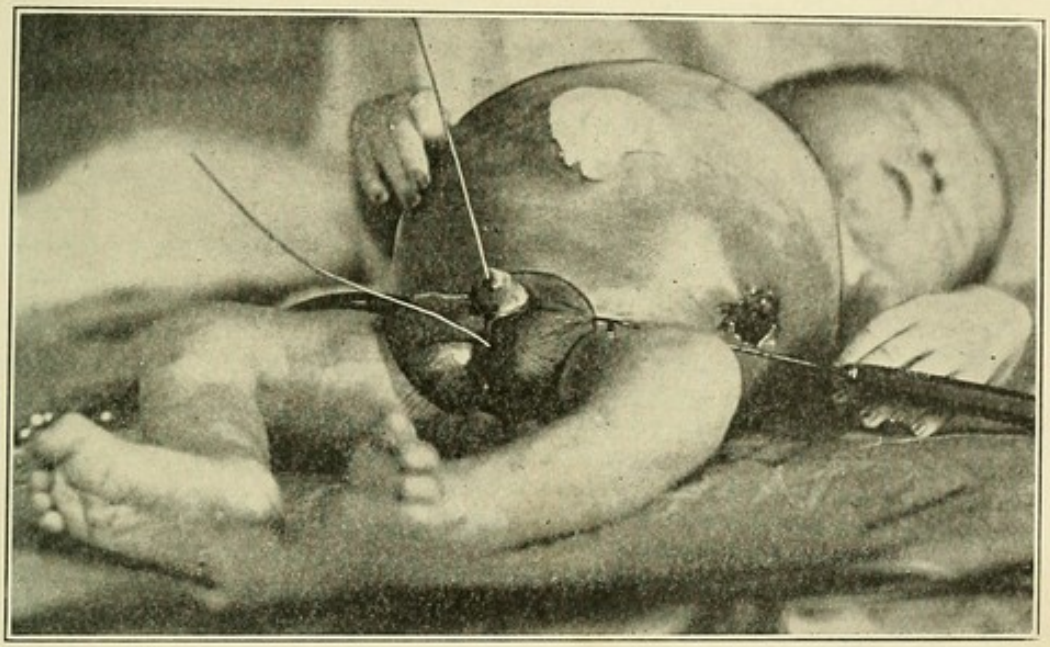


Fig. 224. Malformation of the rectum. Anus absent. A groove partly divides the scrotum in the median line. In the groove near the peno-scrotal junction is the orifice of a sinus. Note the distension of the abdomen and discoloration of the skin. The malformed bowel is shown in Fig. 225.

deep, the other deeper. Meconium-stained fluid and a small amount of gas occasionally escaped from the deeper sinus. The finest filiform bougie or canaliculus probe could not penetrate this sinus more than an inch. The distension of the abdomen and the discoloration of the skin from venous stasis are also shown. On the left side is a fecal fistula located higher than usual on account of swelling and fluctuation in that situation. Fig. 225 shows the internal malformation. The cecum with the appendix behind it was located half way from the umbilicus to the cartilages of the ribs on the right side. Thence the colon extended transversely to the left, made the splenic flexure, then turned to the right and crossed the abdomen at the level of the umbilicus to a large pouch which occupied the usual position of the cecum. This pouch extended beyond the median line and was closely attached to the bladder. It was rounded in out-

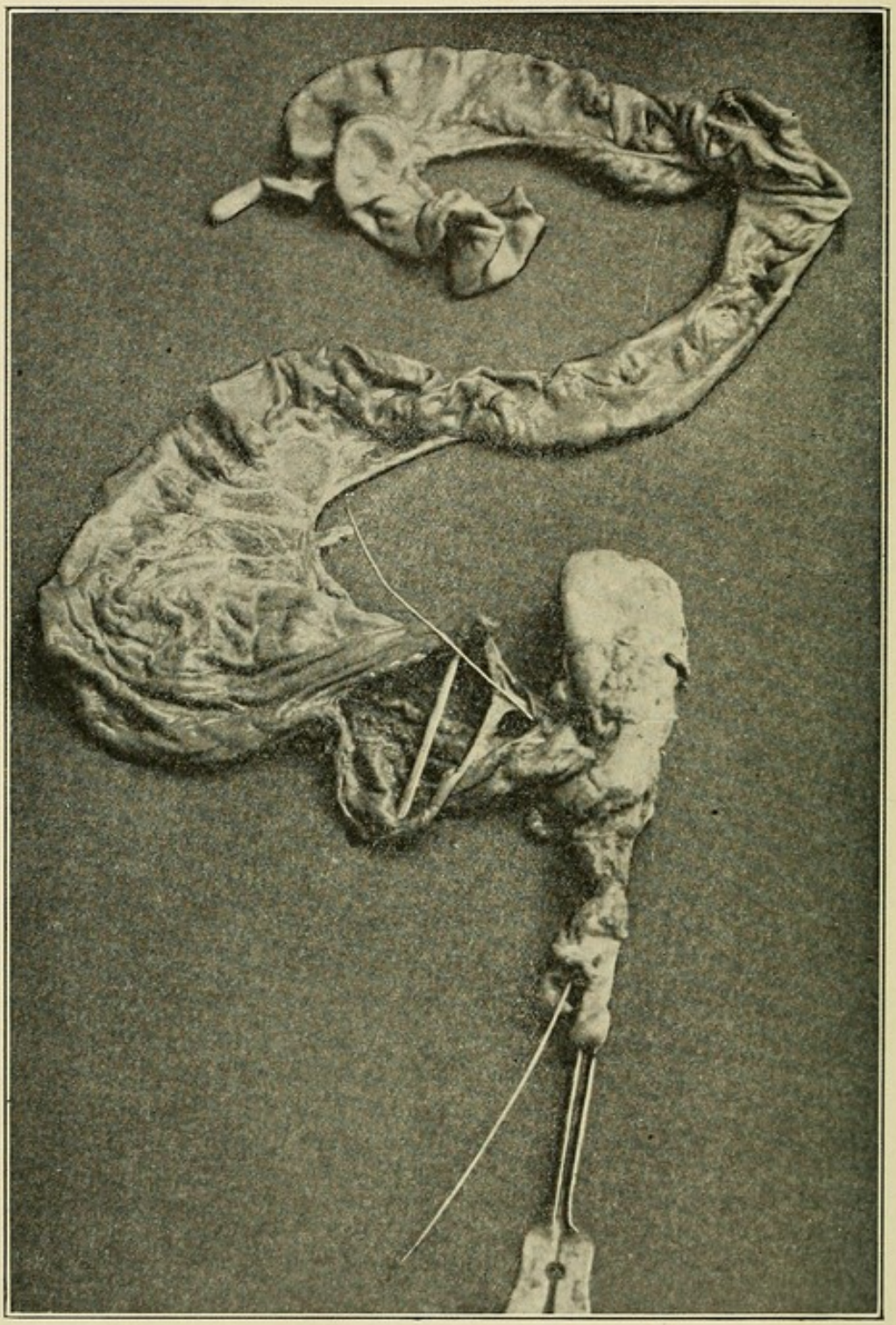


FIG. 225. MALFORMED BOWEL from the case shown in Fig. 224. The specimen is greatly shrunken by the preserve. The enormous pouch occupied the right hypogastrium and terminated in a minute sinus to the right of and posterior to the urethra. The grooved director is thrust through the urethra. The two probes mark the inner and outer openings of the sinus.

line but came to a funnel-shaped tapering end in proximity to the neck of the bladder at the right and posteriorly to the urethra. The funnel point extended toward the fistula in the scrotum and was doubtless continuous with it although too fine to be penetrated by a probe.

The fistulous opening in such cases, as indicated in the heading, may open at any point along the raphe of the perineum or scrotum under the prepuce, or about the symphisis pubis or elsewhere.

Symptoms.—The symptoms vary with the degree of occlusion. They may be those detailed under Species III, or are modified by the escape of meconium and gases through a sufficiently patent fistula.

Diagnosis.—The diagnosis is not difficult in view of the symptoms and the presence of a fistula which, if patulous, gives the surgeon a clue to the location of the rectal pouch.

Prognosis.—The prognosis in these cases as a class is more favorable than in complete occlusion without a sinus; for the reason that the sinus may afford a measure of relief from the obstruction by escape of intestinal contents, and also may guide the surgeon in his operation. Cases having a sufficiently large sinus may live out the expectancy of life without suffering greatly from their malformation. If the sinus is small, tortuous, or impenetrable, the case is scarcely better off than one of Species III.

Treatment.—If the fistulous opening is sufficiently large, or if it can be made so by dilatation, to afford escape of feces, the case may wait for a time. If the opening is not situated in a convenient location for a permanent anus, when the child is in good condition for operation an endeavor may be made to establish an anus in the perineal or sacral region, as before described. The fistula can subsequently be closed. If the fistula is too small to be of any use from the first as an anus, the case must be dealt with as one of complete occlusion, using the sinus if possible for sounding to ascertain the situation of the pouch and guiding it down into the pelvis.

Species VI.—The sixth species is the commonest of all. The varieties are sometimes named according to the point of termination of the rectal opening—as atresia ani vaginalis (Fig. 220), atresia ani vesicalis, atresia ani urethralis. By some pathologists this malformation is considered a tendency to reversion to the cloacal type of lower animals; but its occurrence is easily explained as an error in the differentiation of the genito-urinary from the intestinal portion of the tube which was early in embryonal life common to both.

Atresia ani vaginalis is the most frequently met of any variety of this species. The opening into the vagina may be large or small and may be located just within the fourchette.

Symptoms.—The symptoms will vary according to the size of the rectal outlet. There may be symptoms of a serious obstruction or there may be no symptoms at all to attract attention.

Diagnosis.—The diagnosis is readily made by noting that the anus is absent and that meconium or feces issue from the vaginal orifice.

Prognosis in this variety is favorable both as regards life, and the probability of successful correction of the malformation if this is necessary. It may cause no inconvenience of any consequence.

Treatment.—If the opening is large enough or can be somewhat dilated so that the malformation causes no discomfort, the patient may well be left to grow larger and stronger before operation is considered. Operation for correction of this malformation may be done by one of two principal methods. First, a sound suitably curved may be introduced through the vaginal opening into the rectum and directed in such a manner that its end is made to project near the normal site for the anus. This is then cut down upon from the outside, the rectum dissected loose, brought down into the perineal opening, incised, and the margins of the incision in the gut sutured to the margins of the skin incision. The fistulous opening into the vagina may subsequently be closed if necessary. Second, the malformation may be corrected by dissecting out the end of the rectum, together with its opening into the vagina, and transplanting it entirely into a new situation with the opening in the perineum (Rizzoli). The vaginal wound is then closed by sutures.

Atresia Ani Vesicalis (Fig. 221).—In this variety the rectum communicates with the bladder, by either a large or a small opening.

Symptoms.—In addition to the symptoms of obstruction already fully described under Species III, there is passage of urine mixed with meconium or fecal matter.

Diagnosis is made by absence of the anus, distension of abdomen, straining and other symptoms of intestinal occlusion and passage of urine mixed with fecal matter or meconium. Feces or meconium are not passed without urine.

Prognosis.—In this form of malformation one gives a very guarded prognosis. The fact that the rectum opens into the bladder, which in the infant is an abdominal organ, proves that the rectal pouch is situated very high. Inflammation of the bladder is sure to occur in time, or complete obstruction to supervene at any time the feces become bulky.

Treatment.—In a female infant dilatation of the urethra, and in a male infant dilatation with incision as in lithotomy, might give temporary relief from the obstruction, and these methods of treatment were formerly in use. Yet the relief afforded would only be

doubtful and temporary. A more effectual method should be undertaken. One might well hesitate between the infra-pelvic and the abdominal routes. If the infant were large and vigorous I would make an attempt by sacro-coccygotomy, reserving laparotomy as a last resort. But if the babe were less robust or in an exhausted condition I would attempt nothing more than an inguinal colostomy for immediate relief; and at a subsequent time, if exploration through the external fecal fistula gave promise of success, one could separate by ligatures the colon below the external fecal fistula from that portion connected with the bladder, causing the external fistula to become a permanent artificial anus, and the colon below it to become obliterated.

Atresia Ani Urethralis.—In this malformation the rectum communicates with some part of the urethra. (Fig. 222.)

Symptoms and Diagnosis are the same as with the previous variety excepting that meconium or feces is sometimes passed from the urethra without the admixture of urine, and between the times of urination.

Prognosis.—Prognosis is more unfavorable than in the previous variety so far as concerns danger from immediate obstruction; but rather better with regard to reaching the rectal pouch by the infra-pelvic route, for the pouch probably descends farther than in atresia ani vesicalis.

Treatment.—The treatment is perineo-coccygotomy or sacro-coccygotomy with the establishment if possible of an anus in that situation. Failing in this attempt, inguinal colostomy, followed by obliteration of the lower end of the colon with its urethral communication as suggested in the previous section.

Species VII.—The seventh species of this malformation does not endanger the life of the child and may be left to be dealt with when it is older and stronger and the parts are larger. If the ureters end in the bladder the condition would as well not be meddled with. If vagina or uterus open into the bladder, when the girl is larger the generative organs can probably be separated and the opening between them and the rectum closed successfully.

Species VIII.—This species, in which the rectum is entirely absent, might about as well have been classified as a variety of Species III, as it differs only in the amount of rectum that is wanting. Symptoms are the same as in Species III, and the diagnosis cannot be made until exploration by the sacro-coccygeal route fails to find the rectum. Treatment is by laparo-colotomy and the formation of a permanent artificial anus.

Species IX.—In the ninth species the symptoms are those of more or less obstruction, varying with the freedom of the outlet. The fistulous opening may, if necessary, be dilated or possibly trans-

planted, or an artificial anus formed in a more advantageous situation. But usually there is little to be done for these cases beyond securing a free outlet for feces.

PROLAPSUS OF THE RECTUM

This is a very common affection in infancy and especially in childhood, and is sometimes quite troublesome. It consists in a protrusion of the lower portion of the rectum through the anus. The protruded portion may consist only of the mucous lining of the lower portion of the rectum; or of the entire thickness of the walls of the rectum. Sometimes a third variety is described in which the upper portion of the rectum is invaginated into the lower and protrudes at the anus; but this is really a variety of intussusception, and should not be classed with prolapsus. The large size of the rectum and its straightness, together with the looseness of its mucous and submucous tissues, and especially the straightness of the coccyx, undoubtedly act as predisposing causes of prolapsus. Also malnutrition, and any acute or chronic condition which lowers the muscular tone, favoring relaxation of the sphincters and levators; also lack of adipose tissue. As exciting causes may be mentioned anything which excites tenesmus, such as diarrhea, especially dysentery, or constipation, or mere frequency of defecation, or rectal polypus, the oxyuris, phimosis, or a narrow urethral orifice, vesical calculus, or violent or prolonged straining with the sphincter involuntarily relaxed as occurs in the paroxysms of whooping-cough; or the congestion of the hemorrhoidal vessels and the prolonged bearing down that occur when predisposed children are allowed to sit a long time on the nursery chair or a chamber-vessel in a position that favors straining.

Symptoms.—The characteristic symptom is the protrusion at the anus of a purplish-red mass covered with swollen mucous membrane, during or after defecation, urination, or a paroxysm of coughing, or sometimes, in bad cases, when none of these have taken place. Usually there is no complaint of pain, and often the projection disappears as soon as the child ceases straining or stands up. The protrusion may be only a slight ring at the margin of the anus, or it may be a mass of the size of the child's fist and extend an inch or more. Cases of ulceration, even of sloughing, of peritonitis and death from this same cause have been reported, but such have never come under my care.

Diagnosis.—The diagnosis is very readily made if one sees the protrusion, and it can be made without difficulty from the history and an examination without seeing the protrusion. The conditions which could be confounded with prolapsus of the rectum are hemorrhoids, polypus, intussusception, and nevus. Hemorrhoids are ex-

tremely rare in children, while prolapsus is common. Polypus could be recognized by its globular pedunculated form, if seen when prolapsed or if felt with the finger within the rectum. Intussusception gives a different history; but even if the history was indefinite the two conditions could be differentiated by examination when the tumor projected at the anus. Both present a purplish mass covered with the rugous mucous membrane very much congested, and both have a central opening at the apex of the mass. But with the intussusception one can introduce a finger between the tumor and the anal margin and sweep it entirely around between the tumor and the sphincter or rectal lining. With prolapsus the tumor merges into the anal margin itself. Nevus located just within the rectum or at the ano-rectal margin I have known to be mistaken for prolapsus and for hemorrhoids, and again to be complicated with prolapsus which it probably helped to produce. Nevus would usually be differentiated if borne in mind during the examination.

Treatment.—The treatment of a prolapsing rectum during the prolapsus is to immediately return the protrusion within the sphincter. This can generally be done in a moment by laying the patient on his side, or across one's knees and gently pressing the entire mass in with the fingers. A soft towel or napkin, wet with water or well smeared with vaseline, placed next to the mass while pressure is made, facilitates the procedure. To push up the central portion of the protrusion first makes it recede more easily. Difficulty is seldom experienced unless the bowel has been out a long time and become inflamed and the sphincter very tight. If necessary an anesthetic could be employed. After the reduction the anus should be covered with a muslin pad held by a T bandage and the child kept recumbent for an hour or so. Means must now be instituted to prevent the recurrence of the prolapse. The cause of straining, whatever it is—calculus, phimosis, constipation, over-feeding, bad feeding, worms, polypus—is to be removed. The child should never be allowed to sit and strain at stool. He should be required to defecate while in the recumbent position; or in some mild cases the mother or nurse may hold the child in her hands, one hand under each buttock, and drawing the skin across the anus upon one side. In some cases it may be necessary for the child to wear a T bandage and compress continuously, or a wide strip of adhesive plaster across the nates, squeezing them together and so supporting the anus. Enemata of astringent solutions, such as a drachm of tannic acid or of the dark fluid extract of witch-hazel or of alum, to 4 ounces of water, may be employed daily when the mucous lining is relaxed. Enemata of cold water, even ice water, an ounce or two at a time, have a tonic effect. Astringent suppositories have been recommended, but their effect is too narrowly localized to be of much use

unless they are quite powerful, and then the effect is difficult to gauge. Suppositories of nux vomica and ergot are also recommended. One would prefer to use the nux vomica internally in suitable doses as a tonic. For this purpose it is especially useful in debilitated children with relaxed musculature. Some use hypodermics of strychnia locally once or twice daily.

Operative measures for the cure of rectal prolapse by amputation of the projecting portion, or by clamp and cautery, or by colopexy, or by Verneuil's operation of exposing the rectum posteriorly beneath the coccyx and narrowing its lumen, are not needed in children. It is extremely seldom that any severe treatment is necessary. In chronic and obstinate cases cauterization with nitric acid, of the portion of mucous membrane usually protruded, is recommended by good authority. The directions given are, to paint the whole surface of the mucous membrane with a swab dipped in nitric acid, apply a plug of oiled cotton or gauze and reduce the whole into the rectum. I do not like to cauterize and consequently scar so heroically, such a large area of the mucous lining; and have succeeded in getting a satisfactory effect by drying the mucous lining carefully with gauze sponges and drawing the glass rod or very narrow cotton-wrapped applicator dipped in the nitric acid, in longitudinal lines upon the mucous protrusion, ending below within the muco-cutaneous margin, leaving a half-inch or more of untouched surface between each two lines. Sometimes only two or three lines of cauterization are enough. The point of the Paquelin cautery is convenient to use, and efficient, making lines about $\frac{3}{4}$ of an inch apart. Power dissects off a spiral strip of mucous membrane, not going deeply, lest hemorrhage occur. One would prefer this to extensive cauterization. Of course, for any of these procedures, the bowels must be previously emptied and irrigated, and an anesthetic be used. An opium and belladonna suppository after the operation will quiet the pain. A suppository containing $\frac{1}{4}$ of a grain to a grain of cocaine will quiet the pain more promptly.

NEVUS OF THE RECTUM

Nevus of the rectum has been reported in rare cases. It presents the spongy compressible and erectile characteristics of nevus upon the skin, its surface modified by the covering of mucous membrane. It is troublesome by its bulk and tendency to produce straining, or by hemorrhage that takes place when it is ulcerated. The diagnosis from hemorrhoids is made by the circumscribed form of the latter.

Treatment.—Treatment is by the galvanic needles or by the Paquelin cautery. The treatment by ligature, injections of iron or other astringent, and the like, are no longer in use for nevus in

any situation and would be extremely awkward as well as dangerous in the rectum. The galvanic needles are not only safe but convenient. The Paquelin is more rapidly used upon a large nevus. Treatment by injection of scalding hot sterile water, which is a very efficient means upon nevi elsewhere, I have not had an opportunity to try in nevus of the rectum, but shall do so. (See also Angioma in Chapter on Tumors.)

POLYPUS OF THE RECTUM

This is not uncommon in children. It may be a myxoma, an adenoma, or a fibroma, or more often a combination of various histological elements. (See also Myxoma in the Chapter on Tumors.)

The tumors are single or multiple, occasionally disseminated. They are generally pedunculated, and attached anywhere from just within the sphincter to a finger-length higher in the rectum. They vary in size from that of a pea to that of a cherry, and are red in color unless protruded through the anus and strangulated by the sphincter.

Symptoms and Diagnosis.—The symptoms are the urging to go to stool, passing of blood and sometimes mucus, tenesmus, sometimes but not always pain from traction upon the pedicle during straining. The diagnosis is easy if the polypus protrude from the anus, and is not at all difficult if digital examination of the rectum be made in a case presenting bloody stools, fullness in the rectum, tenesmus, fissure or prolapse; yet many a case of polypus has been overlooked. The rectum should be empty when examined. The polypus is often so soft and glairy that it eludes the finger; but by passing the finger laterally or spirally the pedicle will be caught.

Treatment.—Spontaneous cure sometimes occurs by the tearing loose of the polypus during defecation. One has known this to occur in more than one case. But it is wrong to allow the child to be annoyed or suffer from a polypus in the rectum when it can be removed so easily. Some advise merely seizing the pedicle with a forceps and twisting or pulling or cutting it off. But troublesome hemorrhage may occur and it is much better and takes but a short time (the child being placed under an anesthetic and the rectum dilated) to pass a silk ligature about the pedicle close to its base before snipping it off. One should be sure to search for more than one growth, and remove all.

BILHARZIA ADENOMATA OF THE RECTUM

This disease I have never seen, but frequent communication with the tropics may bring cases to our country at any time, or something similar may be found if searched for in connection with other va-

rieties of flukes in our Southern States. D'Arcy Power mentions a variety of multiple rectal adenomata occurring in children in Egypt, according to Dr. Mackie of Alexandria, as a result of irritation produced by the ova of the Bilharzia hæmatobia. The tumors are fibro-adenomata and are very vascular. The tissue of the tumors contains an abundance of fertilized eggs ready to be hatched and disseminate the flukes by the blood stream.

Symptoms.—The symptoms are rectal tenesmus and bleeding, with diarrhea. The urine contains bilharzia and is sometimes also bloody. The disease is chronic, and finally fatal by anemia and exhaustion.

Diagnosis.—Rectal examination reveals the tumors, and when the urine is examined the diagnosis is made.

Treatment is prophylactic. The disease affects the blood-vessels of the whole genito-urinary tract and local treatment is unavailing.

PROCTITIS

Proctitis or inflammation of the rectum may occur with colitis or alone. It is only when the rectum alone is involved that the above name is applied.

Etiology.—The cause is usually local irritation or infection. A common cause is the use of suppositories of glycerine or of soap for constipation in babies or young children. Injections used for the same purpose are a less frequent cause, as is also the awkward use of the syringe. Proctitis may be caused by pinworms. I have once seen a severe case caused by the ill-advised use of a strong solution of mercuric bichloride for the purpose of eradicating pinworms. Impaction of the rectum with hardened feces will sometimes excite inflammation, though it is astonishing what a degree of abuse the rectum will endure from this cause without becoming inflamed. Gonorrhea or syphilis may appear in the rectum. Children afflicted with various infections, particularly those infections partial to mucous membranes, as measles, scarlet fever, and diphtheria, are prone to be attacked either simultaneously or subsequently with an inflammation of the rectum.

Pathology.—Proctitis may be acute or chronic, and, varying with the cause and stage of the inflammation, the pathologic condition may present considerable differences. It may be that of a simple catarrhal inflammation, with swelling and redness of the mucous lining, which is hypersensitive, bleeds readily and secretes an abundance of mucus. Or in addition to the symptoms mentioned there may be a pseudo-membranous exudation from the inflamed base. Or ulcers may form, either follicular and multiple, or a single ulcer. Ulceration may be superficial or deep and irregular or regular in shape.

Symptoms and Diagnosis.—There are usually frequent movements of the bowels ejected spasmodically, or at least there are attempts at defecation with a great deal of tenesmus. There is pain in the acute cases indicated by verbal plaints in older children or crying and whining in infants. Several times a day the stool may contain a considerable amount of fecal matter, but more frequently there is only mucus or muco-pus, often blood-stained; or if ulceration is present, blood in larger or sometimes even quite large quantities in the aggregate. In the pseudo-membranous cases, by washing the stools, fragments of the false membrane may be found. Prolapse of the rectum may occur from the frequent and violent straining. The general condition suffers. The child becomes more or less pale, emaciated, and prostrated. The condition of the rectal lining may be judged by inspection of the exposed portion when prolapsus occurs, or, better, by examination through a speculum. It is impossible to detect any ordinary ulceration or form a satisfactory opinion upon the condition by digital examination alone. The symptoms most nearly resemble those of colitis or ileo-colitis, but at times the stools are quite normal and there is absence of tenderness over the colon. Microscopical examination should be made if diphtheria or gonorrhea are suspected. Probably very few of the cases presenting pseudo-membrane are really diphtheritic. (See Section on Diphtheria.) Tuberculous ulceration is very rare in children.

Treatment.—A case of any severity should be kept in bed. Rest in the horizontal position is a great help. Any discoverable cause should be removed. In the slight catarrhal cases this is all that is required. Usually free irrigation with normal salt solution is beneficial, cleansing the surface and relieving the tenesmus. It is well to follow this with an injection of an ounce or a few ounces of starch water, or olive oil and lime water equal parts, or sometimes by creamy starch water in which bismuth subcarbonate has been suspended, or a dose of tincture of opium mixed. An attempt should be made to hold such an injection within the rectum for a time.

In the cases with an excessive mucous secretion, and in the pseudo-membranous cases, solutions of boric acid are beneficial, if used two or three times a day. In gonorrheal cases it may be needed many times a day, and also a solution of argyrol, 5 to 10 per cent., applied with a swab through a speculum. In gonorrheal, in ulcerative, and even in some cases of obstinate chronic catarrhal inflammation, an excellent remedy is nitrate of silver, one grain to the ounce. It is best applied through a glass speculum after flushing out the rectum with plain water, and following the silver nitrate in a minute with an irrigation of normal salt solution. In some

cases two grains to the ounce of silver nitrate may be used with a swab, followed promptly by the saline flushing to neutralize the excess. All cases of rectal ulcer are best treated with a speculum, at least at intervals of a few days, irrigation and the like being employed daily. Through the speculum the ulcer may be touched with pure carbolic acid or a solution of silver nitrate, ten or even twenty grains to the ounce, or even with the mitigated stick. Any excess of the acid should be neutralized with alcohol, and of the silver salt with sodium chloride.

In all cases of proctitis the patient's diet should be carefully regulated, and should be ample to keep up his nutrition without unnecessary residue.

SYPHILIS OF THE RECTUM AND ANUS

Lesions of hereditary syphilis are seldom found within the rectum, although gummatous infiltrations of the intestinal coats are occasionally reported. But syphilitic lesions externally about the anus are comparatively common. Erythema is doubtless most common. Cracks or fissures at the mucous margin of the anus and radiating from it into the skin are common enough, and characteristic. Moist papules and confluent groups of these, or mucous patches, and condylomata are sometimes found in luetic subjects.

Treatment.—Lesions in the rectum should be treated locally as directed under proctitis, and also receive mercury and iodide of potassium. The external manifestations should be treated by dusting them with equal parts of calomel and zinc oxide, or touching the patches with silver nitrate. The patient should, of course, also have the anti-syphilitic treatment internally.

VEGETATIONS OR WARTS ABOUT THE ANUS

These should be mentioned in this connection, as they are by no means always of syphilitic origin. They may be simple papillomata covered with squamous epithelium, like warts upon any other part of the body. From the moisture of this situation they are apt to grow rapidly and to swell to considerable size. If kept dry and dusted with an astringent powder, such as oxide of zinc and boric acid equal parts, or these two with lycopodium equal parts, they shrivel to half the size and may disappear. Sometimes they can be ligated and left to drop off; or touched with silver nitrate. Or if many and troublesome the galvanic needle will remove them without hemorrhage; or they may be snipped off with scissors and the bleeding stopped by touching with the Paquelin cautery point.

FISTULA IN ANO

Fistula in ano consists in an abnormal sinus or suppurating track leading from the rectum to the skin surface, in which case it is called a complete fistula; or if the track is open only at one end and either fails to communicate with the rectum or with the external surface it is called an incomplete fistula. Sometimes the incomplete varieties are spoken of as "blind internal" or "blind external" fistula, according to the situation of the opening; and sometimes we hear of "horseshoe fistula," etc., which only draws attention to the fact that a fistula can be very crooked and have more than one opening either outside or inside. Fistula is usually considered an affection of adult life and yet it is not so very rare in children (Allingham, Wharton), and Matthews records a case in an infant three weeks old in which he thought it congenital.

Etiology.—The common cause of fistula is abscess, which opens either externally or internally or both. It may take its origin in a wound, or, it is said, in an ulcer of the rectal mucous membrane. Matthews denies that it ever starts in any other way than in abscess.

Symptoms and Diagnosis.—Tenesmus or pain may possibly be complained of, especially in the "blind internal" variety, which has no outlet externally. But in the complete or the "blind external" varieties often it is the discharge which stains the clothing and leads to examination, when the small opening may be discovered.

If the probe be passed into the external opening and a finger passed within the anus the two may find the internal opening if one exists. If there is no external opening it may be impossible for the finger to find the internal orifice. But possibly a line or a mass of indurated tissue may be palpable either internally or externally or both, indicating the situation of the fistulous tract. With a speculum, pus may be seen exuding from the internal orifice, or pus may be found in the stool.

Treatment.—Treatment is the same as in the adult. The fistula, including all its possible branches and pockets, is laid open from one end to the other and allowed to heal from the bottom by granulation. To be more explicit: The patient is prepared by thoroughly emptying the bowels with laxatives on the day before the operation and also on the morning of the operation, early, and again before going to the operating room, with enemata. He is anesthetized. A probe, curved as necessary, followed by a grooved director, is inserted at the external or the internal opening of the fistula, as the case may be. The grooved director traverses the entire length of the fistula, or as much of it as possible, and both ends of the director are brought out of the anus. A knife is passed along the groove of

the director, severing the tissues. Careful search is made with a fine probe along the track laid open, and just beneath the margin of the mucous end of the cut, and again beneath the margin of the skin opening, for any branch sinus leading in any direction. All sinuses or pockets when found are laid open in the same manner. The edges of the skin orifice are trimmed off, the suppurating track of the fistula scraped out with a sharp spoon. The wound is washed out and packed with iodoform or cyanide gauze and a compress and T bandage applied. The bowels are confined with opium for two days, when the first dressing is made. The packing is thoroughly saturated with hot normal saline solution before its removal. The bowels are moved by enema if necessary, the wound irrigated and repacked, and the bandage reapplied. The dressings are continued until the wound granulates up from the bottom to the surface and the skin covers it.

FISSURE OF THE ANUS

Fissure of the anus is an affection by no means uncommon in children and even in infants. (Allingham, Jacobi, Curling, Wharton.) I believe that if more of the children said to be constipated, but who really refuse to try to defecate, were properly examined, more cases of fissure would be discovered and a few more of hemorrhoids. The child suffers pain during and more especially after defecation and learns to dread to go to stool. The fissure is a small, narrow, linear ulcer in the mucous membrane of the anus. It is hidden at the bottom of one of the small wrinkles that radiate from the opening and are rendered deeper by the strong contraction of the sphincter that exists in these cases, especially when one attempts an examination.

Symptoms and Diagnosis.—The diagnosis is made from the pain that is experienced during defecation and especially for a minute or sometimes quite a while after defecation, and upon inspection. The pain is sometimes severe, resembling that of vesical calculus upon urination, but in other cases is not so well marked and only occasions fretfulness or slight crying. Upon inspection the fissure is so small and concealed that it may be overlooked unless searched for. There may be slight bleeding after defecation which, with the pain, may lead to a suspicion of rectal polypus. Polypus and fissure may co-exist, in which case one or the other is apt to be overlooked.

Treatment.—Divulsion of the sphincter or incision is scarcely ever necessary in fissure of the anus in a child. But in some children it may be necessary to give an anesthetic to make a proper application. The mucous membrane should be stretched so as to expose the fissure, which should be cleansed and then penciled with a solution of silver nitrate, twenty grains to the ounce, or the solid stick of silver nitrate, and then well smeared with an ointment of iodoform in

vaseline, or, if the odor is objectionable, with boracic ointment or zinc ointment, which are not as good. The parts should be kept well coated with the ointment for several days, and the diet and bowels regulated.

HEMORRHOIDS

Hemmorrhoids are very uncommon in children, yet cases of both the internal and external varieties have been reported. One has met them a number of times, the external being more usual. They are invariably accompanied by and apparently the result of chronic constipation. The symptoms are the same but less pronounced than in the adult. Treatment is directed toward the cure of constipation. Locally, during the hemorrhoidal attack, the application of hot water, especially if it be directed against the piles in a jet from a fountain syringe, greatly relieves the pain and soreness. Lead and opium wash may be applied hot on a gauze compress. Suppositories containing belladonna and one-fourth to one grain of cocaine are useful. The rectum should be kept empty. Just before each defecation half a pint or a pint of flaxseed tea, which is like thin mucilage, with common salt a drachm to the pint, should be injected. This protects and lubricates the mucous membrane and causes an easy passage. This simple line of treatment I have found very satisfactory, relieving the trouble promptly. While adults seldom recover permanently without operation, children usually do.

ISCHIO-RECTAL ABSCESS

Ischio-rectal abscess is an inflammation with pus formation in the cellular tissues in the neighborhood of the rectum. It results from injury, such as a fall or a blow or a punctured wound, perhaps even from the pressure of fecal masses in the rectum or from straining at stool. Perforating ulceration of the rectum is set down as a cause, which must be a rare one, deep ulceration of the rectum being unusual in children. But an ulcer may serve as an infection atrium. No doubt many cases, probably the majority, have their origin in infection through the lymph channels in connection with the mucous lining of the rectum, without demonstrable ulceration. Foreign body, may, in rare cases, act as a cause. The symptoms are tenderness, pain, swelling, fever, local redness. The tenderness and pain are quite severe. The swelling may, after some days, be evident externally and become quite tense and brawny, and, if allowed to go on, may fluctuate and finally open; or it may not be prominent externally, but bulge within the rectum. There is not so much of a tendency in children as in adults for ischio-rectal abscess to become chronic or to cause fistula, yet occasionally fistula results. (See Section on Fistula in Ano.)

Treatment.—As soon as abscess can be demonstrated it should be opened by incision. An anesthetic should be used, as the inflamed parts are extremely sensitive, and the opening should be made carefully and thoroughly, and not hurriedly. Unless one waits until the abscess is approaching the surface, which he should not do, as it entails needless suffering and breaking down of tissue, and may cause fistula, it may be necessary to find the abscess at a little depth. The usual direction given is to thrust in the knife and make the incision in a direction radiating from the outer margin of the sphincter, or to make a crucial incision. Matthews insists on having the incision parallel with the sphincter, so that contraction of the sphincter tends to keep the wound open. The essential points are: Free opening of abscess and all loculi, washing out with hot bichloride solution, 1 to 2000, packing with iodoform or cyanide gauze, an outside antiseptic pad; after two days, reirrigation and packing, and so on until healed by granulation from the bottom.

MARGINAL ABSCESS

Marginal abscess is a circumscribed inflammation at the margin of the anus. It starts from infection of an abrasion or excoriation or fissure, or from a mucous follicle. It never extends deeply and when lanced and dressed with carbolized vaseline it soon heals.

FOREIGN BODIES AND IMPACTIONS

Foreign bodies may be accidentally or mischievously introduced into the rectum *per anum,* or, descending from the bowel, may lodge there. They may or may not be embedded in fæcal matter. Prune stones and other seeds, meat bones, fish bones, coins, buttons, irregular shaped articles, or enteroliths may be found. The symptoms are pain, tenesmus, sometimes bloody discharge, not always constipation. They may be readily removed by finger or forceps or spoon handle; or may require anesthesia and the use of specula and other instruments or even a posterior proctotomy for their removal.

INEFFICIENCY OF THE SPHINCTER ANI

Idiotic children and imbeciles may fail to control their dejections. These cases are in a class by themselves. There is no permanent help for them other than general management and training. Or the cause of the fæcal incontinence may lie in some other form of nervous disorder, as in spina bifida, injury to the lumbar spine, myelitis, and meningitis; in the extreme general relaxation which follows any exhausting disease; or in local over-strain such as comes from tenesmus with repeated rectal prolapse, the protusion of a tumor, or the like. Or it may result from accidental injury to the sphincter, or from a surgical operation. Obviously the prognosis and treatment must vary with the cause.

CHAPTER XXIV

THE GENITO-URINARY ORGANS

The Kidneys; Normal Anatomy, and Malformations—Floating Kidney—Injuries of the Kidney—Perinephritis and Pyo-Perinephritis — Hydronephrosis and Hydroperinephrosis—Renal Calculus—Tubercular Nephritis—Tumors of the Kidney—Extroversion of the Bladder (Ectopia Vesicae)—Tumors of the Bladder—Stone in the Bladder—Calculus in the Urethra, Foreign Body in the Urethra or in the Bladder—Rupture of the Urethra—Epispadias—Hypospadias—Adherent Prepuce—Phimosis—Paraphimosis—Other Constrictions of the Penis—Dislocation of the Penis—Balanitis—Urethritis—Undescended Testis, and Misplaced and Hidden Testis—Supernumerary Testis—Tumors of the Testis—Orchitis—Torsion of the Spermatic Cord—Varicocele—Tuberculosis of the Testicle and of the Epididymis—Syphilitic Testitis—Hydrocele in the Male—Cyst of the Spermatic Cord—Misplacement of Ovaries—Ovarian Tumors—Adhesion of the Labia Minora—Adhesion of the Clitoris and Its Prepuce—Prolapse of the Female Urethra—Vulvitis—Vulvo-Vaginitis, Simple and Specific.

THE KIDNEYS; NORMAL ANATOMY, AND MALFORMATIONS

The situation of the kidneys in the new-born is from the level of the disc between the twelfth dorsal and first lumbar vertebræ to that between the third and fourth lumbar vertebræ. It is generally stated that the left kidney is longer than the right, and that the right is placed at a lower level than the left, presumably on account of the large amount of room needed by the liver upon the right side. But Ballantyne does not find this true in the infant, neither as regards the size nor the position. He finds the right kidney measuring about 3.8 centimetres vertically and the left about 3.5 centimetres. The greatest antero-posterior diameter is from 1.5 to 1.8 centimetres, and the greatest transverse about 2.3 centimetres. Thus the right and not the left is the longer. The position on the two sides is the same. The hilus corresponds to the level of the second lumbar vertebra, and the lower end of each kidney is only a few millimetres from the crest of the ilium.

The suprarenal capsule is large in infancy, being about one-third the size of the kidney, upon the upper end of which it rests like a pyramidal cap. It covers more of the kidney in front than behind.

The muscular walls covering the kidneys postero-laterally are but thin and poorly developed in the infant and young child and afford but slight protection from a blow or a crushing force. The kidneys are more lobulated than in older persons, but not so much so as in the fetal state. In some instances exaggerated lobulation, resembling that of the fetal state or even more distinctly marked, exists as a malformation. Again, there is absence of one kidney, or it is diminutive, while the other one is of extra size and probably of unsymmetrical shape. In some cases single kidney has been associated with malformation of some part of the generative organs. Another malformation is known as the horseshoe kidney. In this either the upper or lower ends of the kidneys are connected together by a continuation of kidney tissue, so that the whole organ, composed of both kidneys and the bridge between them, takes a shape resembling a horseshoe. Other forms of fusion may occur. The kidneys are sometimes found fixed in anomalous positions; or loose in their normal attachments and more or less movable from the normal position. Kidneys that are abnormal in shape are more likely to become diseased; and are also more likely to be found in an abnormal position.

FLOATING KIDNEY

Floating kidney is an affection not at all common in children. Yet now and again cases are reported. When found in children it has been more frequent in older girls approaching adolescence, and the right kidney rather than the left. If the cause is congenitally lengthened peritoneal attachments of the kidney, real meso-nephron, as some aver, it would seem there ought to be more cases discovered in childhood. Among the other causes of movable kidney are mentioned tight lacing, relaxed abdominal walls following pregnancy or from debility, emaciation removing the adipose "packing" about the kidney, increased vascularity during the menstrual period, violent descent of the diaphragm as in vomiting, violent physical exertion, and asthmatic attacks, none of which, excepting physical exertion and vomiting, pertain to childhood.

Symptoms and Diagnosis.—The symptoms are of several groups, local, psychic and reflex, and referable to the function of the kidneys. Among the local symptoms are pain and feeling of weight, burning and tearing sensations, referred to the lumbar region, or sometimes to the loin, groin, and thigh. Among the psychic, hypochondria; while the reflex often takes the form of digestive disorder. Kidney

function often shows disturbance by suppression of urine, hematuria or albuminuria. Physical examination may reveal that the kidney is absent from its normal situation; and with the patient lying on the back, thighs flexed and abdominal muscles relaxed, with one hand of the examiner behind the kidney and one in front, the kidney may be palpated, and may be felt to make an excursion upward and downward with each respiratory act. In some cases it can be lifted from its bed and moved about or restored to its normal situation when displaced.

Not every kidney which can be moved should be called a floating kidney, but only such as can be freely moved about. If there is difficulty in distinguishing between spleen and left kidney it is well to remember not only that the spleen has its notch but that the colon lies between the two organs, and by distending it with air the tympanitic area between spleen and kidney can be demonstrated. In the adult a distended gall-bladder and the kidney may be confounded, but in the child enlargement of the gall-bladder to such an extent may be ruled out. There may be hydated cyst connected with the liver even in a young child.

Treatment.—The kidney should be replaced and supported in its normal position by a broad bandage furnished with a pad to make pressure upon the proper spot in front of the abdomen. If hematuria or albuminuria or suppression of urine supervene, the patient should be confined to bed, and a good part of the time in the dorsal decubitus, till the symptoms pass off. If notwithstanding these palliative measures the symptoms are too troublesome, the operation of nephropexy must be resorted to.

INJURIES OF THE KIDNEY

Owing to the thinness of the muscles and ribs covering it, and the lack of fat surrounding it, also to the frailness of the whole body of the child, the kidney is very easily injured by a blow or kick or by the passage of a carriage wheel, or by a fall, or by similar violence.

Pathology.—Contusions and crushes form by far the greatest number of injuries to the kidney. These may vary greatly in degree and extent, from a slight bruising to a pulpifying of a part or the whole of a kidney, or a laceration, or a bursting of the organ by pressure. The outer or the inner portion of the viscus may suffer most so that hemorrhage may take place beneath the capsule, or, if that is lacerated, the blood may collect in the cellular tissue surrounding the kidney. Or hemorrhage may take place only within the pelvis of the organ, or both blood and urine may escape into perirenal tissue.

The more remote results of contusions and crushes of the kidney are: nephritis, perhaps going on to abscess; pyonephrosis, perinephritis, pyo-perinephritis or perinephric abscess, hydro-nephrosis, hydro-perinephrosis.

Symptoms and Course.—Following an injury at all serious to the kidney, there is shock, but less than after injury of other internal organs; pain which may be referred to either the renal region or to the abdomen, testicle, or even to the thigh. Inspection may reveal a local mark, bruise or other external evidence of injury; but serious injury may be inflicted upon the kidney without leaving any external trace. There may be local tenderness or this may not appear until resulting inflammation has supervened, when there will be also fever, tension, increased pain, perhaps edema in the renal region, and distension of the abdomen. Hematuria following violence inflicted upon the kidney region neither proves nor disproves serious injury to that organ. Severe bruising, laceration or even rupture of the kidney may occur without causing bloody urine. The hemorrhage may take place outside the kidney. Or, if hemorrhage takes place into the pelvis of the kidney, the clotting of the blood may plug the ureter and so prevent the passage of bloody urine.

Hematuria after injury may appear at once, or not until after several days, or be continuous or intermittent as clot in the pelvis allows it to pass, or as clots make their escape through the ureter, with pain like the passage of renal calculus. Or clot may plug the urethra at the neck of the bladder and so prevent the passage of bloody urine or cause it to be passed spasmodically or intermittently with frequent urgent attempts and pains like those of vesical calculus. Simple congestion of the kidney from a jar or slight bruise may give rise to hematuria without any visible solution of continuity.

Penetrating and incised wounds, while less frequent than contusions or crushes, are occasionally met with, and give rise to symptoms similar to those previously described, to which may be added external hemorrhage and discharge of urine in some cases. But external hemorrhage is not invariable, nor does the absence of urine from the discharges of the wound make it certain that the kidney has not been injured. Hemorrhage is usually more severe in incised or stab wounds than in lacerations, but it may be concealed internally, and the probability of the peritoneum having been injured should always be thought of. The kidney, either injured or uninjured in its substance, may be torn from its bed, or even in extensive laceration of the loin made to protrude through the parietes.

Diagnosis.—The diagnosis is made upon the following train of symptoms: A child receives some violence in the lumbar region or has a fall by which the body is severely bent. There is shock followed by pain and perhaps vomiting. Soon, or in a day or two after

the accident, there is bloody urine which gradually diminishes or is intermittent for several days or a week. In such a case the presumption is strong that a moderate contusion or even a laceration of the kidney had taken place. But if in addition to these symptoms extreme tenderness and a dull tumefaction appear in the renal region and over that side of the abdomen with fixation of the adjacent muscles, with pain and retraction of the testicle or agony in the groin, with frequent desire to micturate and a hard pulse and rising fever, one would make a diagnosis of a ruptured kidney.

Symptoms of injury to the kidney may be strangely delayed even for days in their appearance; and after a history of injury in this region, with or without the appearance of any of the symptoms of injury, one should be very cautious about dismissing the case as sound. Not merely days but weeks may elapse before symptoms of hydro-nephrosis, or other result, may manifest itself. In cases accompanied by external wound the diagnosis may be easier judging from the extent and direction of the wound.

Prognosis.—The kidney is tolerant of moderate injury, and recovery not only of the patient but of the usefulness of the organ is expected in slight contusions and even in lacerations. Injury to the cortex of the kidney may occasion sharp but not necessarily dangerous hemorrhage, but wound into the renal artery or vein leads to furious hemorrhage. The prognosis often turns upon the point whether the peritoneum as well as the kidney is sufficiently injured to become inflamed. And much depends upon the treatment; whether, for instance, in case of extensive injury the loin is incised and the hemorrhage controlled, or whether, abscess forming, it is relieved by lumbar incision and drainage.

Punctured and incised wounds present their usual dangers, both of hemorrhage, either external or concealed, and of infection; but they are not on the whole more serious than injuries of the kidney without external wound. The external wound may even be turned to advantage as a drain, and renal fistula is not likely to persist.

Treatment.—In the treatment of injuries of the kidney, stimulants should be carefully avoided and absolute rest in bed enjoined. The side or the side and abdomen should be strapped or bandaged, laxatives avoided, and vomiting, if present, controlled, and no bulky food allowed. The strapping promotes rest, and also tends to control hemorrhage by pressure. Even several days after the injury hemorrhage may supervene, or, having been checked, may return by moving, coughing, straining at stool or the like. Pain also is relieved by the strapping and rest, but anodynes, too, may be needed. In hematuria or suspected internal hemorrhage, ergot or gallic acid are advised. If extensive internal hemorrhage or extravasation of urine are evident, nothing will avail but lumbar

incision to evacuate the fluids, and, if necessary, control the hemorrhage. Hemorrhage from the substance of the kidney can generally be controlled by pressure or packing, but clamp or ligatures are necessary for the renal vessels. Nephrectomy should not be thought of at this time unless hemorrhage is otherwise uncontrollable, but the kidney should be given a chance to recover its usefulness.

PERINEPHRITIS AND PYO-PERINEPHRITIS

An inflammation of the cellular and adipose tissues enveloping the kidney is called perinephritis. If the inflammation goes on to suppuration we have a condition which may be named pyo-perinephritis. It has usually been described under the term perinephric abscess.

Pathology.—The inflammation may involve only a small or a large area. It may involve the perinephric tissues alone, or the kidney also. There may be several small abscesses or a larger one, and there may or may not be any opening between the pelvis of the kidney and the abscess cavity outside the kidney.

Causation.—Perinephritis and pyo-perinephritis may be traumatic or idiopathic in origin. They may originate outside of the kidney, or within the organ and then extend outward. Calculus is a very common cause of the disease when beginning within the kidney. Spinal caries is an example of another very common cause lying outside of the organ. Empyema burrowing downward, appendicitis extending upward, may excite a perinephritis. Inflammation from either traumatic or other pathologic cause may extend from bladder, ureter, testicle, spermatic cord, anal region, or rectum. Tubercle, sarcoma, carcinoma, cyst, hydatids, nephritis, or pyelo-nephritis from whatever cause may give rise to an inflammation resulting in suppuration in perinephric tissues. The effects of phimosis and congenital narrowing of the meatus urinarius have been followed by disease of the kidney extending outside of it. Cold or exposure, various local injuries, as blows and wounds, besides falls and jars, have all been charged with producing perinephritis and pyo-perinephritis. In some cases no known exciting cause could be adduced, but the patient was said to be " run down " or " subject to abscesses."

Symptoms and Diagnosis.—The symptoms are by no means uniform, and especially in the secondary cases may be insidious, or masked by the primary disease. Other cases are very frank, with a prompt onset; fever 102°, 103°, 104° F.; local pain, stiffness of muscles in the lumbar region, and, when suppuration sets in, chills or chilliness, fluctuating temperature, and perhaps tenderness, tumor, fullness or heaviness in the loin.

In children, fever is a very uncertain indication of the severity of a disease; and a large abscess may form with very little rise of temperature; and fever tells us nothing of the location of the trouble. Pain may be distinctly located in the loin. But children often do not locate pain accurately, or with them, as with the adult, there may be pain with any movement of the trunk, or the pain may be felt in the knee, thigh, or gentalia, groin or abdomen. In cases secondary to renal disease the urine may give valuable indications —pus, blood, albumen, or casts. In primary perinephritis the urine may show nothing abnormal, or it may be excessively acid or loaded with lithates, or may contain albumen merely from pressure of the swelling on the renal vein. Tenderness in the region of the kidney may be easily demonstrated or may require quite deep pressure. Or the parts may be sensitive to slight touch, and firm pressure cause such sharp pain, sticking and aching as to be unbearable. If there is much swelling or a large accumulation of pus, tumor is generally demonstrable, at least under an anesthetic. But sometimes there is more of a feeling of immobility, or of weight on the affected side, when both sides are tested by lifting, as it were, one loin in each hand as the patient lies upon the back. External edema and even redness of the skin may be met, but a diagnosis ought to be made before that appears.

All of these symptoms are more or less fallacious, and may be difficult to find or to judge in children; which makes it necessary to look very closely for more reliable symptoms, muscular rigidity, and the characteristic attitude and movements of the young patient. The lumbar spine is stiff, and when the patient is recumbent is curved slightly forward. With the patient standing the effort to erect the dorsal spine causes a lordosis. Or, in standing, the patient may support the spine by resting the hand upon the thigh. Torsion of the spine, as in turning in bed, is impossible or causes great pain. Rather than stoop or bend, the patient will squat. Sometimes the body is much inclined toward the affected side. The thigh is partially fixed upon the trunk when either lying, sitting, or standing. While lying on the back the patient cannot extend the thigh to touch the bed or table, nor can the thigh be completely extended by passive motion. Adduction and abduction are possible and the foot is usually pointed forward; but occasionally there is outward rotation.

In standing, the thigh flexion persists and causes a limp in walking, and he may walk, supporting the body by resting the hand upon the thigh. The patient can even stand on the limb of the affected side by leaning far over, thus maintaining the flexion of the thigh.

Pain may be caused by adduction or by jarring. In any case

of suspected perinephritis the bowels should be thoroughly emptied before diagnosis is attempted. Fecal impaction and consequent pain may simulate this disease, and all disappear by appropriate use of enemata and laxatives. The disease must also be differentiated from hip-disease, spinal caries, gravel, lumbago, appendicitis, splenitis, hepatitis, and empyema.

Prognosis.—Prognosis depends on the cause and the severity of the attack, and in case of pyo-perinephritis it also depends on the stage at which the abscess is freely opened. Necessarily an inflammation so deeply seated and so surrounded with important structures is a serious affair. And yet slight cases of primary perinephritis may subside without suppuration and leave no trace. The dangers are from destruction of the kidney, hectic, pyemia, peritonitis from extension to or bursting into the peritoneum, burrowing of pus over into the other loin, or downward along the psoas, or upward into the pleura or lung, or under the liver, or into the colon or ureter. The effects of treatment are rather more satisfactory in the child than in the adult.

Treatment.—A prompt and thorough laxative is not only requisite to a careful examination, but is an excellent therapeutic measure. The bowels should be kept moderately active. No bulky or heavy food should be allowed. Milk, or rather, fluid diet, is advised. The arterial tension, fever and restlessness of the early stage may be controlled by aconite or moderate doses of acetanilid. These remedies also act well upon the skin, and thus relieve the kidneys. They may be supplemented by sudorifics, such as spirit of Minderer.

Pain should be relieved by anodynes, morphia, or, preferably, codeine. A good extract of belladonna, one drachm to an ounce of glycerine, smeared upon the painful region after carefully cleansing the skin, and then protected by oil-silk, aids in relieving the pain, and perhaps influences the local circulation beneficially. Guiacol in oil, or ointment containing iodide of lead, are sometimes applied.

Any of these applications may be covered by a hot-water bag; or hot fomentations, stupes or poultices may be used, with or without any other application. These means or blistering may promote resolution in such cases as do not go on to suppuration. Some surgeons prefer cold applications, and in some cases these prove more grateful to the patient and limit the congestion better than local heat. Hot baths or sitz baths are also useful. Leeching was formerly much used, and should be thought of in plethoric cases. So also wet cupping. Dry cupping has a wider range of application and is more readily consented to by the patient or parents. If pus forms there is nothing for it but removal, and the sooner

the better. Aspiration may serve temporarily for removal of the pus, particularly in chronic or slow cases, but incision is the sovereign remedy. The aspirating needle may be used as a guide to the point for incision. However, that is usually settled upon anatomical grounds, in cases in which tumor or fluctuation offer no indication. Fluctuation, edema and redness of the skin—in other words, "pointing" of the abscess—should not be waited for. The general symptoms indicative of pus formation, together with the fullness or bulging, local pain or aching, hardness or weight, with dullness on percussion extending in a region that should be resonant—are sufficient to call for incision. The incision is the same as for nephrotomy and may be either transverse, oblique, or vertical. My own preference is for the oblique incision, parallel with the twelfth rib. After the skin and muscles are cut through, a blunt instrument, or preferably the finger, seeks the abscess. Flocculi or sloughs should be removed and a drainage tube, or perhaps two of them side by side, should be introduced. It is not necessary to irrigate the cavity at the time of operation in every case. It may be omitted unless the pus is foul. Later, washings with normal salt, boracic, weak bichloride or other lotion may be necessary. The wound is packed with iodoform gauze and surrounded with abundance of sterile or cyanide gauze or pads of sublimated or tarred jute or absorbent cotton.

No fear should be entertained of a permanent fistula, but the external opening maintained until the whole cavity has closed by granulation.

HYDRONEPHROSIS AND HYDROPERINEPHROSIS (50)

An expansion of the pelvis of the kidney by retained urine is termed hydronephrosis. If a similar collection of fluid be outside of the kidney, but of the same nature and connected with the cavity of the kidney, I think it may be appropriately termed a hydroperinephrosis. For its origin more resembles that of hydronephrosis than of congenital cystic kidney or of hydatid cysts, or even of paranephric cysts with which it has usually been classed. Hydroperinephrosis would, therefore, form the connecting link between hydronephrosis and the cysts of the kidney, for it especially resembles the paranephric cysts. But an expansion of the natural cavity of the kidney or of its envelope, outside of the kidney, is not to be confused with cystic growths in the kidney substance or springing from surrounding tissues. Hydronephrosis and hydroperinephrosis are indistinguishable clinically. Either of them may be congenital or acquired; and the acquired disease may be either traumatic or non-traumatic in its origin. One or both kidneys may be affected. They are caused by an obstruction to an outflow of urine. The causes of the obstruction leading to acquired hydro-

nephrosis or hydroperinephrosis may be within the water passage—such as impaction of a calculus in the urethra or ureter, small cystic growths in its mucous membrane, fibromatous growths, or plugging of the ureter by blood clot; or may be caused by cicatricial contraction of ureter or urethra; or from injuries by external forces, or by a fold or kink in the ureter occasioned by traumatic dislocation of the kidney, or by pressure of a tumor, or of inflammatory swelling adjacent to the ureter.

Pathology.—In hydronephrosis the pelvis of the kidney first expands in a more or less globular form. Pressure upon the medullary substance and cortex causes them to atrophy and expand, together with the kidney capsule. The walls of the sac may be thick and strong or thinned and delicate, almost to bursting. In some instances fibrous septa partially divide the cavity; or in cases of hydroperinephrosis a portion of the fluid, perhaps by far the greater part of it, has apparently forced an exit through the wall surrounding the kidney pelvis, and accumulated in an expanded sac continuous with the kidney capsule. The opening between the collections of fluid may be so large as scarcely to separate them into two, or so small as to be difficult to find.

The whole diseased kidney may expand so as to more than half fill the abdomen, or may be smaller than a normal kidney.

The fluid contents may somewhat resemble urine, altered or diluted; and be found by appropriate tests to contain urea, uric acid, water, or oxalate of lime, chlorides, phosphates, epithelial cells, remains of blood cells, coloring matter and fibrin, albumen and, occasionally, cholesterin. Any or several of these may be found in a given specimen or the fluid may consist of nothing but water and sodium chloride, and be colorless.

Symptoms and Diagnosis.—Hydronephrosis or hydroperinephrosis may be present without symptoms. When symptoms are present they will vary with the cause, and there is none characteristic until tumor becomes appreciable. The symptoms other than that of tumor are those of obstruction to the flow of urine and of the disease causing the obstruction.

The symptoms of obstruction are diminution in the amount of urine passed, frequent attempts at micturition, pain in the lower abdomen, and thirst. But in some cases there are occasional discharges of an increased quantity of urine. Pain may not be present unless the cause of the obstruction and resulting collection of fluid is of a painful nature. If both kidneys are affected, symptoms of uremia may come—headache, dizziness or dimness of vision, or convulsions.

No age from fetal to senile life is exempt. Cases in females outnumber those in males, two to one.

Prognosis.—The prognosis depends upon whether one or both kidneys are involved and upon the nature of the obstruction.

Spontaneous cures have taken place, the accumulation discharging itself by the natural passage and never returning, but this is not by any means to be depended upon, as such instances are rare.

Symptoms of uremia are very grave. Great size and pressure of the tumor call for prompt interference, as the tumor may burst internally, with fatal result, or it may cause death by pressure upon stomach or intestines.

Treatment.—Any existing obstruction to the exit of urine, for instance, phimosis, narrow or strictured urethra, calculus or tumors, in or pressing upon bladder or ureter, should be relieved if possible. Hydronephrotic or hydroperinephrotic tumor, if small and occasioning no symptoms, calls for no immediate interference. Cases have been recorded in which massage or manipulation of the tumor led to a discharge of the fluid, and no reaccumulation followed. Great caution should certainly be used with this plan, especially in large or tensely distended tumors, for fear of rupture.

Aspiration is a method much advised and often employed. One or several repeated aspirations have cured cases. Strict antiseptic methods should be observed in aspirating. The needle should be introduced where the peritoneum or the colon does not intervene between the skin and the tumor. If the tumor point in the loin it may be punctured where it points. Otherwise it is usually punctured about half way between the last rib and the crest of the ilium, and just outside of the erector muscles of the spine. Others prefer to enter the needle just in front of the last intercostal space. The needle is directed forward and inward toward the center of the enlargement. It is not advisable to introduce any medicine nor any antiseptic into the cyst, even though the fluid withdrawn appear to contain pus.

Aspiration has the disadvantages of possibly occasioning leakage from the cyst into the tissues and resulting in inflammation; of giving no information concerning the tissues passed through, nor of the condition of the kidney, nor of the nature of the obstruction.

Aspiration or repeated aspirations failing, incision or nephrotomy should be resorted to. Some surgeons prefer the knife to the needle as the first resort. The incision is the same as that for nephrotomy. (See Figs. 16 and 17.)

RENAL CALCULUS

While small renal calculi, usually of uric acid, are very common in infants and young children, it is seldom that trouble occurs from a larger stone. The small calculi are passed by way of ureter

and urethra, and the kidney often seems quite tolerant of calculus of a larger size.

Symptoms and Diagnosis.—Symptoms are the same as in the adult. There is pain in the loin which, in boys, is apt to extend into the urethra or the perineum and to cause retraction of the testis. Pain is worse after exercise, relieved by rest, and sometimes referred to the other kidney. There may be tenderness over the affected kidney, or at least the pain may be elicited by deep palpation or sharp percussion, and so betray which of the two is really diseased. Hematuria is a common symptom and is apt to pass unnoticed by the parents until serious anuria is present. There is apt to be a trace of albumen in the urine. Or nothing abnormal may be found but high specific gravity and excessive acidity. Sometimes, instead of urates, the faulty metabolism manifests itself in the form of oxalates. Often the urine is passed very frequently, and very little at a time. When it is retained it becomes alkaline; when infected, purulent. The Roentgen ray should always be employed in diagnosis. It may furnish positive evidence for diagnosis in lieu of much that is ambiguous. The presence of pus, albumen, or blood in the urine points to renal calculus rather than to spinal caries. Tuberculosis of kidney cannot be positively excluded by microscopic examination. Inoculation experiments and the tuberculin test should be employed in doubtful cases. A history of the symptoms extending over several years, with no evidence of tuberculosis elsewhere, favors the diagnosis of stone in the kidney. Examination under anesthesia may reveal alteration in size, shape, or situation of the kidney.

Treatment.—The treatment consists of rest, and sometimes anodynes during the painful exacerbations, and of the persistent use of a carefully regulated diet. Drinking freely of distilled water, and, in those cases accompaned by acid urine, the use of lithia water or other mild alkaline mineral water is beneficial.

If there are symptoms of stone in the kidney, with pus in the urine, and rise of temperature and chills, an operation is indicated. If the symptoms are less urgent, but the disease is chronic, and persistent pain is present, operation is in order. The operation will be a pyelolithotomy, nephrolithotomy, or a nephrectomy or partial nephrectomy, according to the location of the stone and the condition of the diseased organ, and also of the other kidney. If the kidney is suppurating it should be drained through a lumbar incision. It is best to remove a stone whole if possible; if fragmented the fragments should all be removed. If the kidney is suppurating and the stone cannot be found at once, it may be searched for subsequently after drainage. One should not be hasty in sacrificing a kidney, or even a portion of a kidney, in a non-

tubercular pyelonephritis, or in hydronephrosis with even enormous distension. When an exit is found for pus or urine, the recuperative power of the kidney tissue is remarkable.

TUBERCULAR NEPHRITIS

Tuberculous nephritis may be a part of a general tuberculosis or it may be primary, infection having taken place through the blood. The disease may descend to other portions of the genito-urinary tract, but quite often it remains localized in the one kidney affected. It may be in the form of miliary tuberculosis of the kidney-pelvis; or in foci in the cortex involving the mucous linings of the calices and pelvis. Or the pyramids may become the seat of caseous masses which break down and destroy them, often with adjacent portions of the cortex, and break through the capsule into the perinephric tissues.

Symptoms and Diagnosis.—The symptoms so closely resemble those of stone in the kidney that the diagnosis between them is quite difficult. In other cases they are so indefinite that any certain diagnosis is hard to make. When typical, there is local pain and tenderness in the region of the kidney, and the pain is less apt to be paroxysmal than with stone. Reflex irritation of the bladder, leading to frequent micturition, with pain while passing water, is a marked symptom, and one which does not readily yield to medication, which would relieve irritability from other causes. The urine usually contains pus, often blood, and sometimes phosphates. If, with the foregoing symptoms, tubercle bacilli are found in the urine, the diagnosis is complete. If the bacilli are not found, but the tuberculin test is positive, one is justified in the diagnosis; the bacilli will probably be found later, on repeated examinations. The temperature is more likely to be of a typical hectic character than with pyonephrosis from calculus. The kidney may be found enlarged, especially if perinephritis exist, and may perhaps be detected on percussion and palpation, being careful to distinguish between an enlarged spleen on the left side and the renal and hepatic dullness on the right. In older children, particularly in girls, catheterization of the ureters may determine which kidney is affected.

Prognosis.—The prognosis is necessarily grave; and yet if one could be sure only one kidney is affected there is a fair prospect of recovery after operation.

Treatment.—If the surgeon is convinced that only one kidney is affected, it should be promptly removed. If there is doubt about the soundness of the other kidney the certainly diseased one may be opened and drained until the next step can be determined.

TUMORS OF THE KIDNEY

INNOCENT TUMORS.—Tumors of the kidney are innocent or malignant. The innocent tumors are less frequent than the malignant. They are apt to be fibromata or fibrocystic growths. Dermoids are occasionally found.

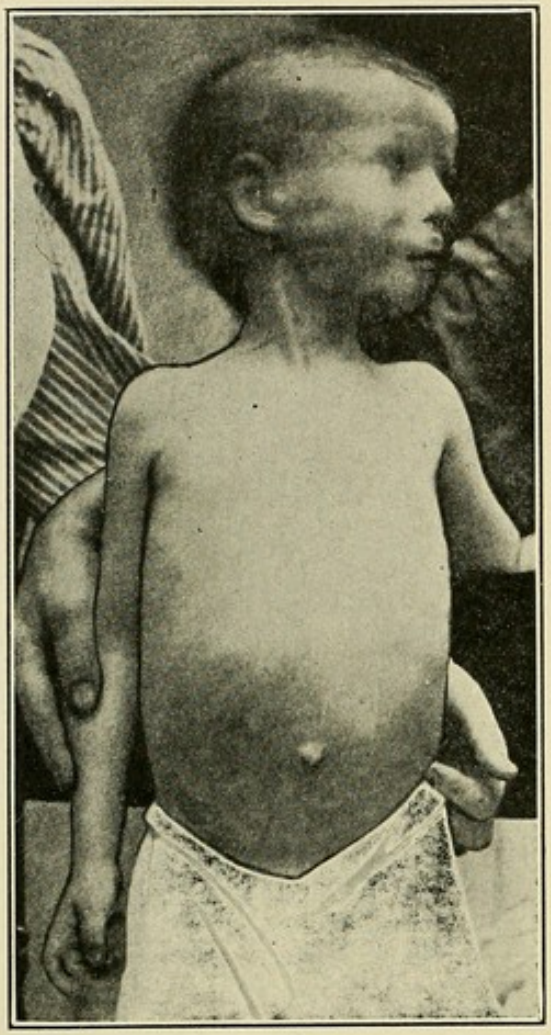


FIG. 226. SARCOMA OF KIDNEY. Ascites. Tumor friable, bleeding at a touch. Blood free in the abdomen. Died the next day after extirpation. Boy 5 years old. Dr. A. F. House's case.

Symptoms and Diagnosis.—Innocent tumors give rise to no symptoms, excepting, perhaps, occasional hematuria, unless they attain considerable size. They grow slowly, occasion pain only in case of pressure, cause no constitutional symptoms, and are less apt to give rise to local peritonitis and effusion than malignant growths.

Treatment. — Removal is necessary if they interfere with other organs or structures.

MALIGNANT TUMORS.—Malignant tumors form the greater number of all the tumors of the kidney; of all the malignant tumors of the abdomen those connected with the kidneys are most common. And of all the malignant tumors of the kidney the greater number are sarcomata. They may sometimes be described as round-celled, spindle-celled, or rhabdo-myosarcoma, but are more apt to be atypical. They may even have the structure of innocent tumors, but the character of malignancy. The tumor may infiltrate the kidney parenchyma, but frequently there is a capsule, or it may spring from the pelvis, or from the cortex, and not infrequently from the adrenals. The tumor may be so soft as to give the examining hand the impression of fluctuation, and so friable as to bleed spontaneously or from handling during examination. A malignant growth is apt to adhere to surrounding

organs, to excite local peritonitis and ascites. (See Figs. 226 and 227.) Secondary tumors may be found in the tissues near by or more remote, not so frequently in the intestines or pancreas, but in the opposite kidney, in the liver or in the lungs; and very early in the retro-peritoneal glands, especially if there be carcinomatous elements in the tumor. The tumor may attain large, or even immense, size and cause damaging pressure upon surrounding structures. The etiology and pathology are discussed in the chapter on tumors. Malignant tumors of the kidney are often congenital, and nearly always occur in early childhood. Traumatism seems to be the exciting cause of the growth in a few cases.

Symptoms and Diagnosis.—Generally, tumor is the first symptom observed. It may be discovered in the loin if there is any occasion for an examination. But usually there is no other symptom to attract attention while the tumor is yet small except it be hematuria. In a few cases the amount of blood lost may be so large as to be noticed by the family, or it may be small in amount and only discovered after microscopic search. In the majority of cases the tumor is discovered only when the abdomen enlarges, for the tumor does not bulge laterally as much as forward. It grows rapidly and in a few months may fill the abdomen. Its surface may be quite smooth, or it may be lobulated or nodulated. It may be quite symmetrical or irregular in outline. Although solid, it may be so soft as to give a pseudo-fluctuation. Pressure upon the ureter may retain the secretion of the kidney in its pelvis and cause hydronephrosis which adds to the abdominal enlargement and obscures the physical diagnosis. Edema of the lower extremities may occur, as in all cases of intra-abdominal tension, by pressure on the vena cava; but with a solid tumor of the kidney this sympton may be quite marked and thrombosis may occur. When an abdominal tumor is small its point of attachment may be demonstrated, but when it is large this may be impossible, on account of its size, the tension of the abdominal walls and sometimes by adhesions to surrounding structures which interfere with its mobility. The location of the attachment is a point one is very anxious to discover, for the tumor may be in connection with a kidney or an ovary, or with the

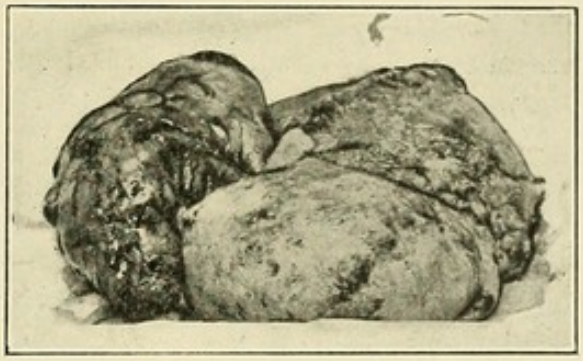


FIG. 227. SARCOMA AND KIDNEY from the case shown in Fig. 226. Histologically it proved to be of mixed types.

liver or spleen, or with the abdominal walls. Or it may be only an enlargement of the spleen. Even when proven to be in connection with the kidney, it remains to be decided whether the tumor is a hydronephrosis or hydroperinephrosis, possibly an abscess, or a new growth, and whether innocent or malignant. With abscess the enlargement is more localized in the loin and there are more symptoms of inflammation. Hydronephrosis and hydroperinephrosis show diminished amount of urine passed. Innocent tumors are of slower growth and not accompanied by cachexia. Pain is not a common symptom, even with malignant tumor, and may only be present when local peritonitis occurs. General peritonitis is unusual, and there is no generalized tenderness over the abdomen. The pressure within the abdomen produces dyspnea from interference with the movements of the diaphragm. Pressure upon the stomach and intestines produces symptoms of interference with their functions. Cachexia does not make its appearance early in the case, but after the tumor attains considerable size it becomes evident; and when the functions of the digestive organs are interfered with, wasting becomes rapid.

Prognosis.—Without operation, the fatal termination may be looked for in from three to twelve months after the tumor is discovered. With operation the prognosis is still very grave, and yet not hopeless. All studies of the subject point to the necessity of early discovery of the tumor and recognition of its nature, and to early operation before secondary growths render removal futile or involvement of surrounding structures makes it impossible, for only in operation lies any brightening of the dark prognosis.

Treatment.—Treatment is by removal of the tumor. The removal of the tumor, and generally of the kidney with it, is so severe for a child so young—often only two or three years of age, and hardly ever older than five years—that every means must be used to fortify the patient against shock and hemorrhage. It is well to prepare him with tonics and hematinics. At the time of the operation, abundance of artificial heat must be supplied, and preparation made for intravenous injection of normal saline solution. The patient is kept with his head lowered both during and for some days after the operation. (Abbe.) During the operation especial care should be taken to prevent loss of blood. A vertical incision in the loin does not afford sufficient room to get at the kidney in a child. My own preference is for an incision nearly transverse, below and parallel to the last rib. This incision can be extended forward as far as it is found necessary. This incision has an advantage if there is any question that the tumor may be a hydronephrosis or hydroperinephrosis, or a retroperitoneal tumor not connected with the kidney. If the tumor is very large the

incision may be made vertically, in the semilunar line. This latter incision might be chosen if there was a question of the tumor being connected with an ovary instead of kidney. If the abdomen is opened by the last mentioned incision the colon should be displaced toward the middle line; that is, the peritoneum should be opened behind the colon, in order to get at the kidney and the tumor attached to it. An attempt should be made to follow the capsule of the tumor if it has any, in the enucleation, and the rule is to remove too much rather than too little tissue. If the kidney, also, is to be removed, the tumor and the kidney are separated all round by blunt dissection, until it is held only by the vessels and the ureter. These are identified and separated and a double ligature of silk or strong catgut passed between them. One ligature is then tied around the vessels as far as possible from the kidney, and the other is tied around the ureter. A hemostat or a pedicle clamp is then placed upon the pedicle of the kidney and the kidney divided so as to leave the stump of the pedicle clamped. It should now be made sure that the vessels are securely tied and the ligature cannot slip, and the forceps may be removed. If the tumor is very large it is often better to place forceps upon vessels and ureter and remove the mass before ligating. In making the dissection, all tissues which may contain vessels should be seized with hemostats and divided between. The suprarenal capsule, also, should be removed. It is essential to remove the fatty capsule of the kidney, if there be one. Quite often there is none in evidence. The cavity is now inspected and dried and all bleeding points secured. The cavity is packed with sterile gauze and closed with gauze drainage, or, if preferred, with tube drainage. If the anterior incision has been used, posterior drainage may be supplied by opening from the inside out through the loin. The incision is now closed. The child is given a coffee saline by the rectum or a saline by a vein or subcutaneously, and strychnia or camphor under the skin, and put to bed, head low, with hot-water bottles. The gauze packing is removed after two days, and, if the wound is clean, need not be renewed.

EXTROVERSION OF THE BLADDER (ECTOPIA VESICÆ)

This malformation occurs most often in the male. A hiatus in the abdominal wall by a failure of the ventral laminæ of the embryo to meet in the middle line causes the anterior half of the bladder to be lacking. In its place there is an area of red and spongy or velvety, sometimes rugous-looking, mucous membrane, constantly wet with urine and often chafed and inflamed by the clothing or crusted with phosphatic deposits. This red area is the posterior wall of the bladder. It may be slightly concave, but is

quite as frequently level with the skin surface, or even protruding beyond it. (See Fig. 228.) At its lower margin may usually be found a rudimentary penis, or the glans without the urethra, or malformed almost beyond recognition. The corpora cavernosa are usually deficient, and, the corpus spongiosum not having united, the urethra is only represented by its floor shown upon the dorsum of the rudimentary penis. This is turned up against the exposed mucous membrane, which represents the trigone and more or

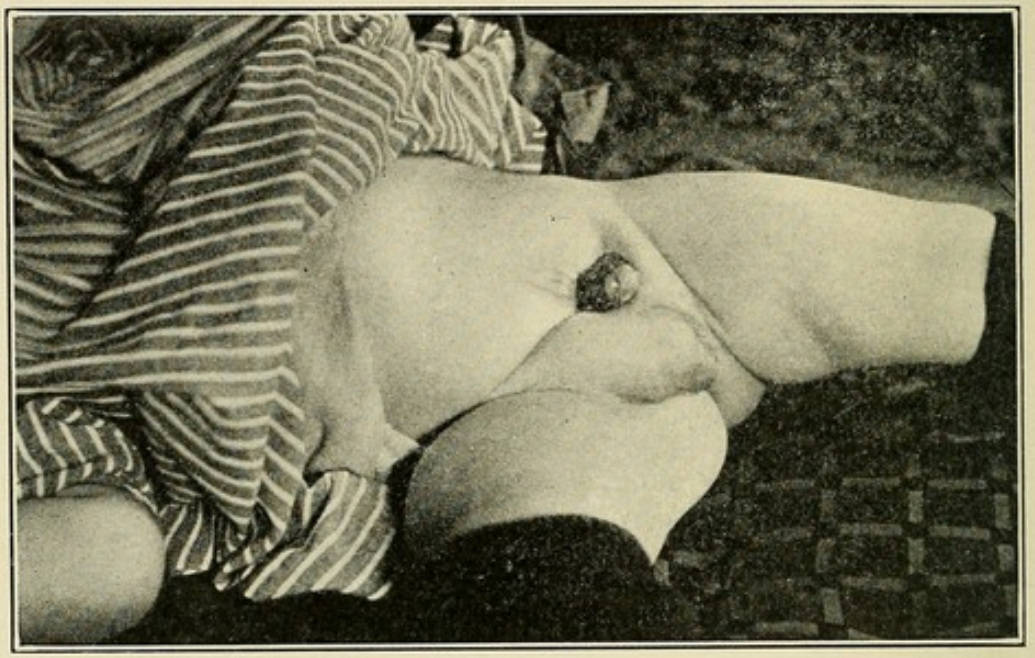


FIG. 228. EXTROVERSION OF THE BLADDER AND RIGHT INGUINAL HERNIA. Boy 2½ years old. The dark surface is the mucus membrane of the posterior wall of the bladder. The epispadiac glans penis and the prepuce below it can be distinguished.

less of the posterior surface of the bladder. The scrotum is poorly developed. The testes may have descended into it or they may have lodged in the inguinal canals. Just behind the glans penis the urine trickles out, and by tracing its point of appearance the openings of the ureters may be seen. The parts adjacent and the clothing are constantly wetted with urine; the skin often is excoriated or eczematous.

This malformation is often accompanied by one or more others; for example: The umbilicus is apt to be lower than normal upon the abdomen; the pubic bones may have failed to unite properly at the symphisis, having only a fibrous union; inguinal hernia, single or double, is not uncommon and very troublesome to truss on account of the wet and often inflamed skin surface; the anus may be farther forward than usual; the genitals may be so malformed as to make the sex indistinguishable; the rectum, with a long, loose mesentery, may be prolapsed. There are different grades of the

deformity, the condition already described being the third grade, which is the most ordinary. (Champneys, Ashby and Wright.) In the first or slightest grade there is slight separation of the symphysis, and perhaps a hernial pouch, but no deficiency of the bladder. In the second, prolapse of the bladder, perhaps through the urethra or urachus. (Vrolik, Froriep.) In the fourth the bladder not only is lacking in its anterior wall, but is divided into two lateral portions, with the opening of the intestine between them.

Diagnosis.—The third degree, the most ordinary form, as before described, is recognized without difficulty.

Treatment.—Relief for this malformation has so far proved a baffling problem. It is impossible to attach to the parts any form of apparatus to catch the urine. Very numerous operations have been planned and tried. They may be divided into two general classes, each with several varieties.

Class 1.—In the first class are those operations designed to construct a receptacle having no sphincter, but of such shape that an apparatus can be attached to catch the urine.

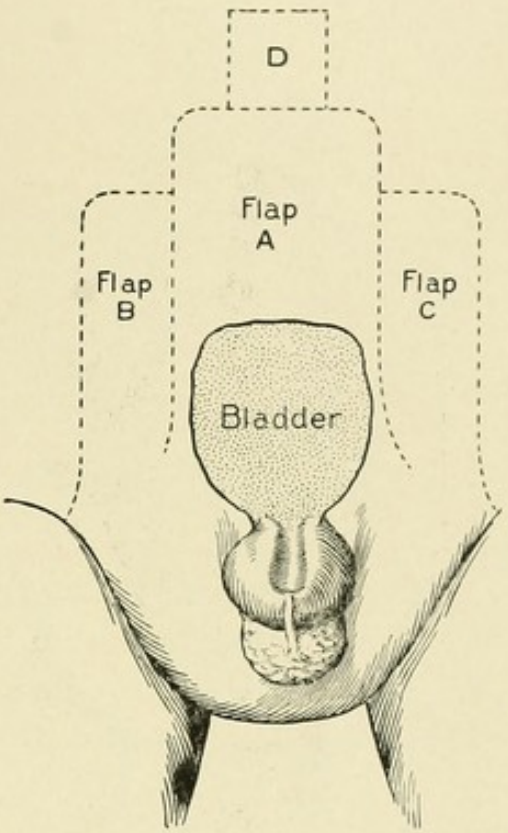


FIG. 229. WOOD'S OPERATION FOR EXTROVERSION OF THE BLADDER, outline of flaps.—Drawing modified from Binnie's Operative Surgery.

Class 2.—In the second class are operations to deliver the urine from the ureters into the intestine.

As varieties of Class I will be mentioned variety A., Wood's operation, which is intended to provide an anterior wall for the bladder, by dissecting up a skin flap from the abdomen, turning it down over the bladder and closing the sides with lateral flaps turned across toward the middle line from the groins. The diagrams and description of Wood's operation are modified from Binnie, Operative Surgery. (See Figs. 229 and 230.) Flap A is dissected from the skin of the abdomen and has its base near the bladder. In dissecting off this flap it should not be loosened within one-fourth of an inch of the margin of the bladder membrane. In this, as in all similar operations, the flaps should be quite a good deal larger than the

surface to be covered, as there is certain to be a shrinking of the flap. If the urethral gutter on the dorsum of the penis is to be closed in, flap A is extended as in D in the diagram, leaving it attached to flap A, that is, all in one piece. (Greig Smith.) Flaps B and C are then cut from the abdominal wall, one at each side of flap A and having their bases below. The margins of the bladder are freshened, excepting opposite the hinge of flap A, and where the urethral gutter leaves the bladder to extend along the penis. Flap A is turned downward, with its epithelial surface lining the anterior wall thus made for the bladder, and its raw surface outward. The edge of the flap is sutured securely to the freshened edge of the bladder. Flap C is then slid around so as to cover half the raw surface of flap A. Flap B is then used the same on the opposite side, and both lateral flaps are sutured in position. If flap D is to be used it is sutured to the freshened edges of the penile urethral gutter and its raw surface covered by a bridge-flap from the prepuce. The raw surfaces made upon the abdomen by the removal of these flaps are partly covered by sliding inward the surrounding skin and the remainder by Thiersch grafts.

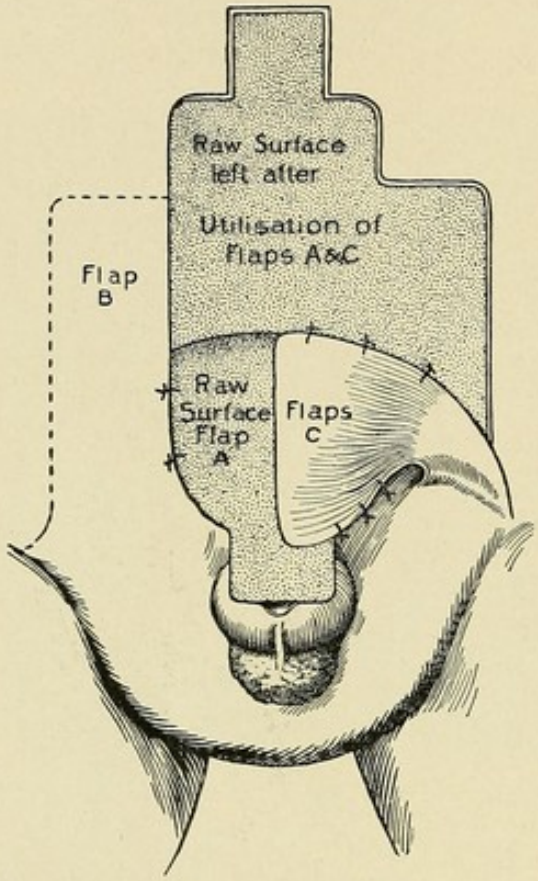


FIG. 230. WOOD'S OPERATION FOR EXTROVERSION OF THE BLADDER. The flaps applied. The raw surface of flap D still remains to be covered by bringing up a bridge-flap from the prepuce.—Drawing modified from Binnie's Operative Surgery.

The objections to this operation and others like it are, that there is such extensive dissection and consequent scarring, even if there is no sloughing of the large flaps; and also that the epidermal surface which is turned inward is liable to grow hairs which prove very irritating and troublesome. Yet this is a representative variety of the class of operations which have most frequently been done for this malformation.

Variety B., in which the object is to unite the sides of the exposed bladder surface so as to make a small receptacle but one

lined with the mucous membrane of the bladder. In Trendelenberg's operation the sacro-iliac synchondroses are opened and divided so that the pubic bones can be brought together, and the abdominal walls relaxed in the middle line, after which the lateral margins of the bladder surface are freshened and united. This has given some good results.

Finding separation of the synchondroses difficult and dangerous, Perkins divided the ilium close to the synchondrosis with the chisel and obtained the same result. (Binnie.)

Variety C.—In this operation, which bears the name of Schlange, the portions of the pubis to which the recti muscles are attached is chiseled loose, thus permitting their approximation and the union of the transplanted portions of bone and of the inner margins of the muscles.

König's operation is similar, but the horizontal and descending rami of the pubis are divided to allow of the approximation.

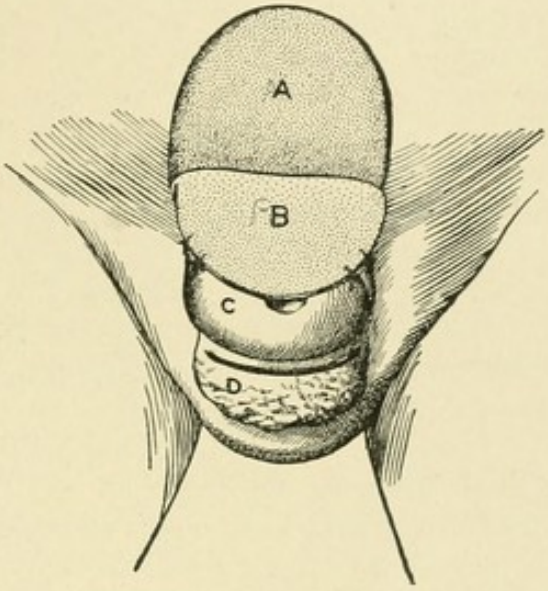


FIG. 231. SEGOND'S OPERATION. A is a raw surface left after turning down the flap B. B is the flap composed of the posterior wall of the bladder with its mucous side downward covering in the groove in the penis. C is the glans penis. D is the usually reduntant prepuce with an incision making a bridge-flap which is to be brought up over the raw surface of flap B.

Very numerous varieties of flap operations have been executed, some of them very ingenious. The flaps taken from the sides of the hiatus as well as from above, and also from below, utilizing the scrotum and the prepuce as flap material.

Variety D.—This one of the varieties of Class I, Rutkowski's operation, involves a different principle, seeking to construct an anterior wall from flap material of a section taken from the ileum (still keeping its mesenteric attachment), thus providing a bladder lined with mucous membrane. It was hoped this mucous lining would prevent phosphatic deposits, but such is not the case.

Variety E.—There is another variety of operation, Segond's, in which the exposed mucous lining of the bladder is made to cover the upper surface of the penis, converting the gutterlike floor of the urethra into a closed canal. (See Fig. 231.) It is performed as follows: An incision is carried around three-quarters of the cir-

cumference of the exposed mucous area and dissected loose, leaving one-fourth attached at the lower side of the flap. This flap is turned down upon the upper surface of the penis. The margins of the urethral gutter along the upper surface of the penis are then freshened and the flap which was turned down is sutured at its margins to these freshened edges. The prepuce, which hangs below the glans, can then be incised transversely, leaving it attached at both ends and can be brought over the top of the new flap with the raw surfaces together and the skin-side out. This operation has the advantage of getting rid of the filthy mucous membrane, making the least possible wound and amount of scar, and of having the mucous membrane for the bladder-lining. But the penis is often so stunted that it is practically impossible to work with it in the manner described. And none of these operations provide any sphincter for the reconstructed bladder. The urine runs from its lower portion as before, but can be collected into an attached urinal.

We will now turn to Class II of the operations for ectopia vesicæ, and mention two varieties and describe one of them more fully.

Variety A.—In this variety of operation the ureters are detached from the vesical wall and transplanted into the rectum or into the sigmoid flexure of the colon; so that the urine collects in the bowel, which becomes tolerant of its presence and is controlled very well by the sphincter ani. This procedure is correct theoretically and has been successfully executed in practice. But it has invariably been followed by fatal septic inflammation traveling up the ureters to the kidneys.

Variety B.—Maydl's operation is another and a better variety of the operations of Class II, and is performed as follows (Binnie): The exposed mucous membrane of the bladder is all excised excepting an elliptical area containing the orifices of the ureters. The whole field of operation is then cleansed. The abdomen is opened and a loop of the sigmoid flexure is brought out at the wound. The gut is emptied of its contents by stripping, and clamped above and below the loop to be used. The gut is then opened longitudinally by an incision of suitable length and the margins of this opening are united to the portion of bladder wall containing the ureters by through and through sutures. This line of sutures is then to be covered by a line of continuous Lembert sutures; so that the elliptical portion of bladder wall is inserted like a patch into the opening in the wall of the gut. Thus the ureters open into the sigmoid flexure. The normal valves or sphincters of the ureters have not been destroyed or disturbed, and they prevent return flow and ascending infection of the ureters. This operation, like the others, has many modifications.

Of these operations, those of Class II are founded upon the better principles, and Variety B., that is, Maydl's operation, comes nearest the ideal. It is more difficult of execution and more dangerous than varieties A. or C. of Class I.

In Class I, Variety E., Segond's operation, has much to recommend it and would be the operation of choice in a case upon which it could be executed. It is far less severe than Maydl's operation, involves less danger and shock and could be risked in a much weaker or younger child. None of these operations should be done until the child is three or four years old. But the condition is so harassing that every child afflicted with it should be given the benefit of operative aid. Fig. 232 from Ashby and Wright shows an excellent result from an operation of Class I. A urinal can be worn over the orifice as now formed. One of the annoyances of such cases is the constant accumulation of phosphatic deposits about the parts. To prevent or lessen this Ashby and Wright recommend the use of a wash composed as follows: Hydrochloric acid, twenty minims; glycerine, one drachm; water, one ounce. If, however, the deposit persists it may be scraped away occasionally with a sharp spoon. Some have recommended scraping or dissecting off all the mucous lining of the bladder excepting that just about the ureters, in order to avoid the secretion of mucus.

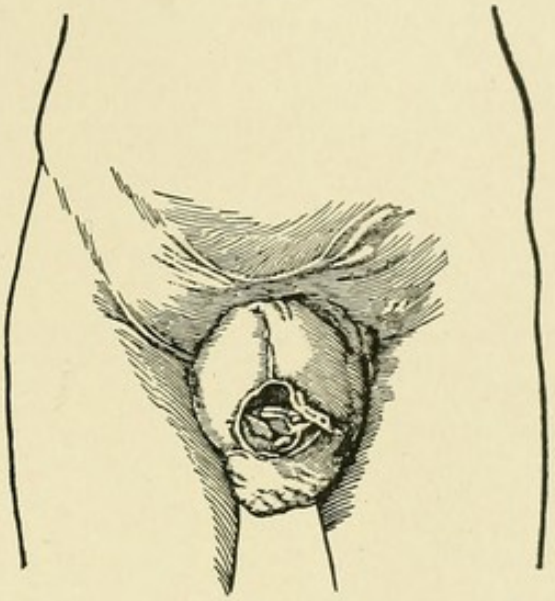


FIG. 232. Result after an operation of Class I for ectopia vesicæ. After Ashby and Wright.

TUMORS OF THE BLADDER

Tumors of the bladder are rare in children. The majority of them are sarcomata. Mucous polypi and papillomata have been reported. (Giraldès, Birkett, Owen, Shattuck.) Cancer is exceedingly rare.

Symptoms and Diagnosis.—The symptoms are frequent desire to micturate, often accompanied by difficulty in so doing, and with pain while passing water and between times. Hematuria may or may not be present; but is very apt to occur after sounding the blad-

der. The diagnosis from stone should be attempted by sounding; from tuberculosis by the microscope; from cystitis by examination of the urine. Tumor and cystitis or stone and cystitis may coexist. Tumor may occasion retention of urine; or tumor may simulate retention. The bladder may appear distended and dull on percussion as if distended with urine, but the catheter being passed finds little urine there. The enlargement and the dullness is due to the sarcomatous mass and the thickening of the bladder walls which it produces. A polypus or a portion of a larger tumor may protrude through the shorter and wider female urethra. In the girl, instead of sounding, the urethra may be dilated and a digital exploration made. With an index finger in the rectum and the opposite hand over the pubes, tumor in the bladder may sometimes be detected, or it may not be detected even when present. It may be impossible to distinguish whether an object felt upon bimanual examination is a stone in the bladder or a tumor, or whether a thickened bladder wall is due to inflammation or to infiltration with a new growth. Yet this method of examination should always be employed. (51)

Prognosis.—No prognosis can be made until one is sure of the nature of the tumor, and in the majority of the cases this can only be surmised until after operation. Given an innocent tumor there is a fair prospect of dealing with it successfully. If malignancy is discovered the prognosis is very dark indeed. The course of the disease is so rapid that by the time the diagnosis is made the disease has gained such headway that complete removal is impossible or is followed by recurrence which proves fatal in a few months.

Treatment.—A small tumor may sometimes be removed through the urethra in a girl. In boys, or, with any but very small tumors in girls, a supra-pubic cystotomy should be done in the same manner as for stone in the bladder, and the tumor excised.

STONE IN THE BLADDER

Stone in the bladder is much more prevalent in some countries than in others; for instance, it is more prevalent in Europe than in America, and in India than in Europe. Certain parts of a country often furnish an unusually large number of cases. It appears as a hereditary disease in some families with gouty or rheumatic tendencies. It has been said that one-half of the entire number of cases of stone in the bladder occur in patients under puberty (which is probably not true in this country); and yet it is rare in infancy, which places in the periods of childhood and youth a large number of the cases of stone occurring in a given locality. There are found twenty times more cases of stone in the bladder in boys than in girls, the stone escaping when small from the short and distensible female urethra.

Vesical calculus in the young patient is most frequently composed of uric acid or urates, amorphous or crystalline, the concretion forming upon or with the mucus of the urinary tract. Phosphates and other salts may be in combination, but this is rare; and in rare instances also the nidus may be a spicule of bone from caries connected by fistula with the urinary tract. It is probable that in the majority of instances the calculus has its origin in the kidney from which it is washed when small into the bladder, where it increases in size and gives rise to symptoms.

Calculi vary in shape, being sometimes oval and smooth, sometimes spindle or oat-shaped, and again irregular in outline or with rough surfaces. They vary in size from that of an oat or a lentil to that of a cherry or almond or larger. More than one may be present in the same bladder.

Symptoms.—The symptoms of vesical calculus are usually acute and well marked in the young. This is due to the extreme sensitiveness of the mucous lining and the activity of the reflexes; and in part to the pyramidal shape of the bladder which causes the stone to gravitate to the trigone, where it produces the greatest irritation and is frequently caught by the contracting muscular fibers, producing severe pain, and where it often suddenly obstructs the outflow of the urine. Thus there is frequent micturition, with a sudden stoppage of the stream, and vesical tenesmus and pain, often causing the boy to cry out or dance about and pull at the prepuce during urination, which may sometimes be followed by the passage of a few drops of blood. The irritation and frequent desire to micturate are not troublesome at night or when lying down. They are aggravated by active exercise. The vesical tenesmus may excite rectal tenesmus, and this may cause prolapse of the rectum. Hernia may result from straining.

Diagnosis.—In the presence of the foregoing symptoms one should exclude other possible causes of similar irritation and pain, such as phimosis, narrow meatus urinarius, retained smegma, impacted urethral calculus, pyelitis, rectal polypus, oxyurides or lumbricoids, appendicitis, urethral polypus in girls, tumor of the bladder. Digital examination should be made per rectum. A stone of considerable size may sometimes be felt distinctly, but in other cases even when present it cannot be detected by this method. With the patient anesthetized and one hand upon the pelvis pressing the bladder down upon the finger in the rectum, one may succeed better. A more certain method is to explore the bladder with the sound. It should be remembered that the curve in the urethra behind the triangular ligament is more acute in the child, and the sound must not only be of a thickness appropriate for the caliber of the urethra, but must have the short curve. Anesthesia is necessary

for satisfactory sounding; though occasionally in girls one may succeed without it. One should not be deceived by the touch of a very hard tumor, or of the rugous lining of a bladder irritated and contracted, which may be mistaken for a stone; nor, on the other hand, of a stone coated with mucous deposit or blood clot in a case associated with cystitis. But the stone if present is much more likely to be struck at once on entering the sound into a child's bladder than would be the case in an adult patient. The conclusion may be affirmed or denied by examination with the X-ray, or better by an Xradiograph.

Prognosis.—A small stone may be fortunately passed per urethram, but such a lucky event is by no means to be waited for. There is no probability of cure by medical treatment. If not removed by surgical means, further results will probably develop. For instance, there may be cystitis, nephritis, or pyelitis, sometimes dilatation of ureters, and of the kidney pelvis, hydronephrosis or pyonephrosis. These, if already present, may subside if the stone is removed from the bladder, and yet, as Erichsen remarks, and Wright confirms the observation, although the mortality from lithotomy is small, one seldom sees an adult who has been cut for stone in childhood. If the condition be more promptly detected and the stone removed before secondary changes in the organs have been produced, the prognosis, not only for immediate results, but for a long life, will be greatly improved.

Treatment.—The curative treatment of stone in the bladder is surgical. Yet the surgeon should be acquainted with the means of palliating the case and putting the organs involved in condition for operation. The greatest point in palliation is to administer large quantities of pure water,—often distilled water is preferable. Before using mineral waters or drugs the urine should be carefully examined. If it is acid, alkaline water, such as Vichy or lithia waters, is useful. If the urine is found to be alkaline, alkalies are contra-indicated. In the great majority of cases the urine is acid, and such remedies as potassium acetate or citrate and, if pus is present, urotropin, are indicated. Infants will live mostly upon milk and cream and gruel mixtures. Children will do best on a diet of vegetables and fruits, with fish and some fats, proteids used moderately, and carbohydrates guardedly.

In the operative treatment of stone one can well recall the time when all the discussion was upon the relative merits of median and lateral lithotomy, and the lateral operation was proven the preferable operation in boys. The greater difficulty of lithotomy in boys is chiefly on account of the small size and undeveloped condition of the parts. Also because the bladder in the child is rather an abdominal than a pelvic organ, and is somewhat narrow and pointed

at its lower end, so that there is danger of not opening fairly and freely into the bladder but of pushing it upward, loosening it from its attachments, dissecting between the bladder and the rectum, or even tearing the urethra across near the neck of the bladder. The prostate is so small that it is necessarily cut entirely through; and the tissues of the child are so delicate that unless extreme care is used extensive traumatism and resulting sterility will result from the operation. There is the advantage in operating upon the child that a finger in the rectum or a hand over the pubes can reach the bladder and aid in bringing the stone into the grasp of the forceps.

In 1878 Bigelow introduced litholapaxy, which after some years became established as the operation of choice among those skilled in its use. The object is to crush the stone and to wash out every particle of it at one sitting. It is scarcely necessary to mention that anesthesia and asepsis are indispensable. The child, anesthetized and surrounded by artificial heat, is placed in the Trendelenberg position. Thus the stone gravitates to the upper and back part of the bladder away from the more vascular region near the neck. The urine is withdrawn by catheter and then four to six ounces of saturated solution of boracic acid at the temperature of the body is injected to distend the bladder. The largest lithotrite that will pass through the urethra without force should be used. It is well to split the meatus urinarius to the fossa navicularis in order to insert as large an instrument as possible. It is passed to the upper and back part of the bladder. The male blade is partly withdrawn, which opens the jaws of the instrument. Its beak is then turned and the stone seized. The instrument is moved from side to side to make sure the mucous lining is not also caught with the stone. The cylindrical handle is now held firmly in the left hand while the screw is turned, closing the jaws and crushing the stone. This maneuver is repeated until the entire calculus is reduced to sand. The lithotrite is closed and opened and closed again empty to prevent any spicules of stone from being held in its jaws during its withdrawal, thus lacerating the urethra. It is now withdrawn and the special catheter introduced. The wash-bottle, containing a few ounces of warm boracic solution, is now attached to the catheter and by compression and relaxation of the rubber bulb attached to the bottle the solution, and with it the sand, is withdrawn from the bladder. The sand falls into the bulb below and does not return into the bladder. This washing is continued until every particle of the crushed calculus has been removed. The necessity for this is not only the irritation that would be caused by its remaining, but because it might serve for the beginning of another calculus. With litholapaxy there is some danger of injuring, even rupturing, the bladder or of rupturing or excoriating the urethra; but a more fre-

quent error is, to fail to remove all the fragments. Before finally removing the catheter the surgeon should auscultate over the bladder while washing to detect the click of a fragment against the catheter. The entire operation may take an hour, less or more, and occasions some shock; but as there is no blood loss this is soon recovered from. There is no damage to the reproductive apparatus as in perineal lithotomy. A possible source of failure in the operation of litholapaxy is inability to crush an exceedingly hard stone. In such a predicament the surgeon should immediately perform suprapubic lithotomy.

Suprapubic lithotomy is not merely a last resort in case of failure to execute litholapaxy. It is preferred to litholapaxy by many surgeons unless the stone is very small, and to lateral lithotomy by many more. It occasions no damage to prostate, urethra or ejaculatory ducts, and no possibility of injury to the rectum. The danger of damage to the peritoneum is not feared since antiseptic surgery is well understood. Infection of the prevesical space or infiltration with urine can be avoided by careful management of the drainage. If the urine is known to be foul, suprapubic cystotomy may be done in two stages, as recommended by Senn. By this plan the incision is made down to the bladder, which is exposed but not opened in the first stage, and several days allowed to elapse during which granulations form under gauze dressings and effectually seal off the preivesical cellular and fatty tissues. Then under local cocaine anesthesia the bladder is opened. If desired the same method can be used in the ordinary case. But the ordinary case in a child is not complicated with a chronic cystitis. The suprapubic operation is well adapted to children also, because with them the bladder projects higher above the os pubis than in the adult, and can be entered without going too close above or behind the bone. The operation is more easily performed by the general surgeon who has not had frequent occasion to remove vesical calculus and become familiar with either lithotomy or litholapaxy. It can be done under the eye without cutting in the dark, and the bladder can, if necessary, be inspected.

The operation is performed as follows: The child's rectum has been emptied by enema. He is anesthetized, placed in the Trendelenberg position, surrounded by artificial heat. It is not necessary to distend the rectum by a water or air bag. The skin is cleansed as if for an abdominal section. The bladder is emptied by a sterile catheter, and then three to six ounces of warm boracic solution are injected so as to fill the bladder moderately. This is held in by gentle compression upon the urethra at the root of the penis by a compress and bandage. An incision through the skin is made, beginning on the upper edge of the center of the symphisis pubis and extend-

ing upward in the middle line a distance of two inches. The dissection is carried down gradually between the recti muscles and prevesical fat until the bladder is reached and laid bare. The bladder can generally be readily recognized by its thickness and greater vascularity and its muscular fibers. Some surgeons, after injecting the boracic acid, tie the catheter in, so that by pressing its end upward toward the incision the bladder wall may be verified. When a small ellipse of the bladder is laid bare, two silk sutures are introduced (without penetrating the mucous lining), one at the upper and one at the lower angle of the incision, so that when the bladder is incised between them the sutures can be used as retractors, being much more convenient than forceps for that purpose. The bladder having been steadied by drawing upon the sutures, and opened with the scalpel, a finger is introduced and finds the stone, which is removed with forceps. The wound in the bladder is then closed with Lembert sutures. Some operators close the external wound also at once. Others prefer to leave it to granulate. If the wound is clean, with no cystitis, there can be no objection to closing it at once. The bladder should be kept empty by catheter.

With stone in the bladder of a girl, anesthesia should be induced, the urethra rapidly dilated and the stone removed by forceps or crushed and washed out. If it is too large or too hard for this method, suprapubic cystotomy should be done.

CALCULUS IN THE URETHRA, FOREIGN BODY IN THE URETHRA OR IN THE BLADDER (52)

A case may present symptoms of stone in the bladder or of obstruction to the flow of urine, and on attempting to pass the catheter or to sound the bladder the surgeon may find the urethra blocked by a calculus, or, in rare instances, by a foreign body placed there by the child himself or herself, or by mischievous companions or by accident. One has known a soft catheter to go adrift from the fingers of an unlucky young doctor. A small calculus is apt to lodge at the fossa navicularis, or at some point higher up. If the stone or the foreign body cannot be removed by seizing it with slender forceps or drawing it out with a tiny scoop fashioned upon the flat end of a probe, it is necessary to incise the urethra upon the obstruction and remove it. Otherwise the blocking of the urethra would result in inflammation and probably sloughing of the urethra at that point, besides serious damage from retention of the urine. But incision of the urethra is not to be too lightly resorted to, for although the wound be afterward carefully sutured, penile fistula may result or the cicatrix contract the urethra at that point.

If a foreign body has found its way into the bladder it will

have to be removed. In a girl, if the body is round like a bead it may sometimes be washed out by flushing the bladder with warm boracic acid or normal salt solution; or this plan may succeed after dilating the urethra. Or, after urethral dilatation, the body may be seized with forceps and extracted. One has had occasion to remove thus, a cotton wad in one case, and a pencil made of chewing gum in another. In a boy suprapubic cystotomy may be required.

RUPTURE OF THE URETHRA

Occasionally the urethra of a boy is ruptured either in its membranes or its spongy portion by falling astride of a fence or the like. This occasions pain and swelling of the part, bloody urine, and, by and by, retention of urine. Later, extravasation of urine may occur with serious local and general consequences, unless the part is freely incised and drained. Immediately after the accident a careful attempt should be made to pass a catheter. If successful, the catheter should be tied in and kept there for several days and then changed. It will probably be necessary to pass instruments at intervals for years if not for life. Ashby and Wright recommend in rupture of the urethra to cut down immediately and unite the torn structure with fine sutures. I have once met also a torn urethra in a girl, who fell from a table, astride of a broken chair. Immediate suture resulted in perfect repair.

EPISPADIAS

Epispadias is that condition of the penis which has been described in the Section on Extroversion of the Bladder. The urethra is merely an open gutter or groove along the dorsum of the penis. It may be present without extroversion or any other malformation of the bladder; but there is apt to be associated with it malformation of the pubic symphysis, which is joined only by ligamentous union. A small bladder with deficient muscular control has also been found in connection with it, the patient not being able to retain the urine when standing. (Partridge, Holmes.) Sexual incompetence and sterility are usual with these patients; yet one should not too hastily consider them all incompetent or sterile, without ascertaining the peculiarities of each case.

Epispadias is not a very common deformity, which is fortunate, for it is not easily nor satisfactorily remedied by surgery.

Treatment.—Treatment is by plastic operation. The older methods consisted of taking a skin flap from the abdomen, groin or scrotum. That described by Holmes, who got the idea from Follin, is a representative of this plan of operation. A flap may be made extending longitudinally upward on the abdomen with its hinge at the root of the penis, as in Segond's operation for hiatus

of the bladder. It should be made of ample size to allow for contraction. The edges of the urethral gutter are then freshened. The flap is then turned down with its epidermal side toward the penis and its raw side up, and attached to the freshened margins of the gutter. The scrotum is then incised transversely in two places, one incision at the peno-scrotal junction and the other at a little distance farther back (or down). The skin of the scrotum between these two incisions is lifted up, which makes a bridge-flap attached at both ends. This flap is brought over the penis with its raw lower surface opposed to the raw upper surface of the newly placed skin-flap. The plan is varied in many ways to suit the individual case. But all such methods have the great disadvantage of placing epidermal surface within the urethra, so that later the growth of hair is very troublesome. To turn the raw surface of a skin-flap inward is less objectionable even with the contraction which is sure to result. To secure suitable material for the construction of the urethra has led to many devices very ingenious in plan, all more or less difficult of execution upon a small field, and some of them dependent for success upon so many fortunate contingencies as to be impracticable for the general run of cases.

Thiersch's operation is one of the less complicated. It is performed in three stages as follows: First, for the formation of the urethra in the glans, an incision is made in the glans longitudinally at each side of the urethral gutter. A glass or metal rod is laid in the gutter or groove, and the lateral portions of the glans, that is, the parts to the outer edges of the incisions, are brought up over the rod, and their raw edges are sutured together with quill sutures. Thus the rod occupies the position of the new urethra. When this portion has completely healed and the urethra is established in the glans the next step is the construction of the penile portion of the urethra.

For this purpose two flaps are made longitudinally upon the lateral aspects of the penis. (See Fig. 233, I, II, and III.) For instance, Flap A has an incision at the left side of the penis and its hinge at the left margin of the urethral gutter. Flap B has its incision at the right margin of the urethral gutter and its hinge on the right lateral aspect of the penis. Flap A is now turned back so that its skin surface covers in the urethra while its raw surface is outward, and is sutured in that position. Flap B is now slid directly across and sutured so that its under or raw surface lies upon the raw surface of Flap A while its skin surface forms the dorsal surface of the new urethra. There still remain two openings, one between the balanic and the penile portions of the new urethra and another at the base of the penis. To close the first opening its margins are freshened and the prepuce is

utilized. The prepuce in epispadias is incomplete dorsally, but somewhat voluminous as it hangs from the under surface. This prepuce is buttonholed by a transverse incision and the glans slipped through the opening. This brings the prepuce on the upper side with its raw surface applied to the freshened margins of

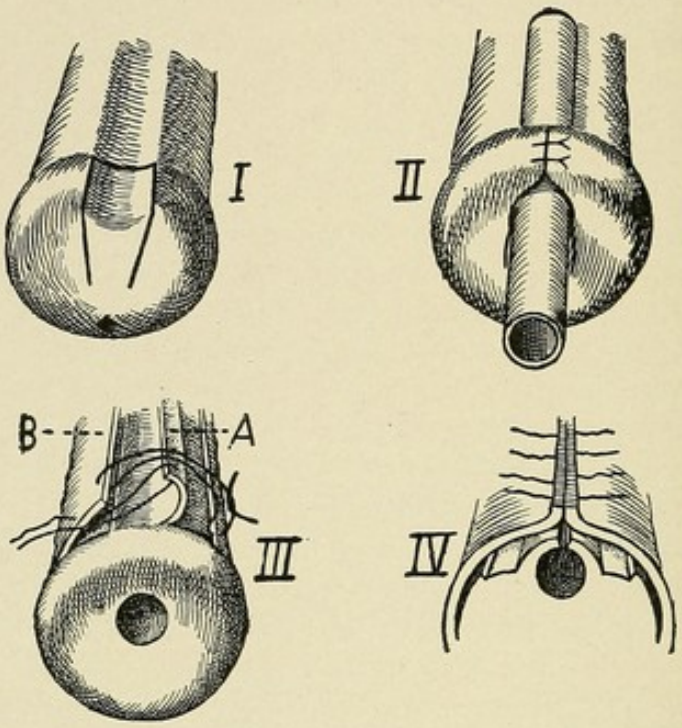


FIG. 233. I, II and III—THIERSCH'S OPERATION FOR EPISPADIAS. IV—DUPLAY'S OPERATION FOR HYPOSPADIAS.

the gap in the urethra, and is there sutured in position. The defect remaining at the base of the penis is closed by turning a small flap of skin from the pubes.

HYPOSPADIAS

Hypospadias occurs much more frequently than epispadias. In the process of development by which the male urethra is formed, a groove appears extending from the uro-genital sinus forward along the perineum and the under surface of the penis to the end of the glans. Then the margins of this groove arch over and join, thus forming a canal, the closure taking place from behind forward. If this closure fails to take place there is present this condition called hypospadias. The arrest of development may take place at any stage—when the closure has gotten no farther than the perineo-scrotal region, or more frequently when it has proceeded to a point somewhere in the penile portion, or,

commonest of all, the canal may end, very likely in a pinhole orifice or a tiny slit underneath the glans. In these cases the prepuce may be normal, but is usually deficient on the under surface and gathered like a voluminous hood upon the dorsal aspect. Hypospadias in its more severe forms is apt to be associated with adhesions between the under surface of the penis and the scrotum by which the penis is tied down by fibrous tissues covered with integuments. Another malformation of the urethra is its closure by a membranous septum at its distal end while it has an opening in the penile or perineal regions.

Treatment.—When the incomplete urethra terminates somewhere near the distal end of the penis it is not really necessary to do anything for its extension. But if it is thought desirable to complete the canal it can be done. There are a number of operations for this purpose.

Beck's operation is by dissecting up a portion of the urethra and stretching it forward and transplanting it into the urethral groove on the under side of the glans, which has been freshened to receive it. In case there is no groove or gutter which can be utilized, Ochsner and others have perforated the glans and pulled the mobilized urethra through this perforation and sutured it there. Or the redundant prepuce can be used as a flap. By this method an incision is made transversely across the prepuce and the glans thrust through this. This maneuver brings the bridge of skin upon the under side, the surface of which has been properly denuded for apposition with the raw surface of the flap. The flap is then sutured in position.

When the urethral orifice is closed by membrane it will require opening; and when diminutive it will need dilating, sometimes quite persistently. A small gap in the perineal or penile urethra may be closed by a small skin flap carried over; but the lack of a large portion of the urethra or the tied-down condition of the penis will necessitate a considerable amount of work for their correction.

Thiersch's operation as described for epispadias may sometimes be adapted to hypospadias.

When the penis is curved downward and held by adhesions it must first be set free and straightened. Duplay does this by dividing the fibrous bands transversely. This can be done subcutaneously. But often the skin also is at fault, and it is better to divide both the skin and the fibrous adhesions. Several such incisions may be necessary. The penis is then stretched upward, which renders the transverse incisions longitudinal, and they are sutured in that position. The penis is dressed in a straight positon strapped up against the abdominal wall during the process

of healing. After the organ has been thoroughly straightened, or in cases in which it was not bound down, one may proceed at once to the formation of the urethra. This begins with the glans, for which Thiersch's operation for epispadias may be adapted. After the balanic urethra has been established comes the task of constructing the penile portion. To avoid the continual soiling of the field of operation and the wound, it is often best to establish perineal drainage. C. H. Mayo advises the use of a Jacobs self-retaining female catheter introduced through the perineal wound.

C. H. Mayo and Van Hook each have a very ingenious operation. Or Duplay's operation, or some modification of it, may be employed. (See Fig. 233, IV.) Two longitudinal incisions are made, one at each side of the urethral gutter, parallel with it and about three-eighths of an inch from it. Transverse incisions are made at the ends of these, and long, narrow flaps are dissected up with their hinges at the margins of the urethral gutter. Two other skin flaps, one at each side, are formed by dissecting back from the first incisions. A glass or metal rod is now laid in the urethral groove or gutter and the first two flaps are turned up over it with their skin surfaces inward toward the rod and their raw surfaces outward. They should not be so wide that their margins meet over the rod. The two lateral flaps should now be slid up over these and attached in the middle line with quill sutures or lead button sutures, with the raw surfaces partly in contact along the middle line and apposed to the raw surfaces of the two first flaps which are lying over the rod.

ADHERENT PREPUCE

In fetal life the mucous lining of the prepuce is normally adherent to the glans, and this condition frequently lingers at birth. Occasionally continued development after birth soon frees the adhesion, but quite as frequently if neglected it becomes stronger. It may give rise to many of the symptoms caused by phimosis, but the most frequent are retention of segma, and balanitis. It should receive attention in every instance without waiting for symptoms. The prepuce should be retracted by force, using a probe or grooved director as a blunt dissector if necessary to separate membrane from glans. The smegma is washed away, the part dried and lubricated with sterile olive oil carbolized one per cent., or with sterilized vaseline, and the prepuce drawn forward. The part should be cleaned daily and dressed in the same manner until each raw surface is healed soundly and separately, and should be cleansed daily thereafter at the bath.

PHIMOSIS

Phimosis is a malformation in which the prepuce is too tight to be retracted upon the glans penis. The tight foreskin may or may not be redundant at the end; and its mucous lining may or may not be adherent to the glans. The orifice may be occluded or small; or far more frequently, even in the cases of redundant prepuce, there is a sufficient opening for passage of urine. Every case of phimosis needs attention. I am not one of those who attribute all the ills of the flesh to phimosis, yet am quite certain it is capable of giving rise to one or more of a troublesome list of symptoms and conditions. The effects of phimosis may result directly through mechanical obstruction to the outflow of urine; such as painful urination and retention of urine. Later this may be so extreme as to cause dilatation of the ureters and the kidney pelves, with the degeneration of the kidney structure that follows blocking of the urinary canal at any point. Hernia, either inguinal or umbilical, may be caused and perpetuated by straining during micturition. Prolapsus ani sometimes results from the same cause. Other effects are produced reflexly through the nervous system. For example, retention of urine from vesical spasm, incontinence from irritation, muscular spasm in a lower extremity causing a limp simulating early hip-joint disease, extreme nervousness and irritability, constipation from reflex inhibition, insomnia or night terrors. With this last-mentioned symptom the boy is in the act of falling asleep when an erection occurs producing pain from tension upon adhesions, or irritation which causes him to wake with a startled cry; when he settles back to sleep again the same performance is repeated, and he becomes worn and nervous. Or the priapism leads to masturbation.

Chorea, epilepsy, amaurosis or strabismus I have never met as reflex effects of phimosis. Another group of results come about by retention of smegma preputialis and interference with cleanliness. Smegma may be accumulated in masses of the size of lentils or larger masses beneath the prepuce, usually behind the corona. One has seen a collection of the size of a navy bean embedded in the glans which was correspondingly misshapen. Retained secretion seldom gives rise to malformation, but often to irritation, and, becoming infected, causes inflammation. Thus balanitis is a common consequence of phimosis; and occasionally leads to urethritis and cystitis.

Treatment.—The best time for treatment is in infancy. With the exception of those unusual cases in which the flow of urine is entirely or almost entirely prevented, treatment may be post-

poned until the umbilicus has healed, or even for a month or two; but there is no advantage in waiting longer; and there is great disadvantage in waiting until the boy runs about and is difficult to restrain during the healing process following operation; or until balanitis has occurred, perhaps with retention, and one is obliged to cut through the swollen and infected prepuce in order to cleanse beneath it. A slight degree, but only a very slight degree, of phimosis should be treated by stretching. Even some cases that might be stretched are better treated if the prepuce is redundant, by circumcision. When repeated stretchings are necessary it is far better to circumcise. The prepuce should not only be retractable, but it should retract freely, and it should easily fall forward again without constriction, lest paraphimosis occur, and this looseness should be secured without the numerous manipulations of repeated stretchings and oilings that some advise. The better plan is circumcision or a modification of that operation. It is not invariably necessary to remove a part of the prepuce. Sometimes it is sufficient to insert a grooved director beneath the mucous lining of the prepuce, move the instrument all about until the adhesions are freed, then split up the prepuce upon the director so as to expose the glans almost to the corona. The corners left in front by the incision may then be rounded off if necessary and a stitch or two be taken at each side to unite the mucous lining and skin.

Circumcision is a small operation, yet it is worth doing neatly and surgically. In very young infants an anesthetic is not necessary; but from six months or a year and upwards anesthesia should be used. The part should be cleansed with soap and water and then by an antiseptic solution.

It is a great convenience to use a small rubber band as an Esmarch around the root of the penis. The redundant prepuce is then drawn forward with forceps, taking care not to draw much more upon its skin than upon its mucous lining. It is then seized just in front of the glans with a pair of thin bladed forceps or the like, and cut off in front of that instrument, which protects the glans from injury. The prepuce is then released and immediately retracts some distance upon the glans, usually farther than the mucous membrane, especially if the latter is adherent. The amount of prepuce that should be removed is a matter of judgment. There should always be enough left to cover the corona glandis when the operation is completed, and one aims to have it of sufficient length to expose but half of the glans. The mucous lining of the prepuce is now loosened from the glans by passing under it a grooved director, and, together with the skin split up to the proper distance, taking care not to incise the meatus at the same time. The corners thus made are rounded with scissors;

and any redundance near the frenum may be trimmed off. The cut margins of the mucous membrane and skin are united by interrupted sutures of fine catgut, first placing one at the angle of the dorsal incision and one at the frenum including the artery. It is worth while to suture each third of an inch. The Esmarch is then snipped open with scissors. If one or two points bleed they may be conveniently caught by an extra suture. After trying many dressings for circumcision I long ago found sterilized olive oil phenolated 1 per cent., the most comfortable and satisfactory. Gauzes, collodion and the rest are all uncomfortable or stick to the wound, or become urine soaked. A narrow strip, a foot or more long, of absorbent cotton should be torn off the layer, and wound about the penis. The organ should be thickly enveloped in the cotton from the root to the meatus. A few drachms of the carbolized oil are then poured in upon the glans, and a patch of cotton laid upon the top. If the boy urinates the urine runs over the oily cotton and does not affect the wound; the oil also tends to prevent readhesion of the mucous membrane and glans. The mother is directed to pour on a drachm of the oil once or twice a day. Some cases are then lightly bandaged around the waist. If the cotton stays in place it is left two days before the first change. The mother is taught how to apply the dressing if the child's restlessness displaces it. The fine catgut sutures usually never need to be removed, as they come away in a few days.

PARAPHIMOSIS

In paraphimosis a somewhat tight prepuce has been retracted behind the corona glandis and caused constriction interfering with the circulation in the parts distal to it. If unrelieved, ulceration and sloughing would occur, sooner or later, according to the degree of the constriction. It is not necessary that the constricting band be extremely tight to cause edema and inflammation. Fig. 234 was photographed on the third day. It shows a constriction only moderately tight, so that for a moment the inexperienced might doubt the nature of the ailment.

Treatment.—The glans must be reduced through the constricting ring or band of the tight prepuce. An anesthetic is generally, though not always, necessary. The corona is then lubricated with oil or vaseline, and the penis encircled, just behind the swelling, by the left index finger and thumb of the surgeon. The swollen glans is then gently and persistently pressed backward by the thumb and fingers of the right hand, while the prepuce is pulled forward with the left, until, the edema having been lessened, the glans recedes through the constricting prepuce. A few minutes' time is usually sufficient for a reduction. But

the process may be much more difficult and tedious. The tissue may be so stiffened from the swelling that relief by this method is impossible. In this case the constriction must be divided longitudinally in the middle line upon the dorsum of the organ, by passing under it a sharp-pointed curved bistoury. A wet antiseptic dressing should then be applied. Following every case of paraphimosis, when the swollen tissues have returned to the normal condition a circumcision should be performed.

OTHER CONSTRICTIONS OF THE PENIS.

Constriction of the penis by a thread or string or rubber band, wire, or metal ring is occasionally met, and the encircling body, if

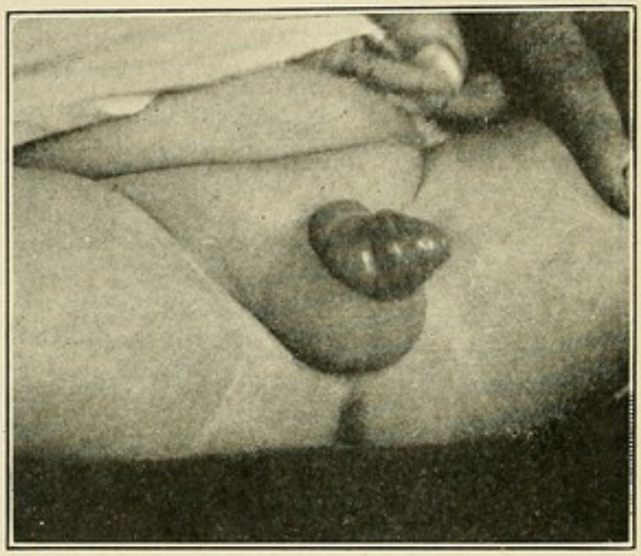


FIG. 234. PARAPHIMOSIS. Only moderately tight constriction 3d day. 18 mos.

narrow, may so bury itself in the swollen tissues as to be hidden. A suspicion of the cause should be suggested by the swelling and lead to its discovery and division.

Treatment.—The removal of a metal ring may be facilitated by bandaging the penis with a narrow bandage tightly and evenly applied beginning at the distal end and squeezing back the blood and serum, part of which may be allowed to escape through needle wounds. When the size of the penis has thus been reduced and a lubricant used the ring may be slipped off. I was once obliged to remove from a boy's penis a heavy steel ring by slipping diagonally beneath it a fine saw such as jewelers use, and cutting outward.

DISLOCATION OF THE PENIS

may be produced by direct violence so that it is thrust downward within the scrotum. It should be restored to its position by careful manipulation.

BALANITIS

Balanitis or inflammation of the prepuce may be due to the presence of the ordinary pyogenic organisms or to the germs of gonorrhea, diphtheria or erysipelas. Phimosis favors infection by retaining the secretions, which decompose. Traumatism sometimes starts the trouble. One has seen it caused by slovenly efforts at loosening preputial adhesions and stretching of the foreskin.

Treatment.—Treatment is by removing irritating material such as smegma from beneath the prepuce and behind the corona. This may sometimes be accomplished by the use of a syringe, and solution of mercuric bichloride, 1 to 4000 or 1 to 5000. Dressings wet with the same solution, or with lead and opium wash, or boric acid solution should be constantly applied.

In the gonorrheal forms the use of silver nitrate solution one or two per cent., or of argyrol solution 10 to 15 per cent., once or twice a day, with mild lotions at short intervals, are efficient. Ice, or ice patches in the acute stages and bathing with hot solutions in passive edema are useful. In phimosis it may be necessary to split open the prepuce in order to cleanse beneath. The circumcision should not be completed during the attack of inflammation, but subsequently.

URETHRITIS

Urethritis may occur independently, but is more often associated with balanitis. It may be simple or gonorrheal. Simple urethritis seldom extends deeper than the fossa navicularis.

Symptoms and Diagnosis.—The simple form causes pain on micturition, and a discharge of pus, and sometimes gluing together of the lips of the meatus with the discharges. The gonorrheal form is more severe, extends deeper and is more persistent. In fact it may present the usual symptoms and complications of the same disease in the adult although they differ in their relative frequency. Constitutional symptoms and orchitis are less common in the boy than in the man. Arthritis occurs, infrequently, but sometimes in a severe form. (See Section on Gonococcus Arthritis.) Conjunctivitis is a far more frequent complication. Secondary lymphadenitis occurs. One should not be surprised at discovering specific inflammation of the genito-urinary organs in very young boys or even in infants, although it is far less common than vulvovaginitis in little girls. The detection of the gonococcus with the microscope is the only positive proof of gonorrhea.

Treatment.—Treatment is the same as in the adult, with the

exception that a great deal more care is necessary to prevent the infection from being carried by the hands of the patient to the eyes or other mucous membranes or to other persons. The parts should be kept dressed with gauze, which should be changed frequently at each cleansing and irrigation or swabbing with antiseptic solutions, such as mercuric bichloride 1 to 5000, argyrol 5 to 20 per cent., protargal 2 to 10 per cent., potassium permanganate 1 to 2000. The urine should be rendered bland and unirritating by alkaline diuretics and the free drinking of water.

UNDESCENDED TESTIS, AND MISPLACED AND HIDDEN TESTIS

The testes, formed in the abdomen, usually descend into the scrotum during the ninth month of fetal life. Yet it is quite common to find in the male infant at birth, that one or both of the testicles are absent from the scrotum. The missing organ may sometimes be discovered by sweeping the finger down over the inguinal canal, or it may remain hidden quite within the abdomen. In many of these cases the descent is completed during the first few weeks of life, and the delay is scarcely a departure from the normal. But it may persist, and this condition, known as cryptorchidism is a worrisome malformation, especially if both testicles are concealed within the abdomen. They may descend at some indefinite time before puberty, but as the boy grows older and they fail to appear the chances lessen, the anxiety of the parents increases, and the boy himself realizes that something is wrong. In other cases the testicle descends, but through some misattachment of the gubernaculum testis it is misguided on its journeys, and fails to enter the scrotum, but lodges in the groin or perineum.

This latter is not so serious a matter, as the wandering organ may functionate out of its usual situation. However, it incapacitates for some athletic exercises and for cavalry service, it is very apt to be injured, and may undergo degeneration. The testicle that remains within the abdomen, even if originally of normal development, becomes degenerated and valueless by the time it should be of use. It may become inflamed and simulate strangulated hernia, or become gangrenous, or produce peritonitis, or become the seat of tumor or of tubercular disease. A testicle that lingers in the inguinal canal may be attached to a loop of intestine and induce a hernia when it descends.

The diagnosis presents no difficulty if one only remembers, in case of finding a small, elastic and usually sensitive swelling in any of the possible situations of a misplaced testicle, to examine the scrotum as to whether both testes are in their right places.

Treatment.—In the very young subject the testicle lingering in the inguinal canal may be assisted in its descent by manipulation repeated each time the infant is diapered. In those cases in which the testicle appears sometimes outside of the abdomen and again disappears within, and yet is not attached to a loop of intestine, it may be caught outside and prevented from returning within by the application of a truss. With a testicle in any of the erratic situations outside of the abdomen, operation is not absolutely demanded unless the misplaced organ is painful; yet it may be transplanted to the scrotum. As an exception may be noted the very rare instances in which the wandering testis has emerged at the femoral ring, in which case it should be undisturbed unless too troublesome, when it should be removed. If a testicle in the inguinal canal is attached to a loop of bowel an operation is required, both for bringing down the testicle and for replacing the bowel and closing the inguinal ring. With both testicles retained within the abdomen, or inguinal canal, or undescended or misplaced upon the outside of the body, it is very desirable that one or both should be transplanted to the scrotum, or at least liberated from the abdominal cavity.

The best time for operation is after the boy has attained sufficient age and strength and the parts are large enough to manipulate conveniently, therefore, not until the sixth year. Yet operation should not be postponed until puberty, as the organ will better undergo the developmental changes of that period if in its normal than in an abnormal situation. Hence, the eleventh or twelfth year is a favorable age for the operation. Yet if an associated hernia demand operation at an earlier age it may be done in connection with the hernia operation at any time after the fourth year. The principles of the operation are the same whatever the situation of the erratic testis. Bevan has considered the subject fully,[1] and his directions are practicable. First, in case the testicle is in the inguinal canal or outside the external ring, an incision is made upon the canal, from the external ring upward and outward a distance of three inches. The incision does not involve the scrotum. The aponeurosis of the external oblique is divided and retracted the same as in a Bassini operation for inguinal hernia; and then the cremasteric and transversalis fasciæ are divided throughout the whole length of the wound. The testicle is then discovered with its pouch of peritoneum. The peritoneum above the testicle should be carefully separated from the cord, and that portion of it in contact with the testicle should be retained as a tunica vaginalis, being cut off from the rest and closed with a purse string suture of catgut. The peritoneum is

[1] Jour. Am. Med. Assn., Sept. 19, 1903.

closed with ligature or suture. The testicle is now lifted from its bed, and the length of the cord is tested, and increased by gently pulling upon it and freeing it by blunt dissection from short bands of connective tissue which restrain it. All surrounding fascia should be stripped from the cord, leaving nothing but the vessels and the vas which should be freely separated from the peritoneum by blunt dissection. By these means the cord should be so freed and lengthened that the testicle may be brought down several inches below Poupart's ligament. If the cord is still not long enough there are other means for lengthening which will be described later. The fingers are now passed in at the lower angle of the wound and down into the scrotum and form a pocket there, in which the testicle is placed. The mouth of the pocket is closed by suture which also passes through the internal and external pillars of the ring, above the cord, but is not drawn tight enough to exercise pressure on the cord.

The wound is closed as in the Bassini operation, but without forming a new canal for the cord; that is, the conjoined tendon and Poupart's are sutured together superficial to the cord.

Secondly, in case the testicle is within the abdominal cavity, or in case the cord is not sufficiently lengthened by the foregoing method, the inguinal canal should be opened as before described. If the testicle is within reach it should be drawn out at the opening with the finger and loosened by blunt dissection. It will be found that the obstacle to the descent of the cord is not the shortness of the vas but of the spermatic vessels whose integrity is not essential to the nutrition of the testicle. The testicle receives a sufficient blood supply from the artery of the vas, as Bennett long ago taught. The spermatic vessels should be doubly ligated and divided; and when this is done it will be found that the testicle can be brought down into the scrotum. (53)

Thirdly, there are to be dealt with those cases in which the testicle is misplaced in the perineum or upon the groin. It may be that only a few fibers of the gubernaculum hold it in the abnormal situation, and when these are divided the organ is readily placed in the scrotum. Or if this fails the organ is exposed through an incision and with the cord turned up toward the injured ring. Then by tunneling under skin and fascia, or by an incision above the scrotum and the formation of a pocket in that receptacle, it is transplanted into its normal site.

SUPERNUMERARY TESTIS

One occasionally hears of a supernumerary testicle, but on coming to examine the boy thus favored beyond his fellows, one finds a hydrocele or a hernia or a tumor, or tuberculosis of the epididymis.

TUMORS OF THE TESTIS

Tumors of the testis are either congenital or acquired, and are innocent or malignant. Congenital tumors are said to be usually dermoids, although myoma, adenoma, enchondroma, sarcoma and carcinoma have been reported. Dermoids of the testicles are extremely rare (see Section on Dermoids in the Chapter on Tumors), most of the cases reported as such having proved to be dermoids of the scrotum. Innocent cysts connected with the seminal tubules occur. But all innocent tumors of the testicle are very rare in children. Carcinoma less frequently occurs than sarcoma. It is usually congenital and runs an extremely rapid course to a fatal end. Sarcoma, the most frequent of the malignant tumors of early life, is a disease of childhood rather than of infancy. The tumor usually begins in the epididymis or the testis itself rather than its coverings. It is generally smooth and rounded in its outlines, and heavy. It is generally hard, although it is apt to undergo cystic degeneration and to fluctuate in some part. In these points it resembles dermoid, though it may be mistaken in the beginning for tubercular epididymitis or gumma. But these enlargements, and all innocent neoplasms, are slow in growth, while sarcoma is rapid.

Treatment.—The treatment of tumors of the testicle is prompt removal. The innocent tumors would do no harm, at least for a time. But with the malignant growths the only hope lies in early and complete extirpation. By the time a certain diagnosis of malignancy can be made it may be too late to prevent a recurrence after removal. If the lapse of time, together with other characteristics, has already proven the innocence of the growth, it may not be necessary to sacrifice the testicle in the removal of the tumor.

ORCHITIS

Acute orchitis usually occurs from traumatism. This may be either accidental injury, or surgical trauma in the neighborhood, such as operations for hernia or hydrocele, or the pressure of a truss upon an undescended testicle mistaken for a hernia. It usually subsides under rest, elevation of the parts, and the use of lead and opium, or other lotion. Orchitis from mumps and gonorrhea must be extremely rare in boys.

TORSION OF THE SPERMATIC CORD

This curious accident I have never met, but cases have been reported by Nicoladoni, Bryant, Owen, and others. It may occur at any age, though most frequently in adolescents or young adults, and is more apt to take place when the testis has not completely de-

scended into the scrotum. The loose suspension of the testis, while it allows of escape from many injuries, seems to favor this accident. Other predisposing causes are flat shape of testis, and the flat or rather double shape of the cord. As exciting causes various forms of violent exercise have been mentioned, but in other cases no cause is given.

The spermatic cord is found to be twisted upon its own axis, having turned once or more, and is strangulated according to the degree of the twisting and the length of time it has remained in that condition. Inflammation or gangrene may have supervened. The tunica vaginalis contains fluid. Sloughing, or in less severe cases atrophy of the testicle, may result.

Symptoms and diagnosis.—A swelling appears in the scrotum, inguinal canal, or groin, together with pain and nausea, a quick pulse and symptoms of shock. The swelling is firm, tender, dull on percussion and irreducible, and the scrotum may be reddened. There is no impulse on coughing. There may be tension of the abdominal muscles, and constipation. Some fever is usually present after a time. This condition in a boy is apt to be mistaken for strangulated hernia, or for traumatic orchitis, or lymphadenitis. But if torsion is borne in mind and the case examined attentively such a mistake need not occur.

Treatment.—An incision should be made exposing the testicle and the cord and their condition examined. If the inflammation has approached gangrene the testicle would better be removed, for even if it does not slough it will atrophy. But if the tissues appear viable the cord should be untwisted and an effort made to relieve the circulation by irrigating with a hot saline solution, or to subdue the inflammation if that is present.

VARICOCELE

Occasionally cases of varicocele in boys have been reported. It is certainly not a common condition in childhood, though not infrequent during adolescence.

TUBERCULOSIS OF THE TESTICLE AND OF THE EPIDIDYMIS

Tubercular orchitis and epididymitis, either singly or together, occur not infrequently in childhood as a local manifestation or as part of a general tuberculosis.

Etiology.—The disease may be primary, but in the majority of cases general infection or other local infection precedes that of the testicle or epididymis. Direct inheritance of tuberculosis occurs with extreme rarity.

Pathology.—The tubercular deposit may appear first in the

epididymis, and then extend to the cord and testis; or it may occur in the testis itself. In some instances, a fibroid change takes place and the tubercular masses entirely disappear. In other cases caseation occurs as with tubercular inflammation elsewhere, and abscess forms and discharges. This is especially liable to occur if pyogenic organisms gain access to the tubercular focus. In mixed infections the lymphatics are more likely to be involved and other foci to become infected and to suppurate.

Symptoms and Diagnosis.—The disease comes insidiously, often being discovered by accident. A history of previous traumatism may be given, but this may be true also of sarcoma, of hydrocele and hernia and even syphilitic testitis. A swelling is found in the testicle or the epididymis or both. The swelling is painless and not tender, nodular or irregular in outline, hard, and grows slowly. Occasionally the onset is more acute. If it suppurates it forms the usual sinuses with livid edges, and runs the slow but persistent course characteristic of tubercle. In suppurating cases there are usually other local manifestations of surgical tuberculosis.

Prognosis.—If the general health can be improved and the local condition be properly treated the trouble may subside, although it is probable that the testicle will subsequently atrophy. Extension to the vas deferens, vesiculæ and bladder is not common.

Treatment.—General treatment for tuberculosis should always be thoroughly and perseveringly carried out. (See Section on Tuberculosis.)

Locally a suspensory bandage should be used. Inunctions of ointment of mercury or of iodide of lead are useful. Also pressure by bandage or strapping. If suppuration persist, or if the part be found riddled with sinuses, it is better to remove it. If only an epididymis is diseased, it may suffice to remove that alone.

SYPHILITIC TESTITIS

This is a very unusual manifestation of lues hereditaria. Both testicles are apt to be affected, with smooth and regular swelling. The epididymis remains free. The swelling disappears under the use of mercury internally, or locally by inunction, and of potassium iodide.

HYDROCELE IN THE MALE

Hydrocele is congenital or acquired. The congenital form is chronic, the acquired may be acute or chronic. The congenital exists because of a fault in the process of development of the tunica vaginalis testis, its watery accumulation being derived from the peritoneal cavity. Other variations in this process of development determine which of several varieties will occur if the disease, acute

or chronic, is acquired as a result of some irritation of the serous sac. Hydrocele in any form may occur upon one or both sides. (See Fig. 235.)

Development of the tunica vaginalis testis.—The testicle in its developmental descent from the abdominal cavity to the scrotum, carries with it upon its anterior aspect a process of the peritoneum. This process should become sealed off from the general peritoneal cavity at the internal ring, and the portion of it which extends from the ring to the upper end of the testicle should become obliterated as a cavity, remaining merely as a strand of fibrous tissue. Only the

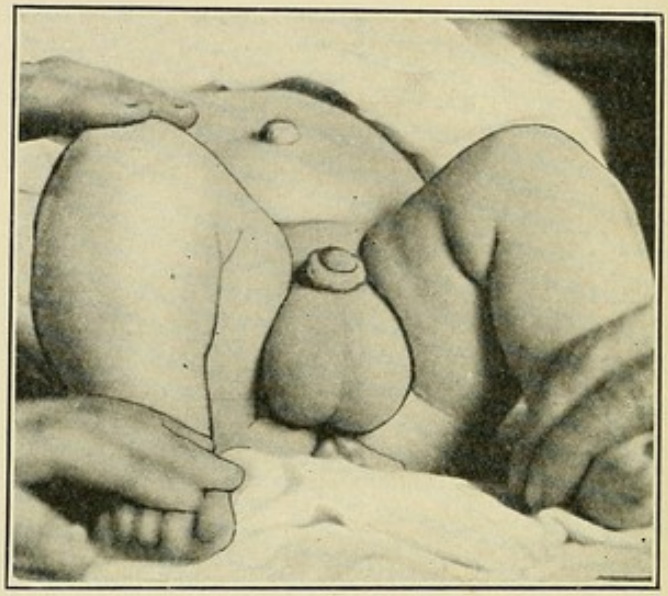


FIG. 235. DOUBLE CONGENITAL HYDROCELE AND UMBILICAL HERNIA.

lower end of the serous sac, that which lies in front of the testicle, should remain a serous cavity, the tunica vaginalis testis.

CONGENITAL HYDROCELE.—But the vaginal process may fail to separate from the peritoneal cavity, and being filled with serous fluid from that cavity forms a congenital hydrocele. (Fig. 236.) This appears as an elastic swelling in the scrotum and cord. It is translucent. That is, if in a darkened room a light be held at one side of it and shaded by the hand, while the tumor is viewed through a spool or any opening a third of an inch in diameter placed against it opposite the light, it appears semi-transparent.

A solid tumor or a hernia does not transmit light in that manner. The fluid from this hydrocele can be gradually squeezed into the abdomen when the patient is recumbent, and on releasing the scrotum and the ring, with patient upright, the sac gradually refills. The fluid does not disappear at once in a mass as a hernia might, nor reappear in the same manner, but gradually, as the fluid runs through the narrow opening at the neck of the sac. Congenital hernia and hydrocele may and often do coexist. Or the opening of the

hydrocele may, through extra strain, be enlarged and allow a knuckle of intestine to protrude.

FUNICULAR HYDROCELE.—Separation may take place only be-

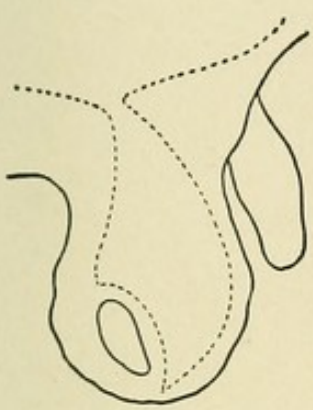


FIG. 236. CONGENITAL HYDROCELE. Entire vaginal process fills with peritoneal fluid.

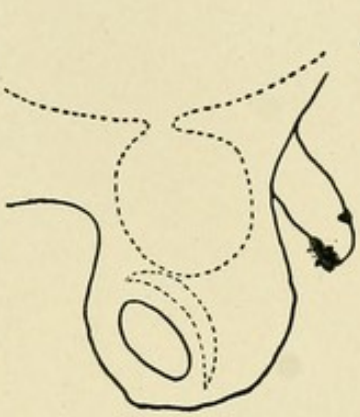


FIG. 237. FUNICULAR HYDROCELE. Funicular process only fills with peritoneal fluid.

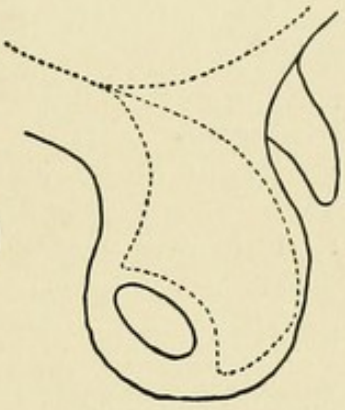


FIG. 238. INFANTILE HYDROCELE. Vaginal process a short sac filled with fluid.

tween the tunica vaginalis and the funicular process, leaving the same condition as that of congenital hydrocele, excepting that the testicle with its serous portion is below the swelling. (Fig. 237.)

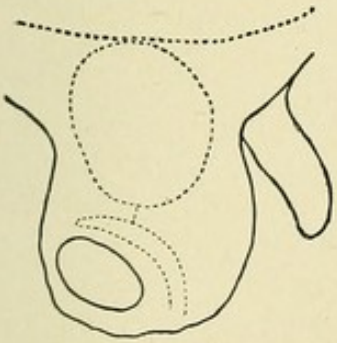


FIG. 239. HYDROCELE OF THE CORD. Funicular process only distended with fluid.

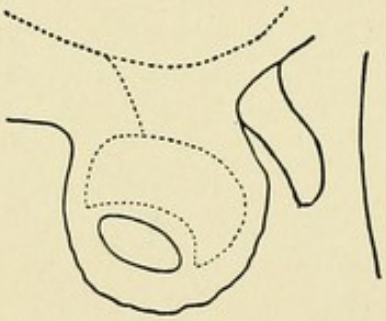


FIG. 240. HYDROCELE OF THE TUNICA VAGINALIS TESTIS. Funicular process closed. Tunica vaginalis only distended.

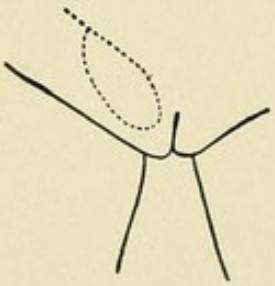


FIG. 241. HYDROCELE OF THE CANAL OF NUCK. Corresponds to infantile hydrocele in the male.

INFANTILE HYDROCELE.—Here occlusion of the opening into the peritoneal cavity has taken place, and fluid accumulated in the common sac of the tunica vaginalis and funicular process. (Fig. 238.) The swelling presents the translucence of the congenital variety and of all hydroceles, but it does not yield to pressure because the fluid does not escape. The tumor is somewhat pear-shaped, rounded below and pointed at the inguinal ring. The testicle is behind and below it.

HYDROCELE OF THE CORD.—The tubular part of the serous pro-

cess corresponding to the cord has become separated from the peritoneum and from the tunica vaginalis, and is distended with fluid. (Fig. 239.) It forms a firm elliptical swelling, between the testicle and the inguinal canal, sometimes extending quite into the canal to the internal ring. This variety of hydrocele more than any other is apt to be mistaken for a solid tumor or for hernia. Both Holmes and Owen record the common experience of seeing children wearing trusses over such cysts. Twice in the last two months cases of this kind have been sent to me as "irreducible hernia," by physicians. They do resemble hernia, and the test for translucence cannot be applied. But they are harder than a hernia, have not the thickness at the neck, are very regular in outline, have no tympany or gurgling.

Hydrocele of the Tunica Vaginalis Testis.—(Fig. 240.) Ordinary hydrocele is less frequently met in children than the other varieties. Its situation, feel, and translucence make diagnosis easy.

Hydrocele in the Female.—Hydrocele may occur in the canal of Nuck, and, being sealed off from the peritoneum, appears as a small, firm, painless, subacute or chronic swelling between the inguinal canal and the labium. (Fig. 241.)

Treatment.—Many of the acute hydroceles, which come from no very clearly defined cause, in the course of an erythema about the genitals or buttocks or perhaps from squeezing the parts between the fat thighs of the infant, disappear spontaneously after a few weeks; also that after scarlet fever. If there is any possible source of irritation in the neighborhood, such as phimosis, balanitis, or a skin eruption, this should be treated. The swelling should be so supported that it is not caught between the thighs. The congenital and funicular varieties should be treated by trussing. Very likely the opening between the sac and the abdomen will close. If it does not, it should in due time be closed by operation upon the same principles as the radical operation for hernia. The other varieties, if they persist after several weeks, may be dissipated by one or two tappings. If this does not cure, some advise injecting a 1 to 5000 solution of mercuric bichloride or a wine-colored solution of iodine, or a few drops of carbolic acid in glycerine, into the sac. The irritant sets up a moderate inflammatory reaction in the lining of the sac, which stops the extra secretion.

Injection methods should never be tried in the congenital, funicular, or infantile varieties. In the first two the irritant will surely escape into the peritoneal cavity and cause trouble. In the infantile form one cannot be sure the separation from the peritoneum is quite complete. And I have more than once known an infantile hydrocele to suddenly disappear into the abdominal cavity, presumably bursting open the old channel which had been closed. Once this

occurred just as I was preparing to operate. I do not use injections at all; preferring, if anything more than tapping is necessary, one of two procedures. One is to lay open the scrotum, dissect out the sac, tying off its neck and closing the wound. If it is infantile hydrocele, a small portion of the sac may be left below to serve as a tunica vaginalis. The other plan is to lay open the sac, touch its interior walls with carbolic acid, removing any excess, and pack the cavity with gauze to close by granulation, or, after granulations form, by adhesion.

CYST OF THE SPERMATIC CORD

A condition may occur exactly resembling chronic hydrocele of the cord in its symptoms and external appearance, being in the same situation, oblong in shape, so tense as to seem almost solid, translucent, not very painful. But upon operation it is found that by careful dissection the thin walled cyst can be removed entire, not being continuous at either end with the tunica vaginalis or the fibrous remains of the funicular process. (See Fig. 242.)

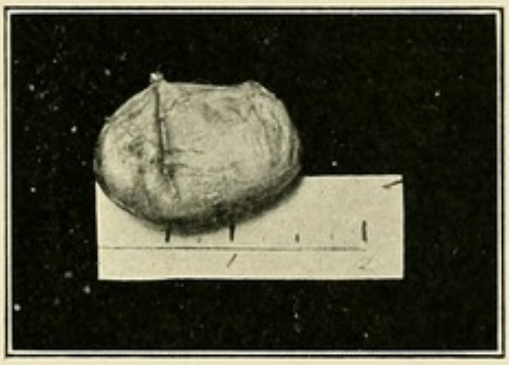


FIG. 242. CYST OF THE SPERMATIC CORD.

One seldom finds any account of such cysts in the text-books. They are probably not hydroceles, but remains of the hydatids of Morgagni, persisting from embryonic life and developing in cyst-like form in close proximity to the spermatic cord.

Treatment.—They may be treated exactly the same as hydrocele. Enucleation is a much nicer method than by opening and cauterizing with carbolic acid.

MISPLACEMENT OF OVARIES

Misplacement of ovaries may occur either congenitally or later. One or both ovaries may be found in the inguinal canal or the canal of Nuck, or in the femoral canal. They may be reducible, or, becoming attached in the malposition, may be irreducible and subject to injury like the misplaced testis, or to pain and swelling at the menstrual periods. Hernia of intestine may follow the wandering ovary.

Treatment.—If reducible, a truss should be used. If irreducible and giving trouble, an operation should be performed restoring the ovary to the abdomen and closing the opening as in the radical operation for hernia.

OVARIAN TUMORS

Ovarian tumors may occur at a very early age, being sometimes even congenital. They are either innocent or malignant. The innocent tumors are simple cystic, fibroid, or dermoid (or tridermic —see Chapter on Tumors). The malignant tumors are either sarcomata or carcinomata, the former being far more common. (54)

Symptoms and Diagnosis.—It is sometimes extremely difficult to make a diagnosis before operation as to the nature of the tumor and as to its attachments. Rapid growth and ascites point to malignancy. A tumor that is freely movable is more apt to be ovarian than renal or hepatic. If ascites is present, tapping may be required before the tumor can be palpated. Examination with one finger in the rectum and the other hand over the abdomen may assist in locating the attachment. Precocious puberty is said to be present in some cases of ovarian tumors. Ashby and Wright mention a case of such premature development associated with a tumor of liver and kidney. Hydronephrosis, which may be congenital, hydroperinephrosis, cysts of the mesentery, hydatids of the kidney, tuberculous masses in the mesenteric glands, tubercular peritonitis, pyosalpinx, and in older children retained menses and precocious pregnancy are also to be excluded.

Treatment.—The treatment for tumors is operation. If the tumor is innocent and has not too many or too close attachments to important viscera, it can be successfully removed with no fear of its recurrence. A malignant tumor removed early and completely may not recur. But in most cases of maligancy, by the time the growth is discovered, the diagnosis made, and consent to operate is secured, the neoplasm has made such headway that complete removal is impossible, or metastases have occurred. Nothwithstanding the doubtful prognosis, prompt operation should be performed, as without it the case is entirely hopeless.

ADHESION OF THE LABIA MINORA

This is a fault of development, although it may be that adhesion occasionally takes place from inflammation. The labia minora may be joined from the posterior commissure to the urethra, or only a part of the way forward. The complete closure is well shown in Fig. 243. By drawing the labia apart with the fingers they are torn asunder, leaving upon each side a slightly oozing linear wound.

These should be kept smeared with sterilized oil or vaseline or a pledget of oiled lint be kept between them or they will readhere, again and again. To separate them is a simple matter in the infant and done in a few seconds with no anesthetic. But if left until the child is older it occasions an unpleasant struggle if at-

tempted without anesthesia, especially if it must be repeated, and if not remedied before puberty the adhesion is so strong as to require cutting, and there may be retained menses to deal with.

ADHESION OF THE CLITORIS AND ITS PREPUCE

Not infrequently young girls are brought because of adhesions between the clitoris and its prepuce which are supposed to be giving rise to a train of symptoms either local or psychic and neurotic. There are physicians and writers of reputation who lay considerable

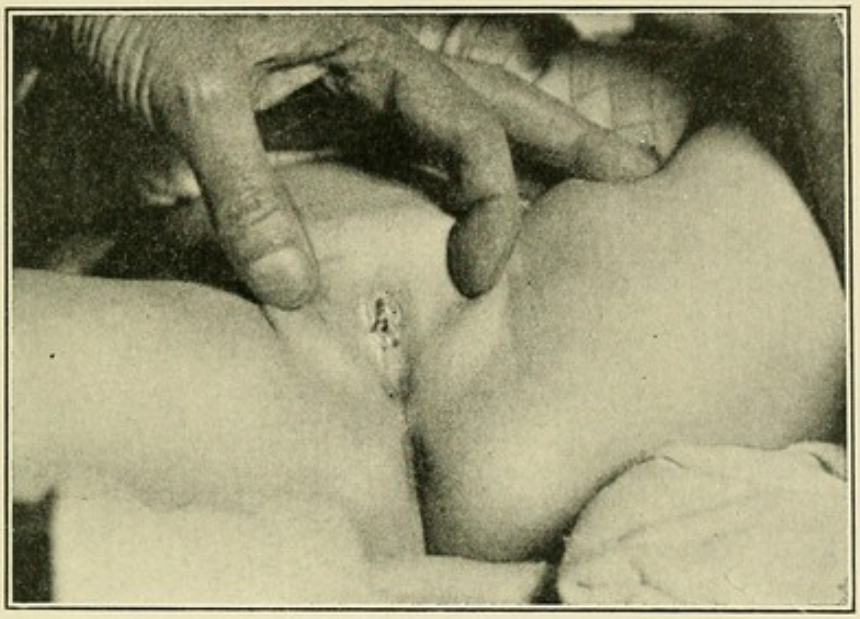


FIG. 243. ADHESION OF THE LABIA MINORA.

stress upon this condition as a frequent cause of various nervous phenomena as well as local irritations. Personally I have very seldom seen marked remote effects fairly attributable to this cause, and do not believe that it very commonly produces serious symptoms. Retained smegma may cause thigh-chafing and similar practices. If evident adhesions exist, they should be torn through with a blunt dissector and the parts thus put in their normal condition.

PROLAPSE OF THE FEMALE URETHRA

The mucous and submucous layers of the urethra occasionally are caused to protrude by repeated and excessive straining. In mild cases to remove the cause of the straining and use an astringent is efficient treatment. It may be necessary to remove the redundant membrane. This may be done by the galvano cautery without hemorrhage and little scarring, or by radial incisions.

VULVITIS

Vulvitis may be herpetic, gangrenous, simple, or specific. The herpetic eruption resembles that frequently occuring upon the lips and face. It is located upon the mucous membrane or skin, or both. Treatment is by cleanliness, and astringent or soothing lotions or powders. Gangrenous vulvitis has been discussed under Noma in the Section on Gangrene. Both simple and specific inflammation of the vulva so frequently attack also the vagina, that it will be sufficient if these subjects are presented in connection with vulvo-vaginitis.

VULVO-VAGINITIS, SIMPLE AND SPECIFIC

VULVO-VAGINITIS is either simple or specific. The slight catarrh, with its sticky white secretion, often found at the vulva of the new-born, is so common and so mild as to be scarcely more than normal, and subsides in a few days with care and cleanliness. Yet without cleanliness infection may take place, and the discharge become profuse, irritating, and persistent, lasting for weeks. (55)

In older children infection of the vulva and vagina with various common pyogenic organisms is of frequent occurrence. They give rise to inflammation with profuse purulent discharge. The disease most easily attacks those who have suffered from the acute infections or other lowering diseases, or who are constitutionally weak, or strumous; and it is favored by bad hygiene, uncleanliness, phthiriasis, scabies, acrid urine, seatworms, rough clothing, and other local irritation.

The prognosis is good if the condition is properly treated. Lymphadenitis with suppuration is a possible complication.

Treatment of the simple form.—All contributing causes should be removed. Locally cleanliness and mild antiseptics are indicated. Free irrigation twice or more a day with solution of borax or alum or cupric sulphate, or saturated solution of boracic acid, are usually efficient. Solution of mercuric bichloride, 1 to 3000 or 1 to 4000, may occasionally precede the milder solution. All washes should be comfortably warmed. After irrigation the parts should be dried and dusted with impalpable boric powder. The inflamed labia should be separated by a pledget of gauze. If the suppuration persists, swabbing once or twice with argyrol solution, 10 per cent., may aid the irrigations and dusting. Occasionally an intractable case may need to be swabbed through a speculum with 2 per cent. silver nitrate, or need touching with the solution at one or two points.

The urine should generally be neutralized by the use of potassium citrate or the spirits of Minderer, and the bowels regu-

lated. Tonics or other appropriate constitutional treatment are usually required. Simple vulvo-vaginitis is contagious.

Specific Vulvo-vaginitis is due to the gonococcus. The source of the infection should always be inquired into, and any charge of rape or of tampering by servants or others accepted only with great caution. The gonococcus is often associated with the more ordinary pyogenic staphylococci and streptococci. It is met sometimes in private practice but more often in institutions where it sometimes takes the form of an epidemic and is exceedingly difficult to control. The discharge may at first appear slight and quite innocent, or a patient may be admitted to hospital suffering with an injury or an acute general disease like measles or scarlet fever, which quite distracts attention from the local inflammation until the infection has already been disseminated. Or a case after treatment may appear to be cured and then have a recurrence and communicate the infection to others; or it may be conveyed by clothing, toys, utensils, etc.

Symptoms and Course.—After an incubation period of two to ten days the discharge begins. This may be preceded by malaise, and fever, and even by chills. The pus is yellow, often greenish, usually thick and viscid, and remarkably copious. The mucous membrane becomes hot and swollen and tender. Micturition may be painful, either from the urine coming in contact with the vulvar mucosa or from invasion of the urethra by the inflammation, which latter, however, occur less frequently in children than in adults. Pruritis may be present. The acute stage of the disease runs its course in from one and a half to three weeks, when it subsides, but continues in a subacute or slumbering form, often to be roused to activity again, when treatment is discontinued or from some cause not always traceable. The contagion may at any time be conveyed to others, or to other parts of the same patient, especially the conjunctivæ. Or the endocardium, the joints, or the peritoneum, may become secondarily inflamed, causing very serious or fatal results. In some cases the damage to the genito-urinary organs is less than one would expect from the virulence of the inflammation, but in others it is as bad as could be, extending finally to the bladder, kidneys, uterus, and Fallopian tubes, and if the child survives to womanhood, producing sterility, besides distressing chronic pelvic disorders.

Diagnosis.—The diagnosis may be made clinically by the symptoms as described; but can only be absolutely differentiated by the finding of the Neisser organism with the miscroscope.

Treatment.—A most important part of the treatment is prevention. To this end, every case of vulvo-vaginal discharge should be subjected to the microscopic test, and in an institution especially,

it should be isolated until its innocence is proven. Children's hospitals should make it a rule to examine smear preparations from the vaginal discharge of every female child before admission.

Specific vulvo-vaginitis must be isolated, and antisepsis carried out with every detail of the nursing. The vulva must be kept covered by a sterilized absorbent pad of gauze or cotton, which should afterward be burned. Each case must have its own thermometer, utensils, clothing, and bed clothing. All fabrics should afterward be boiled in bichloride, 1 to 1000, and utensils boiled. Vigilance should not be relaxed upon the subsidence of the symptoms. If, after thorough treatment has been entirely discontinued for a period of four weeks, a series of smears show no gonococci, it is probable that the trouble is at an end, and will not be communicable.

Treatment is by germicides and by vaccines. Free irrigation by means of a soft catheter passed to the uterus, with solution of mercuric bichloride, 1 to 3000 or 1 to 4000, or with saturated solution of boric acid, or a solution of potassium permanganate, 1 to 2000, or Condy's fluid, should keep the parts free from pus even if it must be practiced every hour or two. But these are not sufficient. A speculum [1] should be introduced and the entire vagina carefully swabbed from above downward with a two per cent. solution of silver nitrate, or fifteen per cent. of argyrol. A wick of gauze which has been rubbed in powdered boric acid should then be deposited in the entire length of the vagina and left as the speculum is withdrawn. This speculum treatment may be repeated two or three times a day at first till the discharge lessens, then once a day, the irrigation being continued. In some cases the disease will be harbored in a sulcus of the vagina, or a tuft of granulations, and persist in recurring until that is treated with solutions of argyrol or protargol, or with silver nitrate two per cent. or touched with ten or twenty per cent. silver nitrate.

So called vaccines, suspensions in a normal salt solution of a definite number of killed gonococci, have proved useful, especially in children rather than in infants, and more uniformly in subacute and chronic than in acute cases. The use of stock vaccines is practicable. In my own cases, the majority of them obstinate and of long standing, improvement and apparent cures have been effected. In some, the disease has recurred after long intervals, when not followed up with local treatment. Many observers have reported brilliant results.[2] One may dispense with the opsonic index and be guided by clinical symptoms. (60.)

[1] Dr. Kelly's cystoscope No. 8, 9, or 10.

[2] Butler and Long: Jour. Am. Med. Assn., Mar. 7, 1908. Wallace Hamilton: Jour. Am. Med. Assn., Apr. 9, 1910. Alice Hamilton and J. M. Cook.

CHAPTER XXV

HARE-LIP, CLEFT-PALATE, AND THE MOUTH, TONGUE, FACE AND NECK

HARE-LIP AND CLEFT-PALATE—MACROSTOMA—MICROSTOMA AND ATRESIA ORIS—CONGENITAL ABSENCE OR MALFORMATION OF THE TONGUE—MACROGLOSSIA—PAPILLOMA, NEVUS AND FIBROMA OF THE TONGUE—CYSTS BENEATH THE TONGUE—TONGUE TIE—EPULIS—SUPERNUMERARY AURICLES AND BRANCHIAL FISTULAE—COLOBOMA OF THE EYELID—EPICANTHUS.

HARE-LIP AND CLEFT-PALATE

THE term hare-lip (labium leporinum) is applied to a condition of malformation due to arrested development, presenting a fissure or fissures extending more or less deeply into the tissues from the margin of the lip. The name is not properly applied to the results of disease or traumatism. The deformity is a rather common one, is very disfiguring to the patient, and distressing to his friends, and the surgeon is frequently besought to remedy the defect. Cleft-palate (fauces lupinum, or wolf-throat) is a common and serious malformation, in which the hard or soft palate, or both, retain the embryonic form, and are more or less incapable of performing their functions in speech and deglutition, and in separating oral and nasal cavities.

Etiology and Varieties.—At the 25th to the 28th day of fetal life the face is undergoing development. Just previous to this the face is all mouth, back as far as the situation of the ears, and overhung by the frontal prominence. Four projections now appear at each side of the neck and grow toward the median line, in the same manner as the visceral plates close in to form the abdomen and thorax. These projections are called the branchial arches, and the superior one of these arches, in connection with the fronto-nasal process which extends downward from the forehead, is destined to form the face.

This superior arch soon presents two secondary projections—the lower, called the mandibular process of the arch, uniting in the median line with its fellow of the opposite side, forms the inferior maxilla; the upper second projection of the superior arch, called

the maxillary process, grows forward to meet the fronto-nasal or intermaxillary process descending to form the vertical plate of the ethmoid and the vomer and the intermaxillary in front, with which it unites to form the upper jaw, leaving openings for the nostrils. The fronto-nasal process is at first divided at its lower end, but this notch in the middle disappears and the incisive process, which later develops the two middle incisor teeth, is formed at the extremity of the fronto-nasal or intermaxillary process. The maxillary processes also form the outer wall of the orbit and the malar bone, and, together with the lateral plates of the fronto-nasal process, from the floor of the orbit. They also extend toward the median line, and by joining the mid-frontal process they complete the formation of the superior maxilla, including the alveolar arches. The alveolar arches, shelving inward from each side, form palatal processes which should meet in the middle line, and, together with the deep aspect of the fronto-nasal process, complete the palatal arch. (See Fig. 244.)

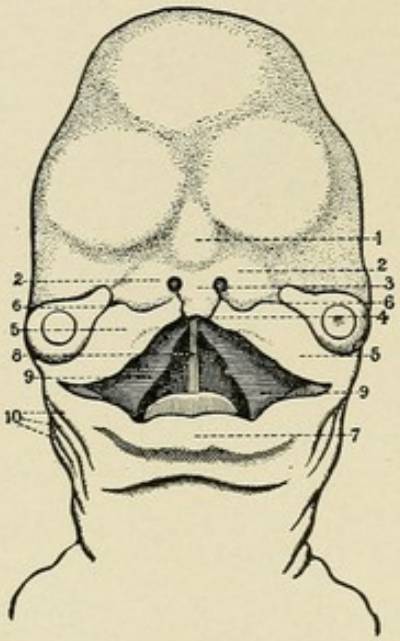


FIG. 244. MOUTH OF AN EMBRYON OF FORTY DAYS. After Coste, as described in Flint's Physiology. 1, first appearance of the nose; 2, 2, first appearance of the alae of the nose; 3, appearance of the closure beneath the nose; 4, median portion of the upper lip, formed by the approach and union of the two incisor processes, a little notch in the median line still indicating the primitive separation of the two processes; 5, 5, superior maxillary processes, forming the lateral portions of the upper lip; 6, 6, groove for the development of the lachrymal sac, and the nasal canal; 7, lower lip; 8, mouth; 9, 9, the two lateral halves of the palatine arch, already nearly approximated to each other in front but still widely separated behind; 10, remains of the branchial arches, still showing fissures between them.

It will be observed that the lateral halves of the mandibular arch unite early and strongly, and, as might be inferred, a fissure of the lower lip is seldom met with, although a few cases have been reported. The usual seat of the malformation is the upper jaw. Here a considerable variety in form and extent of malformation may be found. A failure of the maxillary process to unite with the fronto-nasal process upon one side results in a single or unilateral hare-lip. If the failure occurs upon both sides we have a double, or bilateral, hare-lip. The development may be almost complete, leaving a mere notch with a groove, furrow, or seam above it; or it may extend

clear through the lip up into the nostril, or even into the alveolar process of the upper jaw, or rarely, as in that curious case figured by Guersant, the fissure may extend to the lower eyelids. A cleft in the alveolar arch passes between the central and lateral incisors, or perhaps eliminates the lateral incisor. In



FIG. 245. SINGLE HARE-LIP WITH A WIDE CLEFT, in which the intermaxillary bone is visible. Note also flattening and widening of right nostril, due to absence of bone beneath it and to unopposed muscular traction.

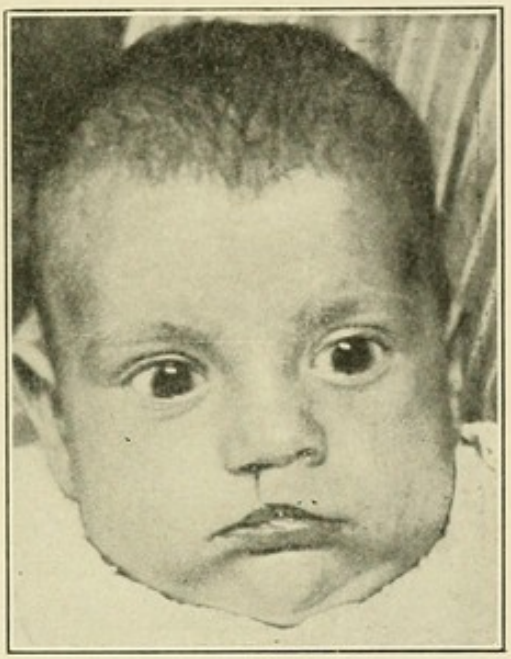


FIG. 246. Same case as 245, after operation. To illustrate faulty result due to inaccurate approximation, or to yielding of sutures under muscular tension. Also contour of nostril and muscular balance are not restored.

double hare-lip the fissures may be alike on the two sides, or one may be extensive and the other slight; or one a mere notch and the other a groove; or either one side or both sides connected with a cleft in the palate. In either the single or double variety the intermaxillary bone may or may not project, or, in the double hare-lip, it may be either covered or not, with a central portion of lip. A fissure may be wide or narrow. In some cases the margins of the fissures are quite vertical, as though there was little lack of tissue, or one or both margins may slope away from the fissure. (Compare Figs. 247 and 248.) But in all cases the fissure is more or less perpendicular and the red margin of the lip extends upon the margins of the fissure.

MEDIAN HARE-LIP, the only variety which exactly resembles the normal lip of the hare, and from which the name of the deformity is doubtless taken, is exceedingly rare, although well authenticated cases are on record. I presume this would arise in a permanence

of the notch at the lower end of the fronto-nasal process, or an absence of the incisive process. Entire absence of the upper lip has occurred.

In case the palatal processes, springing from the alveolar arches at either side, fail to coalesce in the median line, the palatal arch is incomplete and the mouth is not separated from the nasal-fossæ. In other words, we have a cleft palate. This malformation may vary greatly in degree, the cleft involving only the uvula, or only the soft palate, or both soft and hard palates. The hard palate may be cleft only as far forward as the alveolar arch, or it may connect with a hare-lip completely dividing the arch (Fig. 250), and this may occur upon one, or, more rarely, upon both sides. The cleft in the soft and in the posterior part of the hard palate is in the median line, but forward it deviates laterally to the line of junction of the maxilla with the intermaxillary bone.



FIG. 247. HARE-LIP, shown for comparison with 248, the margins of the cleft being more abundant and of normal thickness and of greater length from above downward. The ala of the nostril must be brought up toward the middle line. This is a much simpler case for operation than 248 and was fully restored by a Mirault operation.

Considering the mode of origin of hare-lip and cleft palate, one might expect to find them associated with other failures of coalescence of the lateral halves in or near the median line, such as hypospadias, epispadias, spina bifida, meningocele, hernia cerebri, or ventral hernia, and yet it is said that such do not more frequently occur in connection with hare-lip than other deformities. It is agreed by all writers that heredity is a prominent factor in the production of hare-lip. As an example of a not unusual family history I will cite the case of A. P. (Seen in Figs. 245 and 246.)

There was no deformity known on the mother's side, but her paternal great-grandfather, an aunt (sister of her father), and a cousin (child of her father's brother) all had hare-lip. Yet numerous children escaped the deformity; for example, the parents of A. P. had two older children well formed. Sometimes in such a family other members may exhibit, on close inspection, some slight

defect in the region of the family mark. Occasionally the failure of development in the middle line may take a different form in different generations or in different children; for instance, the father of the boy with extroversion of the bladder, shown in Fig. 228, had a hare-lip. In another instance under my observation the first child in a family had hare-lip and imperforate anus, the second was normal, and the third had, in the occipital region, a meningocele larger than its cranium. As to other possible causes, that

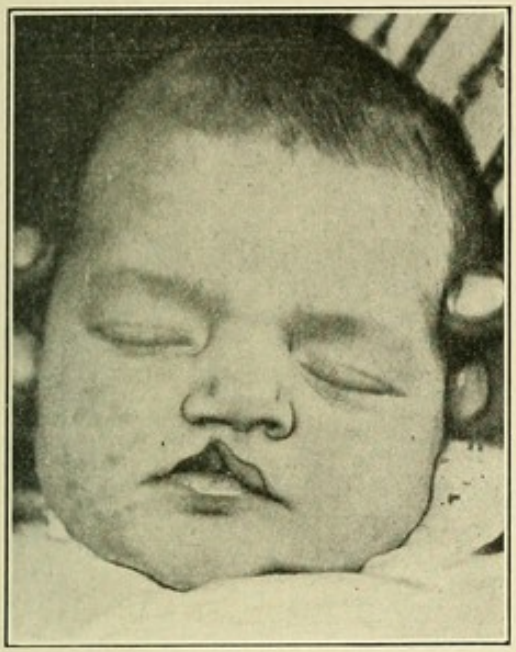


FIG. 248. HARE-LIP in which although actual opening is not wide, the lip is short and tapers up to the cleft. The lip is also thin, and the thinness extends into the nostril which is deformed. See Fig. 249.

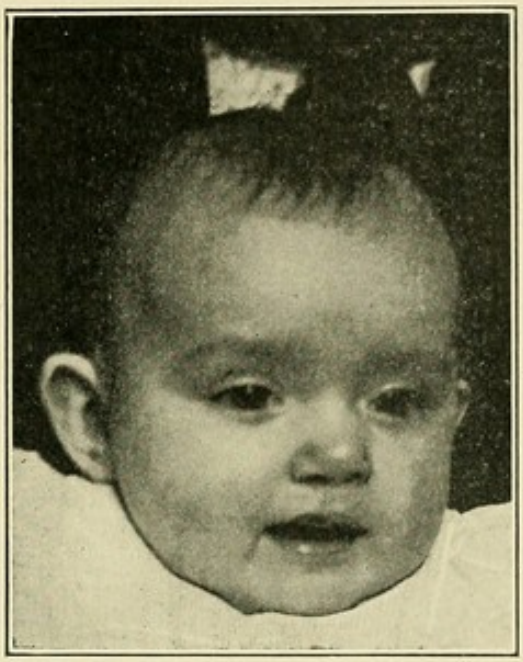


FIG. 249. Same case as 248 after operation. The thinness of the lip has been removed clear into the nostril, lip united, lengthened from above downward, and the shape of the nose corrected.

of maternal impressions is still recurring as a moot question. Doubtless in most, if not every, instance any connection between "impression" and malformation is imaginary. Certainly every supposed case of the kind should be rigidly criticised, and with the fullest knowledge of embryology. A child afflicted with hare-lip or cleft palate may be perfectly normal in every other way, and of average strength and vitality, but as a rule he is below the average in constitutional vigor.

Treatment.—There is no cure without operation. The first question to decide is when the operation shall be made; and the next, how shall the case be managed in the meantime. Many surgeons, notably the French of one or two generations ago, have preferred to operate immediately after birth, and the literature

lack of space prevents my presenting. I can only state my own views, which are shared by many other surgeons.

Muscular action uncorrected increases the deformity. As age advances the intermaxillary bone becomes more rigidly ossified, and when projecting is hard to replace, and the teeth, developed in bad positions, either increase the difficulties of the closure or must be removed. Moreover, the sensibilities of the parents, and of the child, which, subject to observation and remark, becomes conscious of its condition, have a right to be considered. I consider it desirable to close the lip as early as possible, compatible with safety and a good result. The early growth and development of the child after operation will give the plastic work a more natural appearance, and if cleft palate also be present the closure of the lip gives a decided impulse toward a natural lessening of the cleft in the palate (compare Fig. 250 with Fig. 251), and gives a better blood supply to the parts when that operation is performed. It has been urged as an objection against closing the lip before the palate that the palate is more easily accessible to the operator with the lip open. The difference in convenience is not great, and the difficulty of the palate operation is not lack of room between the lips, as enough can be secured after the lip is closed. I think it must be under very exceptional circumstances that the palate, cleft to any marked degree, should be closed in the first few weeks or months of an infant's life. The operation is too severe to justify the risk. It may sometimes be advisable to close a part of a cleft early; as, for example, the alveolar process or the hard palate. But a regular urano-staphyloraphy should be postponed at least until the second year, and perhaps longer. As for the operation of forcing together the superior maxillary bones to bring the palatal process together, a plan well known as the Brophy operation, its use has been discontinued by many practical surgeons who have seen much of its results. By means of a needle made for the purpose, Brophy passes two or more strong silver wires laterally through the superior maxillary bones from side to side, inside of the cheeks. These wires are threaded through holes in lead plates, which are placed along outside of the alveolar processes; and by pressing with the hands and twisting together the wires the two sides of the face are approximated, and the edges of the palatal cleft, having been previously freshened, are brought together and sutured. If the bones are too rigid to yield to this force they are incised by passing a knife through a small opening in the mucous membrane above the alveolar process and cutting toward the median line. Brophy prefers to operate when the infant is three months of age, and his operation is not applicable after the sixth month. The objections to this procedure are not only high mortality from shock, sepsis, and

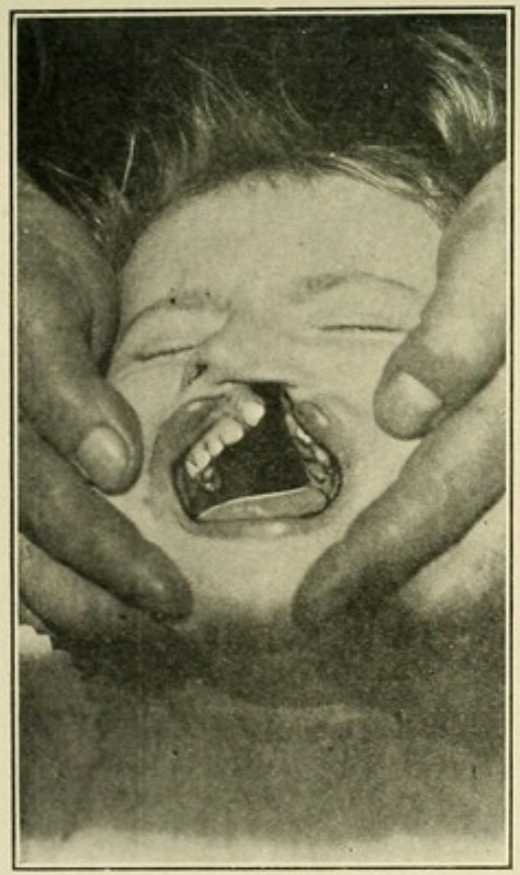


FIG. 250. SEVERE CASE OF HARE-LIP, and wide cleft through hard and soft palate. Child 2 years old. Intermaxillary portion of superior maxilla projects far forward and is firmly ossified. Nose badly deformed. See Fig. 251.



FIG. 251. Same as Fig. 250, two years after first operation. Premaxilla put back and united to maxillary, restoring arch. Nose corrected, lip closed. Cleft narrowed by union of alveolar arch and lip and after development.

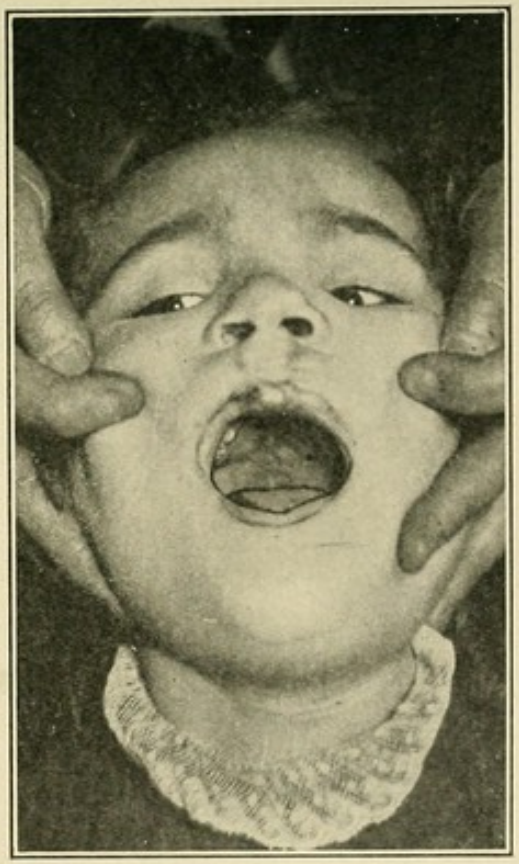


FIG. 252. Same case as Figs. 250 and 251. Union of hard and soft palate after one operation, sliding muco-periosteal flaps from the sides, releasing all tension, and uniting them with silver wire sutures.

meningitis, but results that appear afterward, such as contraction of the palate, narrowing of the posterior nares, irregular occlusion of the teeth and damage to the teeth while yet in their formative state by passing the wires through the superior maxilla. As to speech, as Ferguson says, while in Brophy's operation the palatine attachments of the tensor palati and the levator palati are not interfered with in the least, still it has yet to be shown that the intonation is better than that obtained by other plastic operations.

A new-born babe, fairly strong, but with a hare-lip which prevents it from nursing, may be better able to undergo operation immediately than if one waits until it is older without giving it any more than ordinary attention. But there are means of taking especial care of it, and usually nutrition can be maintained, and I prefer to wait at least until the time for the dangers of septic infection, icterus and the other diseases especially incident to the new-born, has passed by. In the meantime the babe should be prepared for the operation.

Treatment Preliminary to Operation.—Immediately after the birth of a babe with hare-lip, whether or not it has also cleft palate, means should be used to prevent increase of the deformity by traction of unopposed muscles. Muscular traction tends to widen the cleft, not only of the soft parts, but also of the bones when the palatal and lip cleft are one; and it greatly distorts the nose, flattening the ala on the side of a single cleft and drawing the septum toward the opposite side, beyond the middle line. (See Fig. 250.)

Muscular action can be controlled by a Hainsby's truss or similar device; but the easiest and best method is simply to draw the margins as near together as may be comfortable, and apply a strip of adhesive plaster, of the width of the lips, transversely across the face. This strap should be renewed at intervals of a day or a few days or longer, as necessary, with due care to preserve the skin from irritation. Cleansing the skin with boric acid solution and using zinc oxide plaster will favor a sound skin. The strapping does more than control and equalize muscular action. It enables the babe to nurse better; accustoms it to breathing through the nostrils, so that its breathing is less embarrassed when the lip is subsequently closed by operation; it aids in preventing irritation of the mucous lining of the nasopharynx by the free inrush of cold and dust-laden air; it accustoms the babe to restraint of the parts, so that he does not fret under tension of sutures. Besides all these advantages, simply strapping renders the deformity far less unsightly and distressing to the parents and friends.

It may be necessary to pump the milk from the breast of the mother or wet nurse and feed the baby with a spoon, or to nourish it with modified milk or other food, or to use a rubber nipple with

an obturator attachment, to close the palate cleft, or if it cannot suck, gavage may work a wonderful change in its condition and bring it up to a state fit for operation. It is often a very nice point to judge whether an infant is in fit condition for operation, or if not in as good condition as one could wish, whether it is ever likely to be better. An operation upon a marasmic, ill-conditioned infant, or one afflicted with purulent rhinitis or stomatitis, is foredoomed to failure, or even a fatal result. Snuffles or purulent rhinitis should be overcome before an operation is attempted, for in the operation for hare-lip primary union is essential. To put such an infant into a thrifty state of nutrition, with sound tissues, and then operate for extensive hare-lip and bring it through successfully, and then close the palate and get a good result, is no mean test of a pediatric surgeon's skill.

If all is going satisfactorily it may be well to wait until the babe is from a few weeks to a few months old, and vigorous enough to bear the operation and in condition to secure repair, but before ossification or dentition have advanced if the alveolar process is implicated in the cleft. The lip is then closed. A year or more later—perhaps when the infant is a year and a half or two years old, and vigorous enough for the major operation—the palate may be closed. Even then, if there is doubt of its health, the operation may be deferred without fear of failure in restoring satisfactory speech. Or it is sometimes better to close the palate in two stages—the hard palate first (uranorrhaphy), and then, after the patient has recuperated, the closure of the soft palate (staphylorrhaphy) completes the work. In a patient coming late, with a cleft involving only the soft palate and the lip, one may choose to operate upon the palate first and to strap the lip for a while during the recuperative period, and then to close the lip.

Operative Treatment.—The history of the operations for hare-lip (cheiloplasty), and for cleft palate (uranoplasty), and a description of many different operations and modifications, typical and atypical, are too long for the allotted space in this volume, nor can I hope to credit to its originator each method or step. Staphylorrhaphy, according to Verneuil, has been invented four different times; and it is probable that nearly every modification and every step of staphylorrhaphy and uranorrhaphy have been invented over and over again by ingenious operators to meet the necessities which they encountered. I shall only present a few methods and principles which are applicable in most cases, gathered from various sources by observation of a number of skillful operators and their methods and results, and then tested out in practice to my own satisfaction.

Hare-lip Operation (*Cheiloplasty*).—Usually the patient is placed in Roser's position; that is, lying on the back, with the head

hanging over the end of the table. This position brings the anterior nares at a lower level than the entrance to the larynx, and so avoids the danger of the aspiration of blood into the trachea. The surgeon sits opposite the patient's head and face, which are inverted before him. Some surgeons prefer to stand at the patient's right

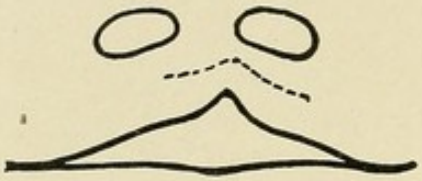


FIG. 253.

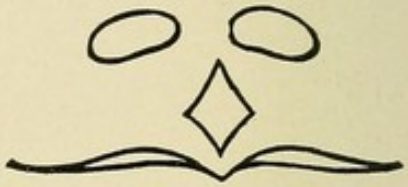


FIG. 254.

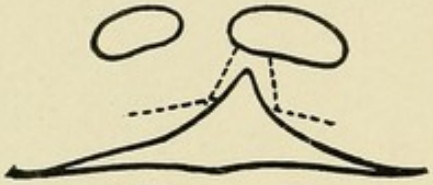


FIG. 255.

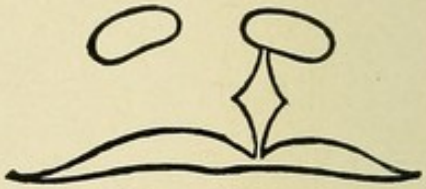


FIG. 256.

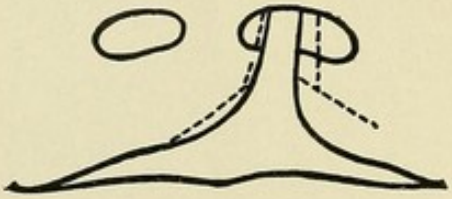


FIG. 257.

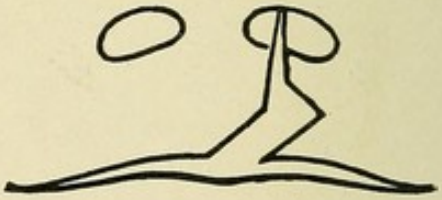


FIG. 258.

FIGS. 253 TO 258 ILLUSTRATE VARIOUS OPERATIONS FOR SINGLE AND DOUBLE HARE-LIP. Figs. 253 and 254 show the method of Nèlaton; 255 and 256, that of Malgaigne; 257 and 258, that of Mirault.

shoulder and lean over the face, or, instead of having the head hanging so far over the end of the table, they turn it to the right side, so that the blood will run out of the mouth or be easily swabbed out. One has sometimes operated upon infants held sitting upright.

Anesthesia.—General anesthesia is, of course, necessary, excepting in very young infants with a small cleft in the lip it is not indispensable. The majority of surgeons probably prefer chloroform for this operation, though some use ether. An ordinary inhaler may be used, but is much in the way of the operator. A

Junker inhaler, having the end of the rubber tube supplied with a bent metal canula, which delivers the vapor into the angle of the patient's mouth, is a convenient arrangement.

Principles of Cheiloplasty and Points in Technique.—Careful

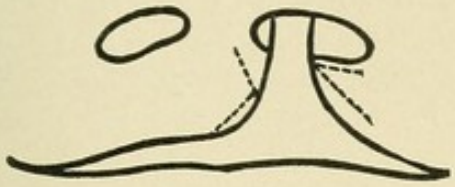


Fig. 259.

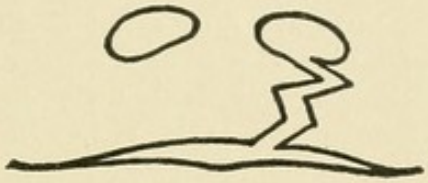


Fig. 260.

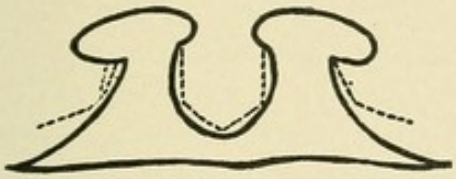


Fig. 261.

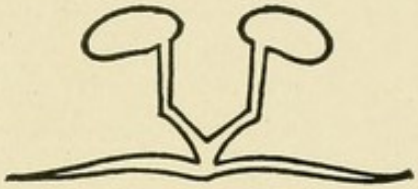


Fig. 262.

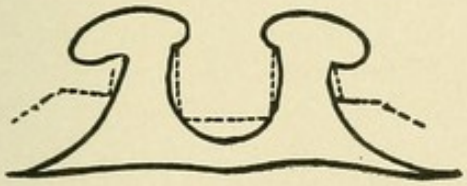


Fig. 263.

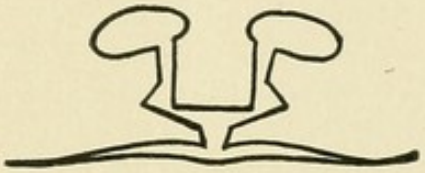


Fig. 264.

Figs. 259 to 264. Diagrams of various operations for single and double hare-lip. Figs. 259 and 260 show the operation of Giraldes; 263 and 264, that of Maas.

antiseptic preparation is essential. A good deal of blood can be saved by passing temporary ligatures through the lip, one on each side, to include the coronary artery. These are removed on completion of the operation. Forceps are inefficient, and the fingers of most assistants are in the way. The edges of the cleft are to be freshened so that, when sutured, union can take place. No tissue should be wasted, yet the margins must be pared sufficiently with knife or scissors. These edges or flaps are to be so contrived that when brought together they fit and are of equal length. The lip at the suture line must project beyond its normal level to allow for contraction of the scar. When the edges of the cleft are thin

the raw surface for approximation can be increased by cutting only part way through the thickness of the lip and turning the margin inward, or sometimes by cutting the edges on the bevel. All of the red margin of the cleft is to be disposed of in the paring. When the cleft extends into the nostril or the nostril is deformed, the cutting must also extend into the nostril, so as to correct it. (These points are illustrated in Figs. 253 to 264.) There must be no tension on the flaps, consequently they must be freely loosened from their attachment. To do this the lip is everted and its mucous membrane incised where it joins the alveolar process. Through this incision the soft parts are divided near the bony surface and separated from the bone a distance of three or four times the width of the cleft. If the central part of the lip below the septum nasi is to be moved, this, too, must be loosened from the bone beneath. If the intermaxillary bone project, it must be pushed back into its place, its margin and that of the maxillary freshened and one or more sutures passed to unite them, the sutures being tied or twisted upon the inside. If the intermaxillary is too stiff to be pushed into place a wedge-shaped piece may be removed from its inner surface, without interfering with the teeth not yet erupted. The intermaxillary should never be removed. The freshened edges of the flaps must be brought together and held together by sutures until healing is complete. In bringing together the flaps it is essential that the marginal line of the muco-cutaneous junction be accurately adjusted. (See Fig. 246.) Another important point is in bringing up the ala of the nostril to the right size and position. (Compare Figs. 248 and 249, and also Figs. 250 and 251.) Without attention to these two points and free loosening of the flaps to prevent tension, all other efforts will be in vain.

Suture with the hare-lip pin is obsolete. Some operators prefer silver wire. With others, silk, silkworm gut, or horsehair are in favor. In my own work I want at least one silver wire or aluminum bronze suture, shotted, for the nose, one shot being placed in the groove just outside the ala, and the other inside the opposite nostril. Silkworm gut and horsehair are ideal materials for the other sutures. There should be one or two strong ones placed at some distance from the margins, rather as retaining sutures, and fine ones close together between, acting as coaptation sutures. It is well to pass the strongest retaining sutures from the under side of the lip and tie them there. Usually one suture is so placed as to control the hemorrhage. The fine sutures are placed upon the outside. Some surgeons unite the inner margins with catgut or silk first, then pass strong retaining sutures and fine sutures between these from the outside. As to dressings, some surgeons still adhere to the plan of passing adhesive straps transversely across the line of union,

their ends extending back toward the ears. Some cross two adhesive straps upon the wound (having a few layers of gauze beneath), their ends diverging upon the cheeks. Some use no dressing at all, leaving the wound entirely open. One prefers to protect the wound with a bit of silk crape, fastened with collodion at either end, as the fashion is at the Boston Children's Hospital; or with a mild antiseptic powder, which forms a crust.

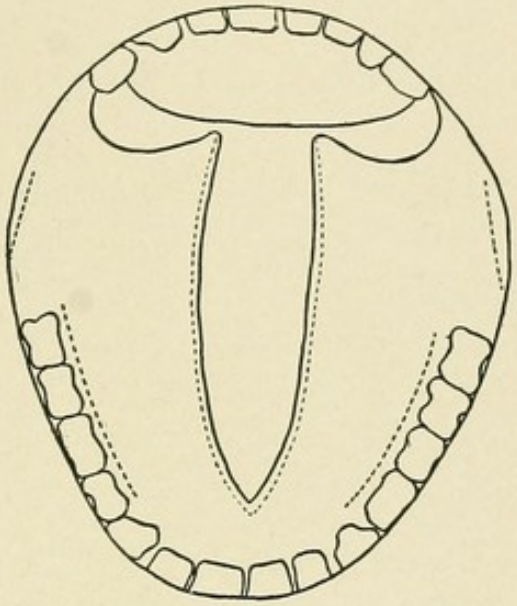


FIG. 265. URANO-STAPHYLORRHAPHY. Dotted lines mark freshened edges and incisions.

Strapping across the wound is apt to press too hard. Yet I think strapping which does not touch the wound is useful to aid in immobilizing the face. A strap on either side may pass upward diagonally across the cheeks, crossing each other upon the bridge of the nose and extending on to the forehead. Or they may start straight up on the cheeks toward the eyes, and then be turned inward to the nose and crossed on their way to the forehead, as Ferguson, of Chicago, places them. The patient's arms should be so restrained that touching the wound is impossible for him. Vomiting, laughing, or crying should be avoided if possible. The patient should be fed with a dropper or spoon. A babe should not be allowed to suck, nor any patient to masticate.

The wound should be undisturbed for thirty-six or forty-eight hours. If any of the sutures upon the skin surface can be spared at the end of that time they should be removed and will leave no scars. Those passed from beneath the lip may be left until firm union is complete.

There are a thousand and one methods of planning the flaps. The few that are shown in diagram will serve admirably in most cases; or will illustrate the principles which the surgeon may readily adapt to special cases.

Urano-staphylorrhaphy. (See Figs. 265 and 266.)—The patient is anesthetized with chloroform or ether and placed in Roser's position. The surgeon sits or stands, according to the height of the operating table, opposite to the patient's head, which must be held by an assistant. A good light shining into the mouth is indispensable. If there is any possible chance of daylight waning before

the operation is completed, an adjustable artificial light must be at hand. The gag is introduced. There are numerous kinds of gags, some of them very ingenious. The complicated special gags are not indispensable. One can use a simple gag and hold the tongue by a suture passed through its tip. Besides the anesthetist there should be an assistant to sponge and a nurse to hand sponges. Many dozens of "small gauze" to be used as stick sponges—that is, fastened on sponge holders or hemostats—should be in readiness. There is sure to be blood flowing, and it must be kept out of the larynx and out of the way of the operator. The tissues, which should for several days previously have received attention in the way of antiseptic cleansing, are now sponged with alcohol. Next, each half of the uvula, at its tip, is transfixed with a silk suture, which is tied in a loop and serves to hold the soft palate much better than tissue forceps; though some operators use a forceps. The edges of the cleft are now pared with a very sharp and very thin-bladed knife. The strip from the margin should, if possible, be kept in one continuous piece, for the purpose of making sure that the freshening of the edges is complete. The strip of margin extends from the half-uvula on one side forward to and around the angle, if it end in an angle in front, and back on the other side to the tip of the half-uvula, and the bridle of mucous membrane is left attached and held up out of the way. These points, excepting the complete denudation, are not indispensable, but they are convenient.

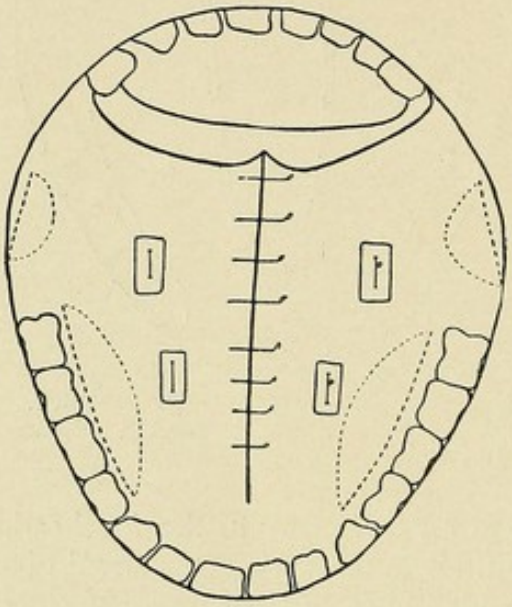


FIG. 266. URANO-STAPHYLORRHAPHY. Flaps approximated and sutured.

There will be considerable bleeding from the cut margins, which the assistant should dextrously stanch as best he may without getting his sponge in the way of the operator. If the margins of the cleft are very thin the operator may choose to split it rather than to remove any. The next step is the loosening of the mucoperiosteal flaps from the roof of the mouth at each side. Here different surgeons differ in their technique. Some cut the edge of the flap loose along the freshened margin of the cleft and introduce the elevator there and work outward toward the alveolar process, separating the periosteum from the bone and pulling down

(*i. e.*, from the roof of the mouth) the flaps, and only make side incisions to relieve tension after the flaps are loosened, or even after the sutures are passed. Others first make the side incisions, which extend from opposite the last molar, parallel to and just within the alveolar process, forward as far as appears necessary. Through this incision a periosteal elevator or blunt dissector is thrust, and the muco-periosteal flap separated from the bone, working toward the middle line. As to the order in which these steps should be executed I find that, working with ordinary instruments with which a general surgeon is apt to be provided, it is better to make the lateral incisions first and work through them toward the middle line. But when provided with special cutting and elevating instruments, set at nearly right angles to their handles, it is better to begin at the margin of the cleft and work outward; for until the flaps have been loosened and an attempt made to bring them together, it is impossible to tell just how long the lateral incisions need be to relieve tension. Flaps from a high Gothic arch come together much better than those from a low Norman arch. During the loosening of the flaps, hemorrhage will be free and should be checked by pressure.

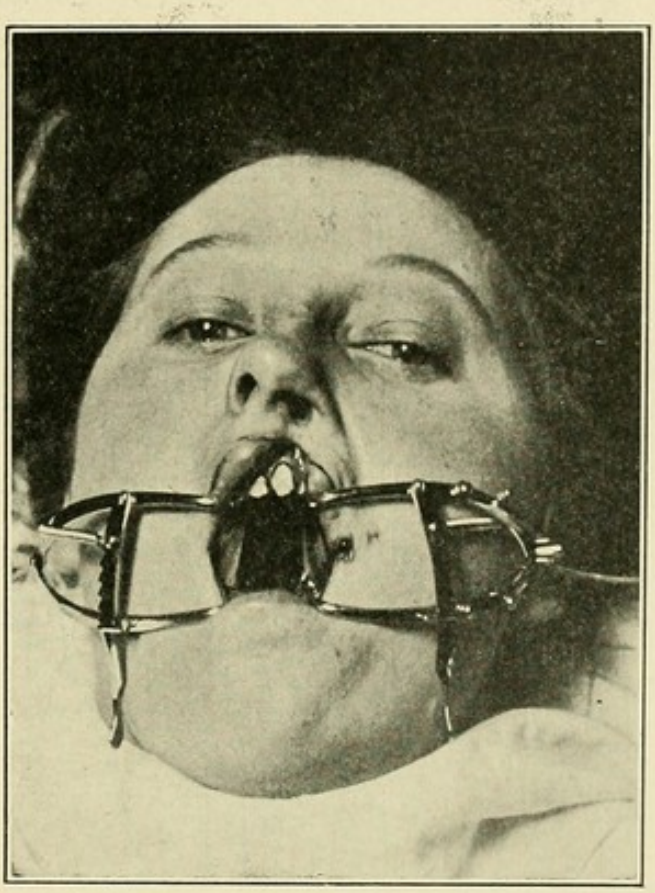


FIG. 267. HARE-LIP AND WIDE CLEFT OF HARD AND SOFT PALATE. The nostril is deformed, and opens into the mouth just above the alveolar process. Whitehead gag in position. Author usually prefers an ordinary gag.

After the flaps are prepared comes the suturing. Here again is a diversity in practice, both in regard to suture material and the method of its use. G. V. I. Brown uses aluminum-bronze wire and buttons of pure silver as retention sutures. The double wire is threaded into the button and the perforated shot, four in a bunch, prepared before the operation is begun. One or two of these double-wired button sutures are used as retaining sutures, and the e ges coapted with chromicized or formalinized catgut. Some use

buttons of celluloid or ordinary agate buttons, and they either twist the wires or shot them. Some use horsehair, which, however, like any other suture that must be tied, cannot be used rapidly in the mouth. Some pass the needle from the mucous side and some from the periosteal side. Like many other surgeons, I prefer well anealed fine silver wire; and can place the sutures more accurately and rapidly with very little handling of the tissues by means of a Reverdin needle passed from the mucous toward the periosteal side of the flap; and twist them more conveniently with a plain "S" wire twister than with forceps. Usually all the sutures are placed before any are fastened.

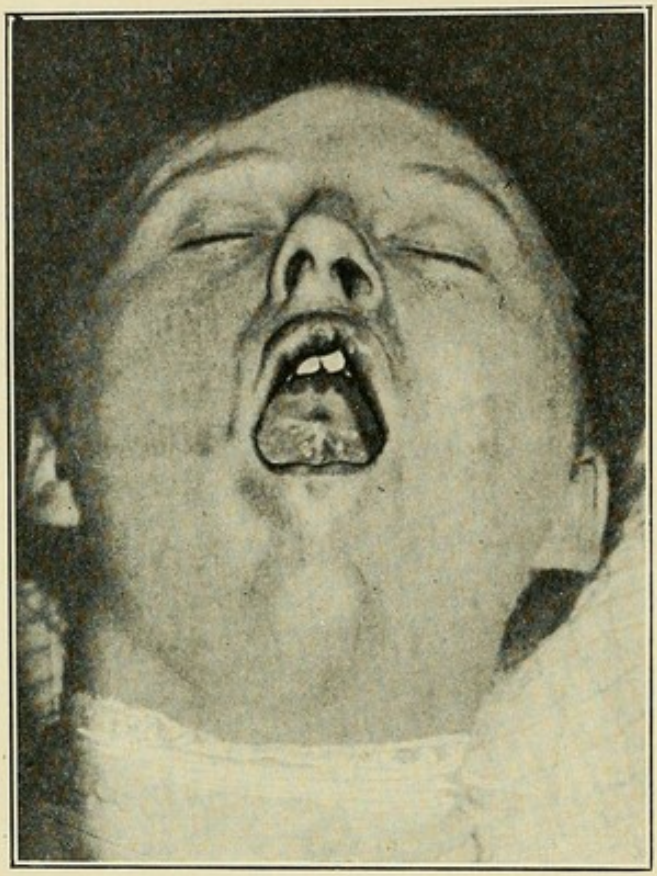


FIG. 268. Same case as 267. Two operations have been done. The hard and soft palate were completely closed at one operation, and the lip and nostril at another, later. The nose is not yet quite symmetrical; and the left central incisor tooth should be turned in its socket by a dentist; but the patient is satisfied and declines further improvement.

The sutures being placed, if the margins of the flaps come together without tension, they may be tied or twisted at once. If not, it may be necessary at this stage to divide the muscular attachments of the soft palate. This can be done by reaching through the lateral incision with knife or scissors. But frequently, if an incision parallel with the outer side of the alveolar process extend backward from behind the last molar, a blunt dissector or the finger can be thrust through it and the soft parts loosened up so freely that no further cutting will be necessary. C. H. Mayo passes a tape through the lateral incisions and around both flaps, drawing them together and preventing tension on the sutures until union takes place. The tape also affords drainage for the space above the flaps. This, however, some think a disadvantage rather than an advantage, as discharges from the nose come into the mouth. The tape is not necessary if the flaps hang perfectly flaccid, as they should, after

being sutured. Suture ends should be cut short and turned up to avoid irritating the tongue.

After Treatment.—The after treatment is very important. The child should be given a coffee-saline enema and be put to bed. (See Sections on Shock, and on Management After Operation.) Vomiting, laughing, crying, and attempts at talking should be avoided as much as possible. Foods should all be fluids and administered with dropper or spoon, no sucking or mastication allowed. The mouth should be rinsed with a spoonful of water after each spoonful of food, and cleansed after each feeding either with a spray or very careful use of swabs dipped in 3 per cent. dioxygen or other mild inocuous solution. The nares, also, should be cleansed.

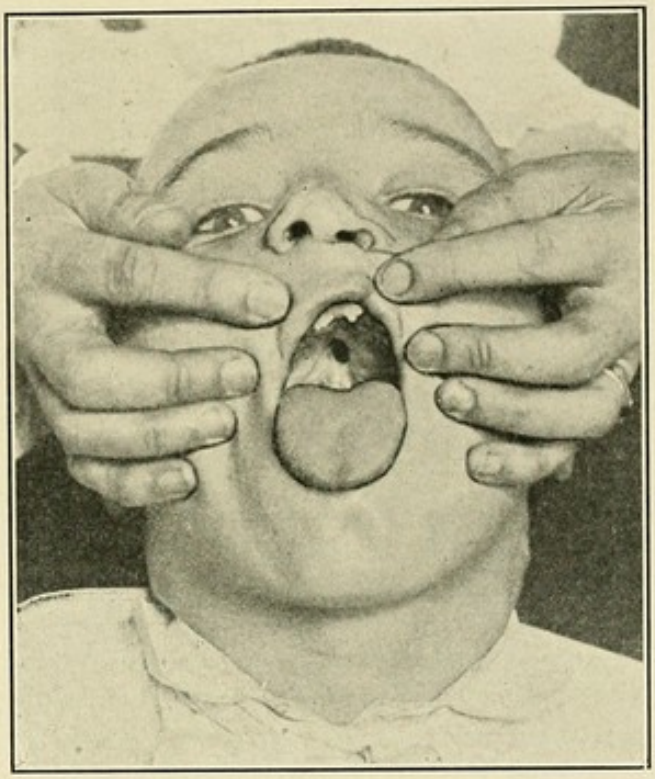


Fig. 269. This case was originally very similar to Fig. 267. The hard and soft palate were operated at one sitting. The pictures show a very common result, namely union with the exception that an opening remains at about the junction of hard and soft palates. This can be easily closed.

Prompt union may be secured along the whole suture line. (See Figs. 252 and 268.) But even if it gape in places, successful closure should not be despaired of; the flaps should be kept in apposition, and healing by granulation or adhesion of granulating surfaces may close the gap. If any portion fails to unite it is apt to be about the junction of the hard and soft palates (see Fig. 269) and can be closed by stimulating granulation or by a slight operation subsequently. If the child is old enough to talk, as soon as the wound has healed, systematic and persistent training in articulation and intonation should be given him by an experienced teacher. There are numerous other methods of closing palatal clefts, both by sliding flaps and by chiseling off portions of the palate bones or the alveolar processes to aid in the formation of the flaps, and by turning and sometimes superimposing flaps. But, so far as possible, the bony structures should not be interfered with and no

tissue should be turned out of its natural relation to oral and nasal cavities and to bony attachments. Of the more complicated methods the Davies-Colley is perhaps the most useful.

MACROSTOMA

Macrostoma is a congenital enlargement of the mouth. The usual form is produced by a partial failure in the fusion of the superior and inferior maxillary processes. Failure of union between the superior maxillary and the fronto-nasal or the external nasal process may take place. (See remarks on Etiology of Hare-lip and Cleft-Palate.) The malformation is usually unilateral, but may be bilateral. It is more frequent in girls than in boys. It is apt to be associated with hare-lip or with branchial fistulæ, or supernumerary auricles, or malformation of the auricle, as shown in Figs. 134 and 135.

Treatment.—The condition should be remedied by plastic operation, denuding the edges of the fissure and uniting them by sutures passed inside the cheek, or subcutaneously, or both.

MICROSTOMA AND ATRESIA ORIS

The mouth may be imperforate, or congenitally too small.

Treatment.—In the former case plastic operation will be necessary, making an opening of suitable size by transverse incision. Also in the latter case if dilatation does not succeed. If enlarged by cutting it will be necessary to unite the mucous membrane to the skin to make the lips, and especially to turn membranous flaps into the angles of the mouth.

CONGENITAL ABSENCE OR MALFORMATION OF THE TONGUE

Absence of the tongue may occur, but is an extremely rare deformity. Occasionally a tongue is cleft, or tridented, or it may lack muscular development upon one side

MACROGLOSSIA

Enlargement of the tongue may occur as a result of lymphangiectasis (see Chapter on Tumors), and may so interfere with breathing and with the functions of that organ as to be a very serious matter.

Treatment.—Slighter cases may be treated with electrolosis. (See Section on Nevus.) The dangers of injections or any treatment liable to cause increased swelling should be foreseen. Pressure has been recommended, but is hard to apply. Astringents are

said to have been used with benefit, but are superficial. If none of these succeed, a wedge-shaped piece of the tongue may be removed and the sides united; or a portion cut off with the hot or cold wire ecraseur.

PAPILLOMA, NEVUS AND FIBROMA OF THE TONGUE

Various tumors may occur upon the tongue, and can be removed by excision or by galvano cautery.

CYSTS BENEATH THE TONGUE

Quite a variety of cystic enlargements may take place beneath the tongue and in the floor of the mouth. Of these will be mentioned salivary retention cyst, from occlusion of the sublingual salivary gland, which seldom occurs; mucous retention cyst, caused by obstruction of a mucous duct; ordinary ranula; dermoid cyst, filled with fluid, sebaceous matter and hair, and located at the point of junction between branchial arches; enlarged bursæ, which, as in bursitis elsewhere, may contain melon-seed bodies; and congenital sublingual cysts, due to persistence of the sublingual duct. Any of these are likely to be called ranula, but that name is only properly applied to the first two varieties mentioned, of which the second is far more common. Ranula, caused by retention of mucus in an obstructed duct, is a bluish, pearl-colored, fluctuating, translucent painless swelling beneath the tongue. It may be marble- or egg-sized and it causes no symptoms excepting by its bulk. If snipped open it discharges a clear viscid fluid like egg-albumen, and when the wound heals it refills. A small seton of silver wire may cause its disappearance. Or it may be necessary to cut away a portion of its wall so as to lay it freely open, and cauterize its lining membrane with silver nitrate or carbolic acid, removing any excess of the caustic.

TONGUE TIE

The surgeon may be asked to inspect quite a number of infants supposed to be "tongue tied" before he finds a real case of this malformation. Yet it does occur that the frenum linguæ is so short, or attached so far forward, that the tongue cannot be protruded to the lips, or even beyond the alveolar ridge.

Treatment.—The anterior margin of the frenum should be nicked—not too close to the tongue, nor too deeply, lest the ranine arteries be injured—and then torn back with the finger nail until sufficiently free, but not too free.

EPULIS

Epulis is a growth located, as its name indicates, upon the gum. It may be fibrous or sarcomatous. (See also Sections on Fibroma and Sarcoma.)

Fibrous epulis is a hard, slow-growing tumor springing from peridental membrane. It is covered with mucous membrane which is not very dark colored unless inflamed, and may or may not be ulcerated.

Sarcomatous epulis grows from the periosteum of the alveolar ridge, more often of the upper jaw. It is of a deeper color than the fibrous epulis.

Treatment.—The treatment of either form of epulis is removal. If malignancy is suspected this should be done very thoroughly, even if a part of the jaw must be removed with the tumor. If thoroughly removed it is not likely to recur. Even with fibrous epulis it may be necessary to sacrifice a tooth, the growth is so close to or springing from its socket.

FISTULÆ AND CYSTS OF THE NECK

These are located either centrally or laterally. The former usually originate in the thyroglossal duct; the latter in faulty obliteration of the branchial clefts and are therefore apt to appear externally somewhere along the anterior margin of the sterno-mastoid and to extend upward and inward. But multilocular branchiogenous cysts may arise anywhere in the triangles of the neck, and their exact etiology is disputed. Pharyngeal and esophageal diverticula are also branchiogenous. A branchial fistula may open either internally or externally or both. Its deeper portion is lined with cylindrical epithelium, that more external with the pavement variety. A portion of such a tract being occluded may become a cyst, which, if its lining membrane be cylindrical, will contain a seromucous fluid and be called a hydrocele of the neck. Lying deeply it may appear also within the mouth. If lined with pavement epithelium the accumulated contents will be sebaceous and it will be called a dermoid. Or the contents may contain the characteristics of both varieties. A fistula usually discharges. A cyst slowly grows and becomes a more or less fluctuating painless tumor. There is a variety of cyst of the neck sometimes called multilocular branchiogenous cyst which differs somewhat from those just described in being multilocular and often multiple. The contents are serous. These tumors somewhat resemble cystic lymphangioma but are distinct from hygroma and from Berger's polycystic tumors of the parathyroid.[1]

Branchial cysts may become malignant. Either cysts or fistu-

[1] GUIDE PRATIQUE DE CHIRURG. INFANTILE, E. Estor, p. 233 *et seq.* Estor and Massabau: Revue de Chirurgie, Sept., 1908.

lous tracts are liable to infection, producing inflammation. In diagnosis, lymphangioma, lymphadenitis, angioma, hygroma and sarcoma must be excluded.

Treatment.—The cure of either fistula or cyst of the neck is more of a problem than might at first appear. Shallow fistulæ may sometimes be closed by destroying the lining with the galvanocautery. Tincture of iodine or solution of silver nitrate may be used similarly. Unilocular cysts may be treated in the same way after evacuating their contents, but the method is tedious and uncertain. The only certain way is to dissect out the fistula or cyst, removing every portion of its lining wall. This may be difficult, leading to the pharynx or tonsil or carotid region in the branchial, or behind the larynx and thyroid in the thyrohyoid varieties. A fistula should first be injected with methylin blue and then a probe introduced, thus furnishing guides by which the dissection may be made. If pharynx or esophagus are opened, they must be securely sutured. (61.) The deeper portions of the wound are approximated with catgut. A slender drain should be placed, to be left forty-eight hours. The flaps of skin and fascia are closed with subcuticular suture of silkworm gut. Rectal feeding should be used for some days. Fistulæ of the neck may be accompanied by supernumerary auricles, see Appendix (62).

COLOBOMA OF THE EYELID

This is a congenital malformation consisting in a cleft or fissure, usually of the upper eyelid. It is sometimes associated with harelip, cleft-palate and with coloboma of the iris and choroid, and occasionally accompanied by dermoid of the cornea.

Treatment.—The edges of the cleft should be pared and united with fine sutures of horsehair or silk passed through skin and cartilage.

EPICANTHUS

Epicanthus is a congenital malformation in which a crescentic fold of redundant skin, with the concavity of the crescent toward the eye, extends from the inner end of the eyebrow down across the canthus. It is usually bilateral, apt to be hereditary, and to be accompanied by a flat nose, and sometimes by other defects of the adnexa or of the eyes themselves.

Treatment.—The appearance of the eyes, and also of the wide and flat bridge of the nose, can be improved by a small but neat operation. A small ellipse of skin, with its long diameter vertical, should be removed from the middle of the bridge of the nose. The folds of skin adjacent to the ellipse should be freely loosened in the direction of the canthi, so that when the margins of the ellipse are united by suture in the middle line the overhanging skin is drawn away from the eyes.

CHAPTER XXVI

CLUBFOOT AND SOME OTHER DEFORMITIES OF THE EXTREMITIES

CLUBFOOT—WEAK ANKLES—CLUBHAND—SUPERNUMERARY ARMS OR LEGS, HANDS OR FEET—SUPERNUMERARY DIGITS (POLYDACTYLISM)—INTRA-UTERINE AMPUTATIONS AND CONSTRICTIONS AND SUPPRESSION OF INTERMEDIATE PARTS, ABSENCE OF PARTS—WEBBED FINGERS OR TOES (SYNDACTYLISM)—IRREGULAR ALIGNMENT OF DIGITS—MALFORMATIONS OF JOINTS.

CLUBFOOT

CLUBFOOT (*Talipes, Pes Varus, Pes-contortus*) may be either congenital or acquired. It is an abnormal position of the foot with relation to the leg, and usually also of the pes or anterior portion of the foot with relation to the talus or ankle portion. The altered positions are either in the upward or downward, inward or outward directions, or in combinations of these. The deviation takes place in the ankle joint or in the medio-tarsal joint, *i. e.*, between the os-calcis and astragalus behind, and the cuboid and scaphoid in front. One should remember that the foot has two arches, an antero-posterior and a transverse, the articulating surface of the astragalus being the apex of both arches, that the bones composing these arches are maintained in position by ligaments, fasciæ and the tonicity of muscles.

There is also to be considered the cartilaginous, unossified condition of the bones, the softness and weakness of muscles, fasciæ, and ligaments, and the abundance of plantar and subcutaneous fat in the infant and child as compared with the adult. The bony arch does not begin to form in the infant until after the first year, but the cartilages are somewhat supported below by fat.

Etiology.—The etiology of congenital clubfoot is in many cases unsatisfactory. (See Section on Malformations.) That of the acquired forms will be referred to in the description of the special variety.

Varieties.—Of clubfoot there are four principal varieties, sometimes called the simple forms., viz., Talipes varus, in which the foot is turned inward; talipes valgus, in which the foot is turned outward; talipes equinus, in which the toes are held downward

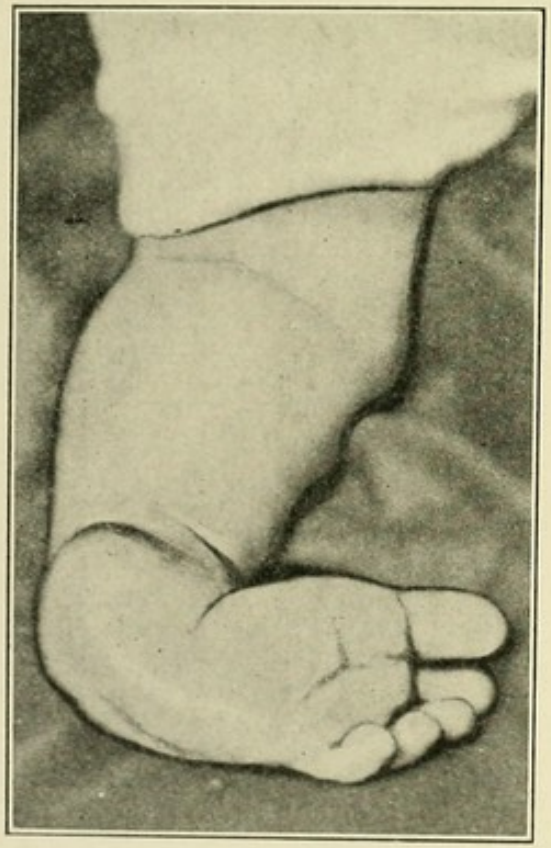


FIG. 270. TALIPES VARUS. Posterior view. Note also diminutive heel, convex outer border, deep fold upon inner border.

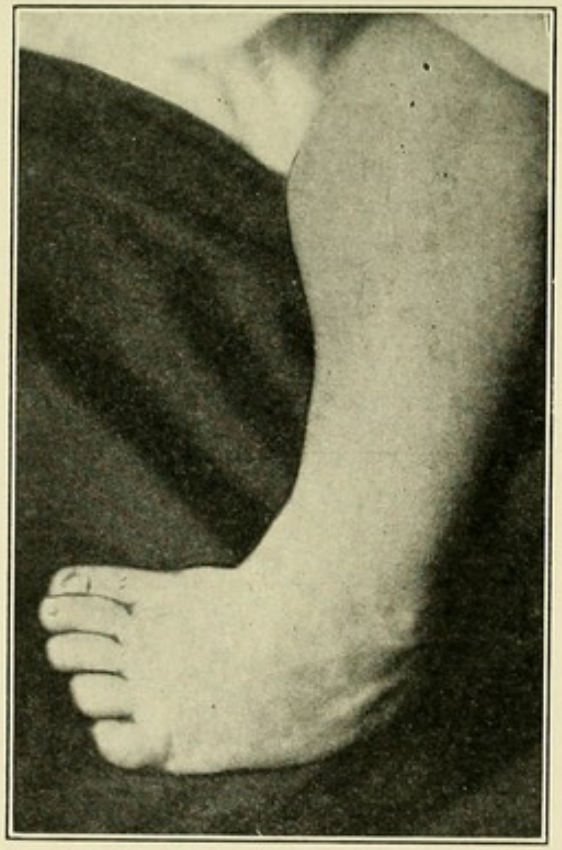


FIG. 271. TALIPES VARUS. Anterior view. Same case as Fig. 270. Foot treads upon its outer and anterior aspect.

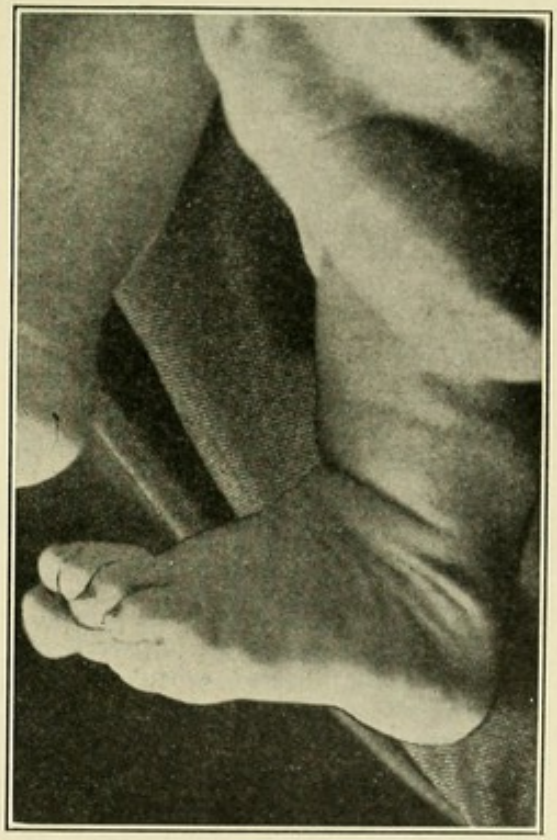


FIG. 272. Same case as Figs. 270 and 271 after tenotomies and three months' use of plaster bandages.

up to the present shows the greatest diversity of opinions, which and the heel elevated; and talipes calcaneus, in which the toes are elevated and the heel depressed. Besides these are talipes cavus, in which the antero-posterior arch is exagerated, and talipes planus, in which it is somewhat flattened. The compound forms are combinations of the others, and are named accordingly, for instance equino-varus, calcaneo-valgus, et cetera. The most common variety is a compound one, equino-varus; that next in frequency, calcaneo-valgus.



FIG. 276. PES PLANUS OR FLAT FOOT. Note the outward curve of the tendo-Achillis, seen best in the left foot.

TALIPES VARUS.—This malformation in a very mild degree is often observed in the new-born, and alarms mothers, but soon corrects itself. In the pathological degree it is very rare in the simple form, being a bending inward of the pes, the sole usually facing somewhat backward. (Figs. 270, 271, 272, also Figs. 277, 278, 279.) In combination with equinus it forms the most common variety of clubfoot.

TALIPES-VALGUS.—Valgus, in which the foot turns outward and the scaphoid and astragalus project on the inner side, while not common as a congenital deformity, is more common than varus. (Figs. 273, 274, 287.) In its acquired form it is common. Acquired valgus is classified as rachitic, paralytic, static and traumatic. Rachitic valgus is very common in children and frequently accompanied by knock-knee and anterior bowing of the tibia. Paralytic valgus is common, due generally to poliomyelitis. Static valgus, due to weight-bearing on a weak arch, is not so common in childhood as in adolescence, yet is sometimes met, usually in connection with weak ankles in overgrown youths of feeble musculature, especially girls such as have lateral curvature of the spine. (Fig. 288.)

TALIPES EQUINUS.—Congenital equinus unassociated with varus is seldom met. The majority of the cases are acquired, following spastic paralysis, pseudo-hypertrophic muscular paralysis, and infantile paralysis, or traumatism.

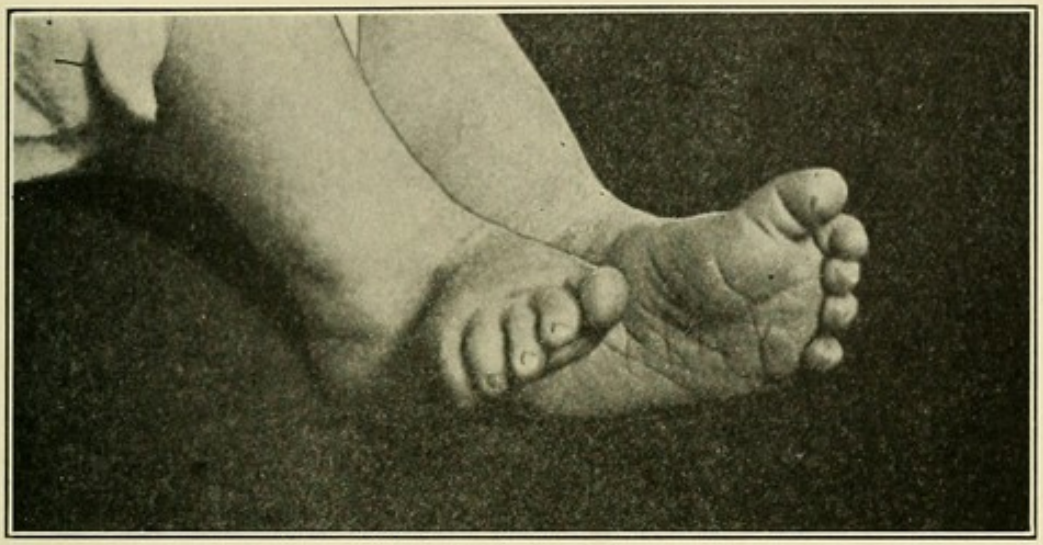


FIG. 273. TALIPES EQUINO-VARUS of the left foot and valgus of right in same child. An unusual association.

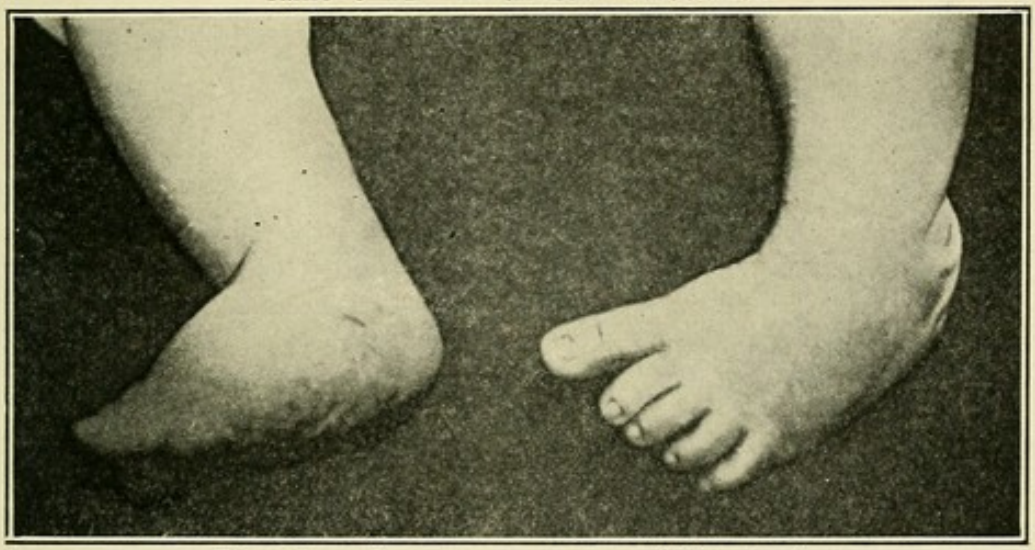


FIG. 274. Same case as 273, different view.

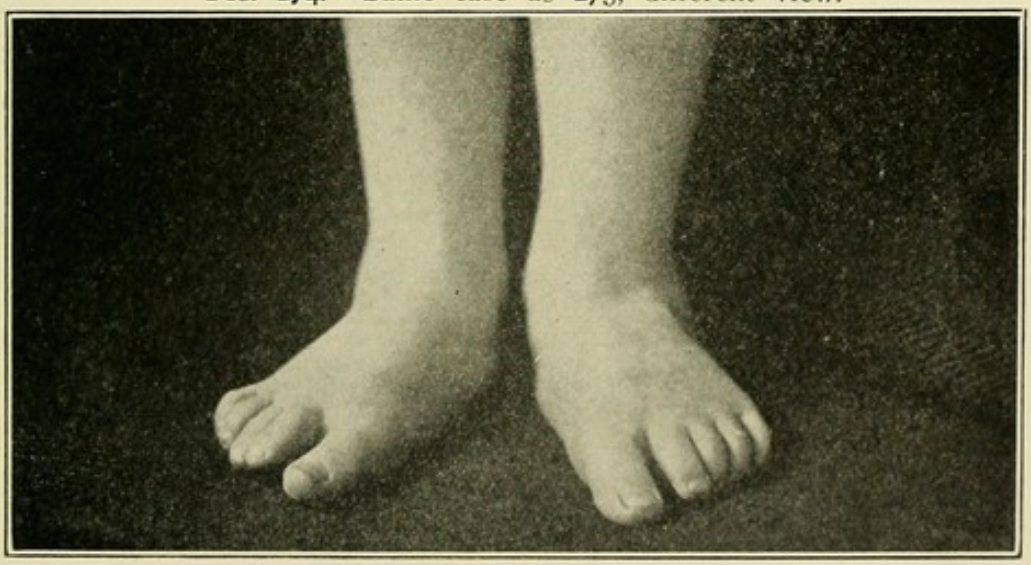


FIG. 275. Same as Figs. 273 and 274, after treatment by tenotomies and plaster bandages.

TALIPES CALCANEUS.—Calcaneus is rare as a congenital deformity, being almost always a result of poliomyelitis.

PES CAVUS.—This may be either congenital or acquired, but is

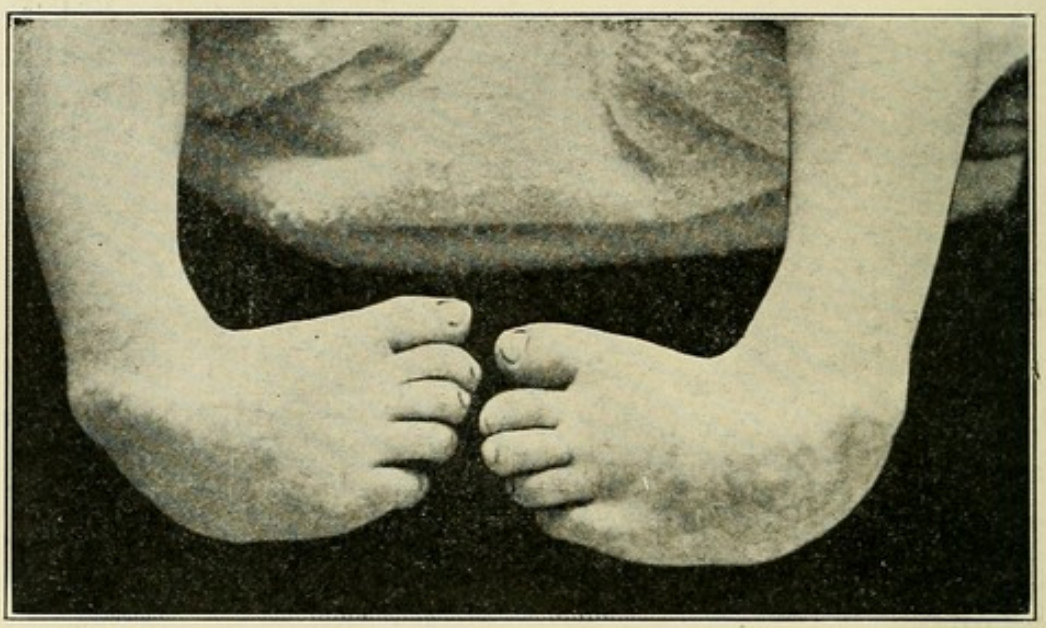


FIG. 277. DOUBLE TALIPES VARUS. Anterior view, see also Figs. 278 and 279

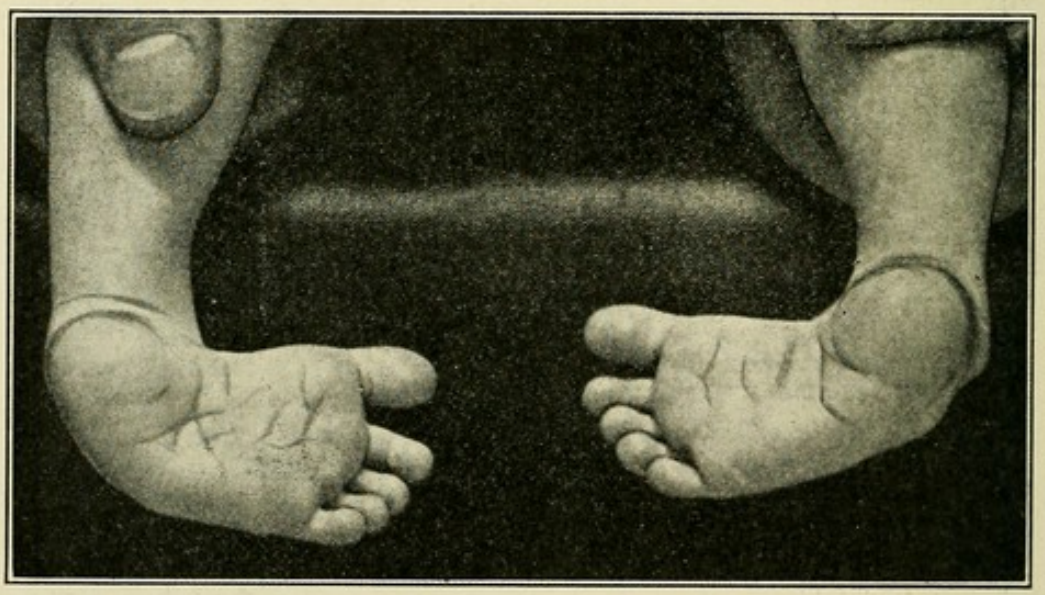


FIG. 278. Same as Fig. 277. Posterior view. Referred by Dr. L. H. Wagner.

usually acquired. Cavus is an exaggeration of the arch of the foot. When congenital it is seldom alone, but usually associated with equino-varus. When acquired it results from paralysis, with contractions of the tibialis anticus, peroneus longus, and the plantar fascia.

PES PLANUS.—In planus, or flatfoot, the arch is lowered by

lengthening of the plantar ligaments and relaxation of muscles. It differs from valgus only in that the foot is not everted. (Fig. 276.)

TALIPES EQUINO-VARUS.—This is the most common and most typical of all the varieties of congenital clubfoot, and may also be acquired. The deformity involves the muscles, ligaments, fasciæ and bones of the foot. The tendo-Achillis and the tibialis posticus and anticus, the short muscles of the sole and the flexors of the toes

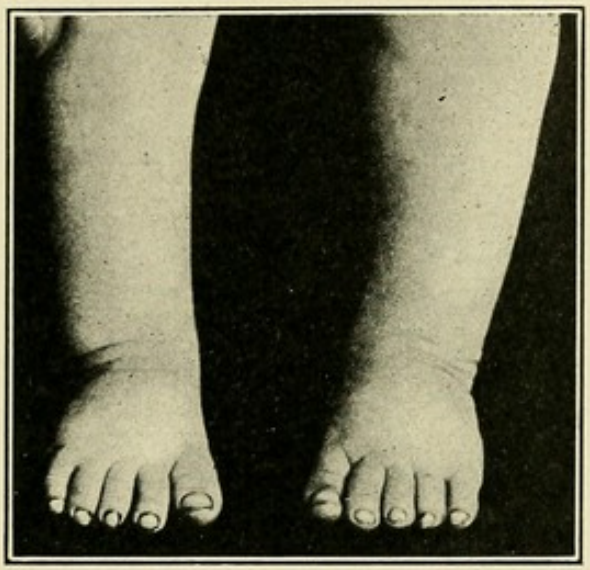


FIG. 279. Same case as Figs. 277 and 278 after treatment by tenotomies and plaster bandages.

are contracted. The posterior ligament of the ankle, the anterior part of the internal lateral ligament, and those between the astragalus and scaphoid and on the inferior surface of the calcaneus and scaphoid as well as the plantar ligaments and fasciæ are short. Thus the foot is held in a distorted position with the heel elevated and the anterior part of the foot adducted and rotated with its inner side forward and upward. (Figs. 280 and 281, 282, 283 and 284.) The greater part of the adduction and rotation takes part at the medio-tarsal joint. The heel is dwarfed. The astragalus projects on the dorsum of the foot. The scaphoid articulates with the inner side instead of the anterior surface of the deformed astragalus and may even articulate with the tibia. The cuboid, the cuneiform, and the metatarsals are rotated inward, and so retracted upon their under surfaces as to produce more or less cavus. The tendo-Achillis lies near the internal malleolus, and the fibula may be drawn quite behind the tibia. Bursæ are found upon the convex side of the foot; and in children who have walked, calloused areas. The overstretched muscles are atrophied but not paralyzed.

ACQUIRED EQUINO-VARUS.—In the acquired form the condition, if of long standing, is much the same as in the congenital, but when

the result of poliomyelitis, the overstretched muscles, and sometimes the whole extremity, are paralyzed as well as atrophied.

TALIPES CALCANEO-VALGUS.—This may be congenital or acquired, and like the other and more unusual compound forms, needs no special description.

Prognosis.—The prognosis in congenital clubfoot is good. One cannot always be sure that the growth of the deformed foot, or even of the leg, will keep pace with that of its fellow, for in some cases not paralyzed, there seems to be a fault with the trophic centers or for some reason normal growth does not take place. But the deformity can always be corrected in from a few weeks to a few months or a year, and will remain corrected if properly managed. The paralytic cases are not promising as a class, but sometimes much can be done for them.



FIG. 280. TALIPES EQUINO-VARUS.

Treatment.—One can easily recollect when the treatment of clubfoot was almost entirely by mechanical means. It was sought by shoe-like appliances of various forms to which levers or screws were attached, to use considerable pressure and gradually force the foot into correct position and to hold it there until it would stay of its own accord. This often required months and years of persistent and oft-repeated attention, and then sometimes failed to accomplish its purpose. That plan is still used for mild cases taken in hand soon after birth. But for the more marked cases and those coming to the surgeon later, there is a better method. By operation or mechanical force the deformity of the foot is corrected or even over-corrected at once, and then apparatus is used of which only slight pressure is required to maintain the proper position until it becomes natural. This can be accomplished with far greater certainty, less discomfort, and less time than by the old method.

To illustrate this method the treatment of equino-varus will be first described; and then the same principles applied to other varieties.

Treatment of equino-varus.—The sooner after birth the case comes to the surgeon and treatment begins the better. The resistance of tissues to correction is tested by the hands of the surgeon. If the foot can be easily placed in correct position it is probable that

no operation will be necessary. By the use of mechanical means alone the foot can be held in over-corrected position for a sufficient length of time and it will remain permanently corrected. A convenient means of maintaining correct position of very mild club-foot in new-born babes is a splint made of strips of tin, of about the width of the foot and of the length of the foot and leg. Enough strips of tin are fastened together with adhesive plaster to make a splint of convenient stiffness. This is bent to proper shape and

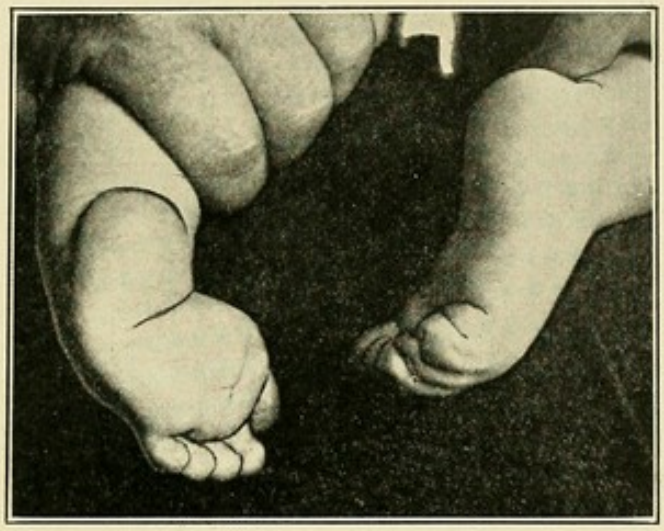


FIG. 281. DOUBLE TALIPES EQUINO-VARUS.

bandaged to the foot, holding it in over-corrected position. The splint is removed and replaced, the foot being massaged and manipulated by the nurse twice daily, and a cure soon effected. Other cases will do better with the gypsum bandage, covering the foot all but the toes, and extending the bandage half way to the knee, the foot being held in over-correction while the bandage is applied and allowed to harden. A new bandage is applied once in a week or two or three weeks as necessary. If the deformity cannot be overcome easily by the surgeon's hands, the resisting tendons and perhaps fascia should be divided. (See Sections on Operations on Tendons, Subcutaneous Tenotomy, Open Tenotomy.) It will be necessary to tenotomize the tendo-Achillis, probably the tibialis posticus and perhaps the anticus and the plantar fascia.

The tibialis anticus tendon is usually felt at the bottom of the concavity at the inner side of the foot, and is cut near its insertion into the cuneiform. The tenotome may be passed beneath it or cut down upon it.

The tendon of the tibialis posticus is a little more troublesome to find in a fat infant. It may necessitate an open wound at the posterior border of the tibia just above the internal malleolus, where

it can be lifted with a hook and divided; or the sharp tenotome can be introduced at a point half way between the anterior and internal borders of the tibia and passed so as just to graze the inner margin of that bone. The blunt tenotome is then introduced through the same opening and thrust flatwise farther under the tendon, the edge then turned outward and "the tibia used as a fulcrum" (Jacobson) while the tendon is severed, usually that of the flexor longus digit-

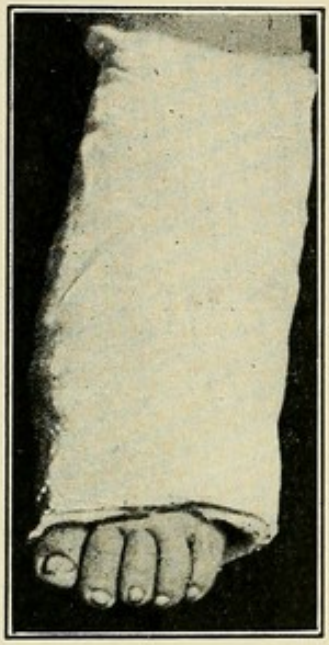


FIG. 282. Same as Fig. 280, after correction of varus by tenotomy of tibiales and plaster bandages applied.

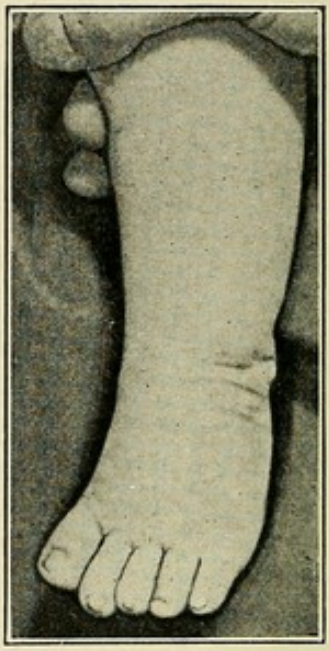


FIG. 283. Same as Figs. 280 and 282, varus corrected, the tendo-Achillis still maintaining the equinus.

orum being cut with it. The plantar fascia may be cut at any point, or at several points that seem to need it, at the bottom of the concavity on the inner border of the foot. The tenotome is introduced on the inner side of the foot and passed flatwise between the skin and fascia (which is not kept tense during this step) until its point has reached the outer margin of the fascia. The edge of the blade is then turned toward the fascia, now made tense, and with a sawing motion divides it until it yields. If there be present a marked degree of varus it is better to correct this before dividing the tendo-Achillis, leaving the latter to hold the heel firmly while the surgeon straightens the pes upon the talus. (Figs. 282, 283.) One or both tibiales and the fascia having, if necessary, been divided, the tenotomy wounds dressed antiseptically, and the deformity of the foot itself corrected and over-corrected, it is held so and put up in a plaster bandage. The plaster can be applied next the skin, but it is better to cover the skin and surgical dressing with a flannelette roller before the plaster. The plaster leaves the toes exposed but extends up

the leg. If there is a tendency to inversion of the leg and foot, or if the heel is very small, the plaster would better be extended above the flexed knee, the foot being held in over-correction and rotated outward while the plaster is being applied and until it hardens. In a few weeks the case is one of simple equinus, and can be corrected by division of the tendo-Achillis. This tendon is cut subcutaneously [1] at its narrowest part a half-inch or more above its insertion, passing the tenotome from the inner side between the posterior tibial artery and the tendon, and cutting toward the surface. The equinus is corrected and slightly over-corrected and the member put up in plaster. Formerly it was the practice not to correct the deformity immediately at the time of the tenotomy, but to wait a week or more, and then make the correction. But that delay is not necessary nor useful. The plaster bandages will need renewing once in a fortnight, or a month or more, perhaps until the infant is ready to walk. It may then be allowed to walk with the foot encased in plaster or a retention splint; or if preferred, a walking shoe may be used. The retention splint or shoe is merely a metal sole and heelpiece with straps to hold the foot upon it, and fitted with a rigid upright at each side of the ankle running to a band encircling the leg. (See Fig. 285.) It is placed upon the foot and an ordinary shoe put on over it. The walking shoe is made with the uprights jointed at the ankle, placed inside of the shoe, not fastened to it, and sometimes has a toe-lift running from the outer side of the foot to the encircling band upon the leg. The joint at the ankle is best made so that it can be flexed but cannot be extended beyond a right angle and needs no toe-lift. Such apparatus is not expected to exert corrective force. It merely retains, without pressure, the corrected position and prevents relapse. It should be worn until there is no possible tendency toward relapse. If there is any inclination toward "pigeon-toe" or inward rotation of foot and leg, the uprights should be extended above the knee (and better even to a pelvic band) and given an outward turn to correct that deformity. (See Fig. 286.)



FIG. 284. Same as Fig. 283, after tenotomy of tendo-Achillis and use of plaster bandages.

[1] A better procedure is tendon-lengthening.

Very few cases of equino-varus in children require any more severe treatment than that described. In older children, who have been neglected and in relapsed cases other procedures must be resorted to.

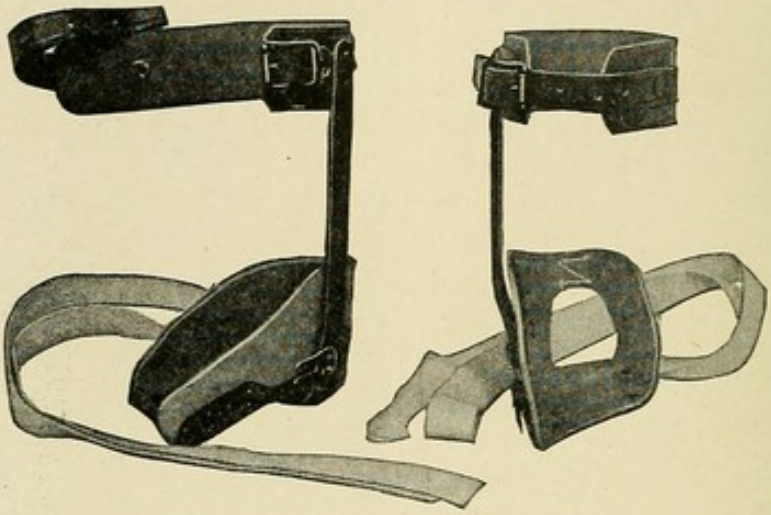


FIG. 285. RETENTION BRACE FOR CLUBFOOT.

Treatment of Neglected and Relapsed Equino-Varus.—Cases of neglected and relapsed clubfoot usually require more than ordinary preparation, during several days or a week before operation. Corns and callosities should be removed by poultices of soap or flaxseed and soaking in soda solutions. Then cosmoline at night and daily scrubbing with mercuric solutions and alcohol will render the skin pliable and comparatively aseptic. On the evening before and the morning of the operation the usual antiseptic preparations are made.

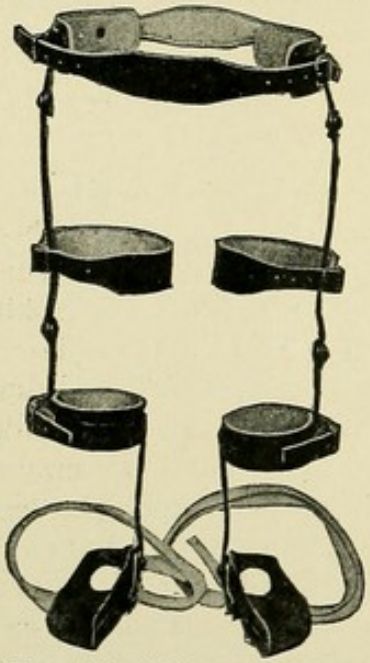


FIG. 286. WALKING SHOES FOR DOUBLE CLUBFOOT, when there is also inward rotation or pigeon toe.

These cases may be treated by stretchings and modelings, under anesthesia, with or without tenotomies or fasciotomies. Manual strength alone is usually not sufficient. But much force may be accurately applied by the hands of the surgeon in modeling a foot and stretching short structures across a wedge-shaped fulcrum. (See Fig. 287.) A clubfoot wrench or similar apparatus adds immensely to the power of the hand, though it does not increase but rather decreases the accuracy with which the force is ap-

plied. (See Fig. 288.) After the reshaping of the foot it is put up in plaster of Paris.

Phelps' operation.—It is sometimes advisable in neglected or

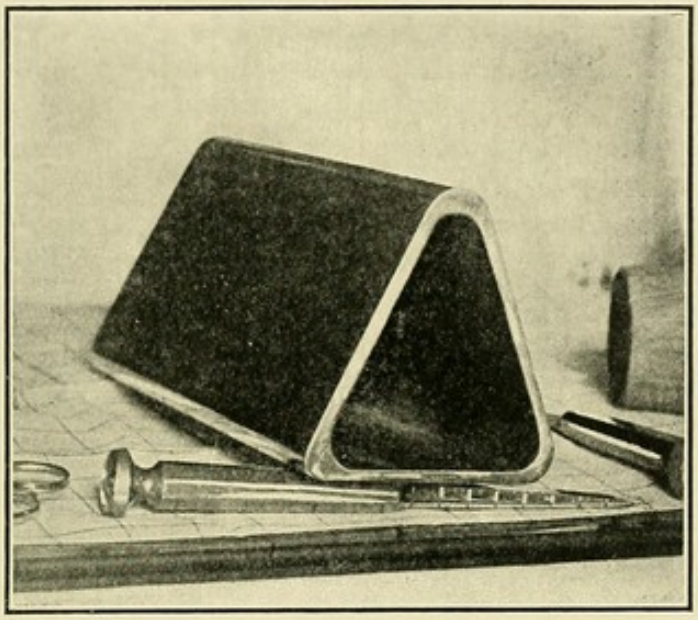


FIG. 287. AUTHOR'S METALLIC FULCRUM. An improvement on the König block.

relapsed cases in older children or adolescents, where the bones, however, are not too severely deformed, to make an open section of

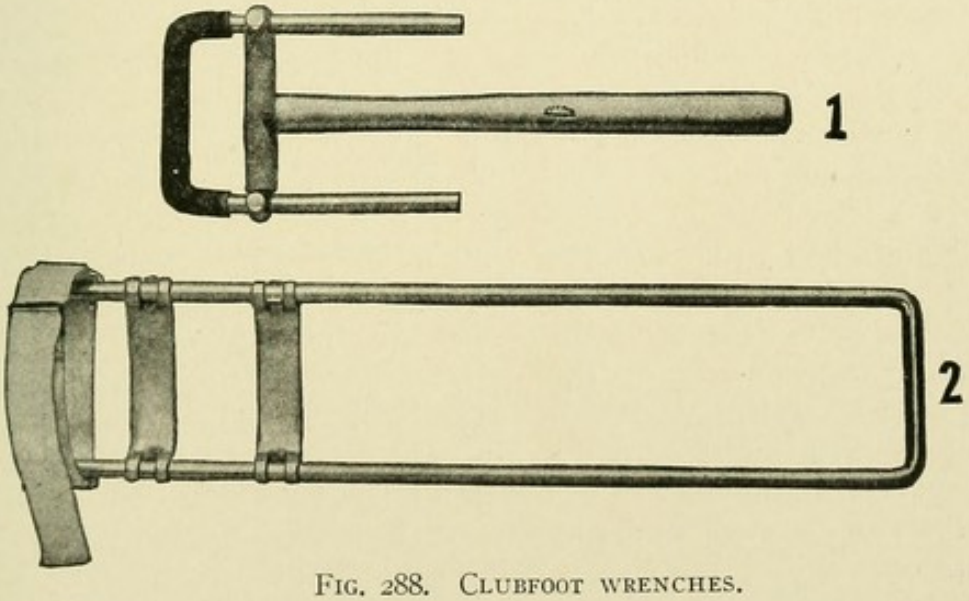


FIG. 288. CLUBFOOT WRENCHES.

all contracted structures on the concave side of the foot. The Esmarch bandage is used. The incision is just in front of and beneath the internal malleolus and extends obliquely forward and

across one-fourth or one-half the sole and divides all resisting soft parts on the inner and lower border of the foot. Skin and fascia, tendons, muscles, ligaments, are divided sufficiently to allow correction of the deformity to be made with powerful use of the wrench or other force. Care should be taken that the astragalus and calcaneum do not remain in faulty position with relation to tibia and fibula. The posterior ligament and the tendo-Achillis may require section. Rubber tissue or cyanide gauze is placed next the incision, an antiseptic dressing firmly applied, the Esmarch removed, the foot and leg put up in plaster of Paris and kept elevated for twenty-four hours. The first dressing remains on a month. Usually the wound is healed by this time. When healing is complete use retention splint or walking shoe. The Phelps operation has the advantage of lengthening the foot, while cuneiform tarsectomy shortens it.

Cuneiform Tarsectomy.—This operation may be used when the bones are too seriously misshapen for the Phelps operation. It has the disadvantage of shortening the foot. It consists in making an incision longitudinally over the most prominent part of the convexity of the foot, reflecting all the soft parts without injury to the tendons and excising a wedge of bone. Care should be taken to have the wedge of sufficient size to permit correction of the deformity.

Cook's operation.—It is claimed for this operation that it opposes flat clean-cut surfaces of bone with no bruising or mangling of surrounding tissues and no cavity to fill up; and that if the wedge of bone is sufficiently large and the angles of the wedge are correct, there is no tendency to relapse, as every step the patient takes tends to maintain the foot in its new position. It is performed as follows: First, if necessary subcutaneously divide the fascia on the inner side of the foot and also the heel-cord, and then bring the foot into as good position as possible, using nothing but the hands and being careful not to bruise the tissues. Next make an incision through the skin and superficial fascia, just in front of the external malleolus. Viewed from the outer side this incision should be perpendicular from just above the bend of the ankle to the sole.

Next with an osteotome remove a large wedge of bone, making the first incision far back, just in front of the fibula and going completely across the bones. Be sure to get the wedge large enough. The foot can now be brought, without force, into excellent position; and by giving the anterior part of the foot a quarter turn, its outer border should be elevated. Before closing the wound, see that the cut surface of the anterior part of the foot

does not project so high as to interfere with extreme flexion of the ankle. No sutures, excepting skin sutures are required. Gauze dressing and then plaster are applied. Dr. Cook uses a slight retention splint in preference to plaster. Children may walk after

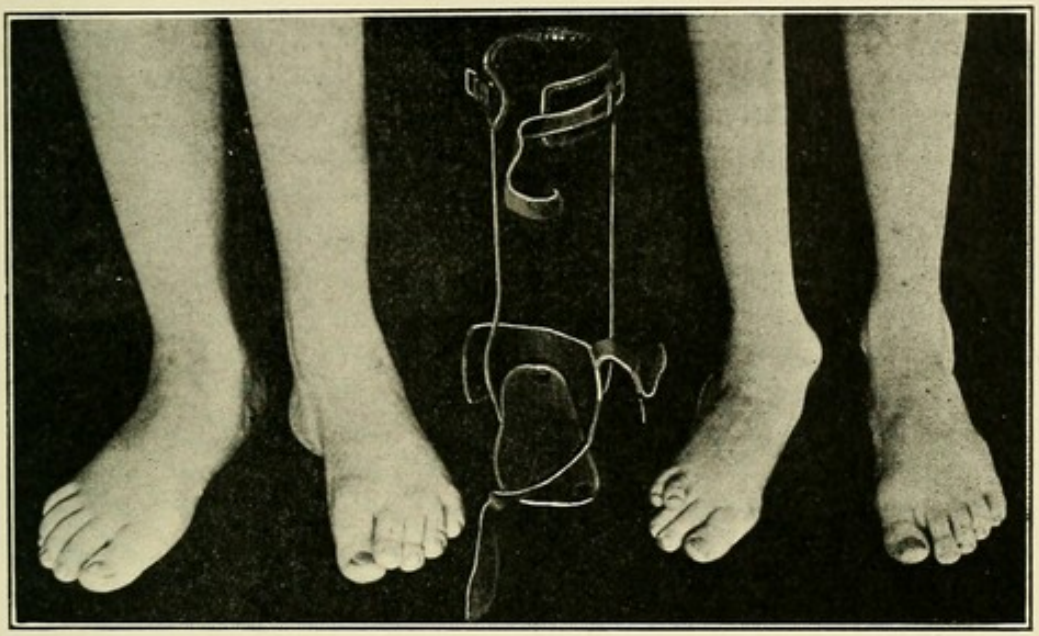


FIG. 289. TWO PAIRS OF FEET. EACH PAIR HAS ONE FOOT PARALYZED AND THE OTHER SOMEWHAT FLATTENED FROM EXTRA WEIGHT-BEARING. One paralyzed foot has a degree of cavus; and the other a degree of valgus, a flail joint at ankle, and contracted toes. To this foot belongs the brace shown.

two weeks. Dressing is worn six or eight weeks and then an ordinary shoe.

Treatment of Varus.—This has been sufficiently discussed in the treatment of equino-varus.

Treatment of Valgus.—The congenital form generally yields to repeated manipulations, with stretchings of contracted tissues, followed by plaster. In neglected or relapsed forms tenotomy of the contracted tendons or tarsectomy may be required. In the rachitic form the treatment consists in massage and corrective movements, alternating exercise and rest periods, a shoe with sole thicker upon the inner side to throw the weight upon the outer border of the foot and a felt pad or metal support under the arch. (See also Sections on Pes-Planus and on Weak Ankles.)

In paralytic valgus, a very common result of poliomyelitis, transplantation of some of the contracted tendons to the inner side of the foot may be useful. And the possibilities of nerve transference should be considered. A proper shoe and arch support, perhaps also an ankle brace may solve the problem. In extreme paralysis or flail-foot, arthrodesis at the ankle joint, or better still,

astragalectomy, often render the foot useful. Astragalectomy gives a considerable degree of stability with some motion, unavoidably with some shortening.

The treatment of static valgus, an exaggerated form or degree of flat-foot with eversion, is sufficiently described under the caption of planus. Traumatic valgus is extremely rare in children. It comes as a result of crushing injury to the foot with union in deformity, or to fracture of tibia and fibula near the ankle with angular union leading to eversion of the whole foot. Treatment consists in refracture or osteotomy, with correction or rather overcorrection, fixation until firm union takes place and then the use of a shoe or brace, massage and exercises until complete restoration to function.

Treatment of Equinus.—This has been sufficiently described with equino-varus.

Treatment of Calcaneus.—Congenital calcaneus seldom requires tenotomy. If manipulations do not suffice a brace should be worn with its ankle joint so constructed as to allow extension but not flexion beyond a right-angle. Acquired calcaneus is generally accompanied by cavus or valgus. Manipulation, stretchings, gypsum and braces may be considered but are very disappointing. Whitman operates by making a long external incision behind and above the external malleolus, going below its extremity and terminating at the end of the astragalus. The peronei tendons are divided far forward and reflected, the joint is opened and the foot displaced inward. The astragalus is eneucleated. Sections of bone are removed from the outer surface of the oscalcis and cuboid. On the inner side the sustentaculum tali is removed and the calcaneo-navicular ligament separated. The cartilage is removed from both malleoli. The foot is then displaced backward as far as possible, bringing the external malleolus over the calcaneo-cuboid juncture. The internal malleolus is pushed into the depression behind the scaphoid. If the peronei are active they are used to reënforce the tendo-Achillis. The foot is put up in plaster in the equinus position.

Jones advises[1] an operation in two varieties and done in two stages as follows: (a) Calcaneo-cavus where calf-paralysis is complete. Stage I. The plantar fascia is divided if contracted and the foot straightened as much as possible with hands or wrench. An incision down to the bone is made on the inner side of the foot, with its center opposite the angle of the cavus. With periosteum elevator the soft parts are separated from the tarsus

[1] Jones: Amer. Jour. Orth. Surg., Apr., 1908; Liverpool Medico-Chirurgical Journal, Jan., 1909.

both above and below, from inner to outer side. A V-shaped section extending across the tarsus is removed. If valgoid deformity is also present, the section should be wider upon the inner than the outer side. If necessary the foot may be opened on the outer as well as on the inner side in removing the wedge. Sutures are placed and the deformity of the foot is then obliterated by extending it. The foot is bandaged to the tibia in a position of exaggerated calcaneus. Stage II. Four weeks after the first stage. A longitudinal incision is made back of the heel with its center opposite the ankle joint. The joint is opened and from the astragalus a wedge is removed sufficiently large to be accurately obliterated when the foot is brought to a right angle. The cartilage is removed from the tibia and fibula. The wound is sutured and the foot put up in fixed dressings. (b) Calcaneo-cavus where some power remains in the calf muscles. Stage I is the same as in (a). Stage II. Shortening of the capsule and of the tendo-Achillis are performed.

Treatment of Cavus.—Slight cases in young children with a flexible foot may yield to the force of the surgeon's hands, followed by the use of a metal sole with a broad strap over the arch. But a footwrench or even an osteoclast may be required to lower the arch, even after division of the plantar fascia and contracted tendons. When complicated by equinus lengthening of the Achillis tendon will be required, but this should not be done until after the work upon the foot itself has been completed.

Treatment of Planus.—Pes planus, broken arch or weak foot is so common as to deserve considerable attention. It must be treated according to its cause and its degree. Infants about learning to walk are often brought by anxious mothers who fear flatfoot because no arch is apparent. This condition is scarcely abnormal at this stage of development, and if the babe is healthy, disappears with farther development and education of the muscles. But search should be made for evidences of malnutrition, rickets, actual malformation of bones, paralysis or contractions.

That class of weakened tarsal arches common in older childhood and adolescence and due usually to a combination of weak musculature, ill-shaped and high-heeled shoes and too much standing, can be cured only by attention directed to the cause or all the causes; and when these have resulted also in actual elongation of the plantar ligaments and the high heels have produced contraction of the gastrocnemeus and soleus, or when in addition to the causes mentioned there is also knock-knee, sabre-leg, inbowed-leg or partial paralysis, the case is one of difficulty and involves treatment of more than merely the feet. Cases which have become

painful or tender will be made more comfortable by rest, hot and cold douching, water compresses, and hot-air baking. When pain and tenderness are not present or have been relieved, a course of muscular improvement should be pursued persistently. The tibial muscles especially should be exercised by adducting and inverting the foot, and the toe muscles by using them to pick up marbles from the floor and similar exercises. Then all the muscles of the foot and leg go into training with circumduction and this with resistance applied by the hand, tiptoe and pigeon-toe and varic walking, barefooted or in stockings only. Corrective walking should be practiced by treading upon the outer borders of the feet, with toes straight forward or inward, never outward, and taking as long steps as the contracted calf muscles will permit. Exercises should never be carried to over-fatigue and should be followed by the hot and cold douche, massage and rest. For those who are obliged to be much upon their feet, the muscles should also be temporarily assisted by strapping systematically in layers with adhesive plaster as one does for sprain of the ankle (Gibney's method), carrying the straps from the outer side of the leg under the heel, under the arch, and up the inner side of the leg.

Proper shoes are essential. The shoe should have a low broad heel. On the inner side the heel may extend forward under the arch. It should be roomy at the toes. The inner border should be straight or even concave throughout. It is useful to have the sole and heel of the shoe thicker on the inner than on the outer border by applying leather of one-sixteenth to one-fourth inch thickness.

Various so-called arch-supports or sole plates have been devised. An insole of leather or of felt and leather may be arched upward on its inner side so as to support the arch in a more natural position. Such an insole and shoe raised on the inner half of the sole are often all that is necessary in infants and young children. For older ones there are sole plates of many materials and varieties that need not be described in detail. Those for sale ready made seldom fit the individual case. Some are arched upon the outer side, raising that border of the foot from the ground, which is always an error; and some attempt too much correction of the transverse arch. The object of the plate is not merely to raise the longitudinal arch from the floor, but to shift the weight to the outer side of the foot. The inner margin of the plate should curve up high enough to support the scaphoid and astragalus. Among the many kinds of modelled plates those of German silver have served my purpose best. This metal in the rolled plate, gauge 18, can be shaped with a hammer by a skilled mechanic; and when nickel-

plated or when it contains eighteen per cent. nickel alloy, simply burnished, it makes a strong, light, smooth and durable arch support that can be modified in shape to suit the changing arch. The plate can be modelled from a diagram of the sole drawn while the patient stands upon a sheet of paper. The pencil traces the outline closely around the edge of the sole and then, the arch being raised from the paper, the pencil is passed beneath the inner border of the foot and the outline of the arch is traced. Or a plaster cast of the foot may be made by placing the foot smeared with vaseline, without weight-bearing, in a shallow box of plaster of Paris and water mixed to the consistency of thick cream. Care should be taken to have the plaster cover the foot upon the inner side above the level of the scaphoid and astragalus. When the plaster has firmly set the foot is removed, the mold smeared inside with vaseline and filled with creamy plaster to make a cast. This cast may then be shaved to the degree of correction desired and serves for a model for the mechanic. Or the foot may be encased in a plaster bandage which, being cut off, serves for a mold to make the cast. In working with young and fidgety children or when in haste I have found it convenient to use modeling wax or plasticine or sometimes the doughy mixture known as wallpaper cleaner to take the mold of the foot. Too much correction should not be attempted with one plate lest tenderness result. It is better if necessary, to make new plates or remodel them at intervals, as the foot improves.

Compound forms.—The compound forms occurring occasionally are treated by an adaptation of the same principles as have already been discussed.

WEAK ANKLES

Sometimes associated with talipes planus or valgus, and sometimes occurring alone, are weak ankles. (Fig. 290.) The parts are neither malformed, paralyzed nor contracted, but the muscles are simply too weak to maintain the proper position of the ankle joint with the patient standing. They relax and sag to the inside.

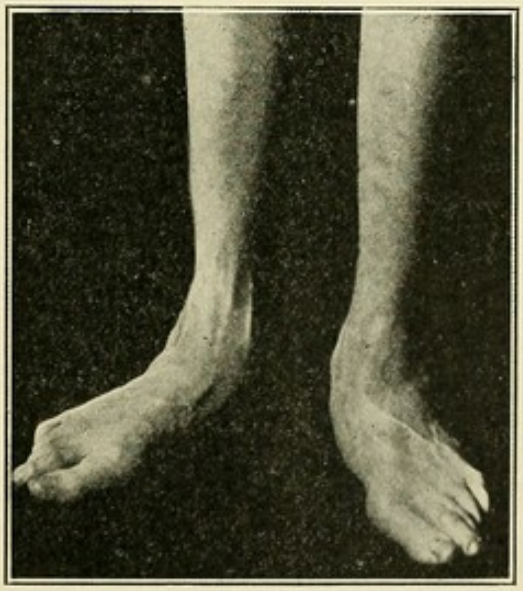


FIG. 290. WEAK ANKLES AND TALIPES VALGUS. Girl has also lateral curvature of spine. Eight years old.

Treatment.—The treatment consists in properly managed rest and exercise, massage, baths, sometimes electricity, general tonic

and hygienic measures as described for pes planus and for those who are obliged to be much upon their feet, some form of support for the muscles that does not interfere with their action, until they have developed adequate strength. A good way is to apply adhesive straps as in Gibney's method of treating sprains of the ankle but carrying the strapping well up the leg. For infants just learning to walk the only brace necessary is the high soleleather counter made for the purpose and worn inside the ordinary shoe. For older children, in severe cases, a simple brace with an upright fastened to the shoe and extending part way up the leg to an encircling legband and a pad opposite the inner side of the joint. The joint for the ankle should allow vertical but not lateral movement. (Fig. 140.)



FIG. 291. SUPERNUMERARY FINGERS. A rudimentary sixth digit attached to the outer border of each little finger.

CLUBHAND

Clubhand is a rare deformity. It is usually associated with or produced by absence or faulty development of the lower end of the radius or ulna, the hand being distorted with relation to the forearm. The hand may be drawn to or beyond the right angle on the radial or the ulnar side or in flexion or extension.

Treatment.—This deformity is not very amenable to treatment. If begun quite early, and used persistently, treatment by splints and various forms of braces, together with massage and systematic exercises, may do much to ameliorate the condition and prevent its becoming still more distorted. Cases have been reported treated by transplantation of bone into the forearm, also by exsection of a portion of the bone that exceeds the other in length so as to bring

the articulating ends on a level, and by other atypical operations. But there is no systematic method of treatment comparable to that for clubfoot.

SUPERNUMERARY ARMS OR LEGS, HANDS OR FEET

Reduplication of a large extremity, or of a large or complex portion of an extremity, is a very rare deformity, and its considera-

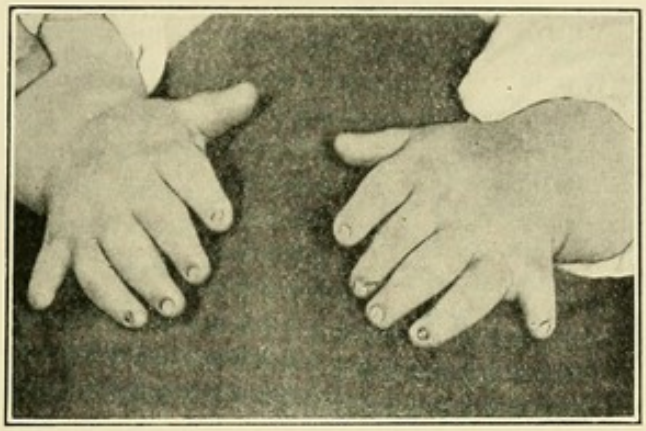


FIG. 292. SUPERNUMERARY FINGERS. A sixth digit attached to the ulnar border of each hand.

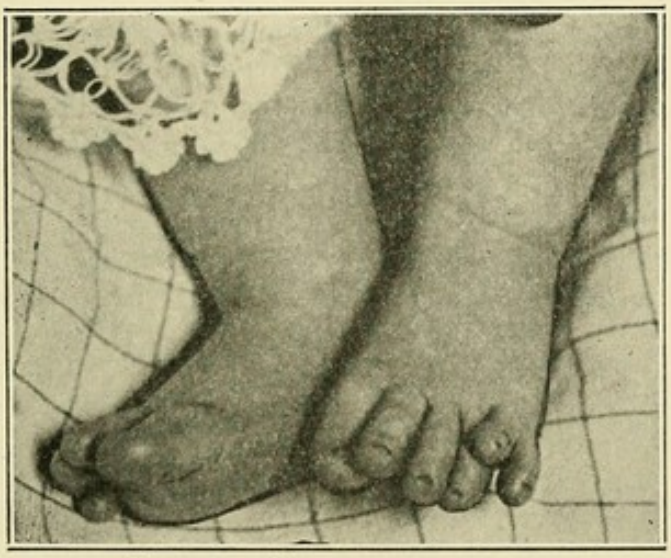


FIG. 293. SUPERNUMERARY TOE.

tion can be given little space. The etiology of this curious malformation by excess of development, which is evidently inherent in the embryo, has been referred to in the Section on the general subject of the Malformations, and on Teratomata.

Treatment.—As a rule the extra member is neither useful nor ornamental and should be removed when this can be done with safety.

SUPERNUMERARY DIGITS (POLYDACTYLISM)

The smaller and simpler structures are those more frequently found in excessive number. Polydactylism may affect either fingers or toes, or both in the same individual; may be symmetrical on the two sides, or occur on only one side, or each hand or foot may show from one to three or four supernumerary digits.

The supernumerary member or members may be rudimentary like a mere protuberance, or be more fully formed even to complete development, and be merely appendages or capable of partial or perfect motion. Polydactylism is frequently but not always hereditary.

Annandale classified supernumerary digits into four varieties according to their degree of development and mode of connection with normal anatomical parts. Figs. 292, 293, and 294 represent the first and second varieties of Annandale's classification.

Treatment.—In dealing with the hand, especially if the patient be a female child, much care should be taken to preserve symmetry and a smooth outline and to avoid scarring. As a rule the earlier the deformity can be dealt with the better and in all cases strict antiseptic principles should be observed. Supernumerary digits attached loosely by a pedicle should be snipped off.

Extra digits of the second class, having joint attachment but no voluntary motion, should also be removed with antiseptic precautions. In case a supernumerary finger and the normal one are very closely connected in a common capsule it may be better to divide the proximal phalanx of the supernumerary digit outside the articulation.

In the third variety, in which a perfect digit articulates with a metacarpal or metatarsal of its own, it is usually advised not to interfere. In the fourth variety, in which the supernumerary is united throughout with another digit, it is seldom advisable to attempt removal.

INTRA-UTERINE AMPUTATIONS AND CONSTRICTIONS AND SUPPRESSION OF INTERMEDIATE PARTS, ABSENCE OF PARTS

Cases occur with great rarity in which amputation of more or less of an extremity takes place in utero by the constricting force of bands of lymph stretched from one part of the uterus to another, or from one part of the fetus to another, and the amputated part is found lying loose in utero. It is less uncommon to find the amputation stump without any trace of the dissevered member, which has become disintegrated, the amputation having taken place very early in fetal life. In other instances grooves or fissures are found

of greater or less depth surrounding a limb as though the constricting band had begun but failed to complete the amputation.

Another group of cases has an intermediate segment of a limb suppressed, and the distal parts or rudiments of it attached to what remains of the limb. For instance, the forearm may be absent, and fingers project from the lower end of the upper arm. Again, distal parts of an extremity, as fingers or toes, hand or foot, may be absent or rudimentary. (Fig. 294.) In some of these cases of suppression and of absence of parts it may be impossible to determine whether the condition was caused by pressure, amputation, or originated in a fault in the embryo itself.

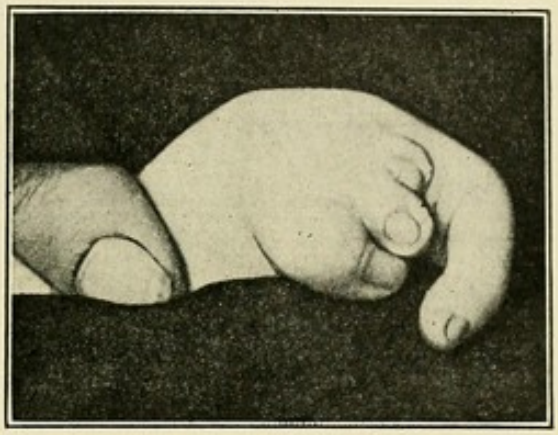


FIG. 294. MALFORMATION LEFT HAND. Index, middle and ring fingers rudimentary. Thumb and fourth finger useful. Referred by Dr. R. Bailey.

Treatment.—Most cases under this heading admit of no treatment.

WEBBED FINGERS OR TOES (SYNDACTYLISM)

This is a rather common deformity. It may be a family mark occurring occasionally through hereditary influence in successive generations. Or it may occur in single instances. Some cases are apparently caused by the parts being enveloped in lymph bands, and may show amputation of a portion of the digits and webbing of the stumps. There are varying degrees of the deformity. The normal web may merely be extended too far forward or may unite two or three of the phalanges. More rarely the web may be present between the distal and not the proximal phalanges.



FIG. 295. ABNORMAL ALIGNMENT OF THE TOES.

Again, instead of a merely cutaneous union, the deeper tissues, even the metacarpal or metatarsal and phalangeal bones, may be fused together. The malformation

is apt to be symmetrical and may involve either hands or feet or both. It is not uncommonly associated with some other deformity.

Treatment.—Webbing of the toes really needs no treatment. If adjacent fingers are united by union of the bones or joints they should not be interfered with. If they are united only by skin and fibrous tissues they should be separated. Simple division by cutting effects little, since the wound granulates at the angle and the parts gradually reunite more or less. This has sometimes been obviated by perforating the web and keeping a lead or silver wire or stylet in the opening until it healed and then dividing the remainder of the web, and by other similar methods. Also by dividing the web and then turning a triangular flap of skin and subcutaneous tissue so as to cover the angle between the fingers, and prevent their reunion (Norton). Finally there is the familiar method of Didot figured in all works on operative surgery. Two skin flaps are cut. One is raised from the dorsal aspect of one finger and the web. and the other from the palmar aspect of the other finger and the web. The flaps being raised, the remainder of the union is cut through, and each flap is wrapped around the finger to which it remains attached. Plastic methods should not be undertaken when the parts are too small and the tissues too delicate for convenient work, but after the infant or child is older.

IRREGULAR ALIGNMENT OF DIGITS

Deformity may occur in the form of irregularity in the alignment of the phalanges and their metacarpals or metatarsals. (See Fig. 295.) This may be congenital or may result from shoe-pressure. Early and persistent treatment by manipulation and adhesive plaster and only broad toed stockings and shoes may suffice. But if ulcerations, callosities or contractures are troublesome it is better to amputate the toe.

PIGEON-TOE

This deformity, in its most aggravated form, has been described under talipes varus. But there are numerous cases of toeing-in of less degree which demand attention from the children's surgeon. The incurvation may involve no more than the great-toe, or it may be a bending of the pes upon the talus, or an inward twist of tibia and fibula, or an in-knee, or inward rotation of the femur. Treatment consists in persistently repeated forcible untwisting of the affected structures. Voluntary corrective exercises, under instruction, with or without gymnastic machinery, are very effective. But often these means must be supplemented by apparatus to be worn. In babies a rubber tape attached to the inner side of the shoe, carried spirally around the leg and thigh and fastened out-

side, at the hip, sometimes helps in mild cases. I have often improvised a form of brace made of brass spring wire which passes back of the pelvis, makes a spiral turn opposite the hip-joints, descends to the knees where it makes another spiral turn and descending to the feet, is fastened to the shoes giving them an outward turn. Worn outside of the underclothing or diaper this simple device is not uncomfortable. It can be used in conjunction with plaster casts on the feet in talipes varus. Or in more marked cases a regularly constructed brace as used for equinus-varus (Fig. 286) can be used. Or the uprights extending from knee to pelvic band in such a brace may be substituted by spiral springs, as in Doyle's brace for clubfoot and pigeon-toe.

APPENDIX.

(1) **Anesthetics.** (p. 41.) As a local anesthetic the hydrochloride of quinine and urea has advantages over cocaine and others in being absolutely free from toxic effect and in maintaining anesthesia from a few hours to several days. It is used commonly in 1 per cent., sterilized solution, and is rather slow in taking effect, requiring from 5 to 30 minutes. It produces local edema, a disadvantage in some operations, but of no moment in others.

(2) **Hemorrhage.** (p. 45.) The pathological conditions favoring hemorrhage, such as hemorrhagic diseases of the new-born, are not here under discussion. They are well considered in the standard works on medical pediatrics. See, also, Graham: *Jour. Exper. Med.*, April 1, 1912.

(3) **Shock.** *Acapnia as a cause.* (p. 46.) Henderson (*Am. Jour. Phys.*, 1908, Vol. 21, p. 126; 1909, Vol. 23, p. 345; Vol. 24, p. 66; 1909-10, Vol. 25, p. 385) considers shock due to a diminished amount of carbon dioxide in the blood, a condition termed (by Mosso) acapnia. Carbon dioxide being a hormone or chemical regulator of respiration, is held responsible also for the failure of the circulation and the nervous system in shock.

(4) **Shock.** *Transfusion.* (p. 51.) Transfusion is the best treatment for shock following hemorrhage. Done with Brewer's glass tube it is very simple. The tubes of different sizes are boiled in liquid albolene. Artery of donor and vein, basilic, femoral, or external jugular (Vincent) of donee are exposed and dissected up for an inch or more. Each vessel is lifted and tied distally and encircled proximally by a narrow tape, lightly controlled by hemostat. Each vessel is severed between ligature and tape and the open end of the vessel beyond the tape washed out with normal salt solution, and then smeared inside and out with albolene. A tube of proper size for both vessels is selected from the hot albolene, and shaken to free its lumen of superfluous albolene. An end of the tube is tied into the vein and the other end into the artery. The small amount of air within the tube may be disregarded. The blood is allowed to flow through the tube, the proper amount being measured by the state of both patients as to pulse and general condition, and by testing the hemoglobin of the donee at intervals of a few minutes.

(5) **After Operation.** (p. 51.) Graham claims rectal injection of olive oil after anesthesia quickly raises the opsonic power of the blood,

which is lowered by anesthesia (*Jour. Infect. Dis.*, 1910, viii, 147; *Jour. Am. Med. Assn.*, March 26, 1910, p. 1043). If so, would not hypodermatic use of olive oil be better still?

(6) **Acromegaly.** (p. 61.) Acromegaly is now attributed to hyperplasia or an adenomatous condition (with over activity) of the hypophysis. Diminished functionation of the anterior lobe produces adiposity and sexual infantilism (Crowe, Cushing, Homan: *Johns Hopkins Hosp. Bull.*, May, 1910. For Surgery, see, also, Kanavel: *Jour. Am. Med. Assn.*, Nov. 20, 1909; *Surg., Gynec. and Obst.*, April, 1910; Eiselberg: *Ann. Surg.*, July, 1910).

(7) **Tumors.** *Morphological study.* (p. 64.) Mallory says (*Jour. Am. Med. Assn.*, Oct. 29, 1910) ". . . every simple tumor is due to the proliferation of one of the type-cells and that the blood vessel and stroma are furnished by the surrounding and included tissues and are not themselves tumor cells. The type-cells out of which the tumor is built is the one important element and gives the name to the tumor." In the morphologic study of epithelial tumors he insists on more thorough investigation of the embryologic origin of each kind of epithelial cell, of the histological differentiation which each type of cell undergoes, and that groups of epithelial tumors should be studied together to determine relationship, not separated as in a clinical classification.

(8) **Angioma.** *Naevus and cutaneous nerves, and naevus coincident with paralysis.* (p. 84.) Baerensprung sees a relationship between naevus of head and face and the cutaneous branches of the trifacial nerve. Cushing suggests as a cause, prenatal disease of the Gasserian ganglion, and also that when children with trigeminal naevus develop spastic paralysis, the latter is due to hemorrhage from a coincident nevus of the dura mater. (*Jour. Amer. Med. Assn.*, July 21, 1906.) See, also, a study of naevi by Fitzwilliams (*Brit. Med. Jour.*, Sept. 2, 1911), and "Inherited Hemorrhagic Telangiectasis," W. Ostler. (*Riforma Medica*, Jan. 16, 1911, xvii, No. 3.)

(9) **Nevus.** *Treatment.* (p. 85.) There are other methods of freezing nevi, for instance that with the solid carbon dioxid. The solid carbon dioxid is easily prepared from the compressed gas sold in iron cylinders by purveyors to the soda fountains. A somewhat porous tube of the size of the vent of the cylinder, is prepared by rolling a piece of chamois skin or a towel tightly round a rod, the rod being then withdrawn and the lower end of the porous tube tied shut. The cylinder is placed, vent downward, at an angle of 45 degrees, the porous tube held over the vent and the gas allowed to escape into the porous tube wherein a deposit of snow appears. This is taken from the towel or chamois, and shaken into a brass tube to make a snow pencil of the size desired. The snow may be rammed firmly into the tube with a rod and then pushed out of the tube in the form of

a pencil which will last from one to two hours, gradually dwindling. It can be handled with gloves or in lint, cut with a knife to suitable shape and used on the growth by applying it with pressure for 5 to 30 seconds, which is sufficient to freeze the tissues. During the thawing process there is some smarting which is allayed by warm water compresses but soon subsides. An antiseptic dressing is applied. The effect is considered to be not an escharotic destruction of tissue, but causes a flooding of the treated area with leucocytes during the circumscribed inflammatory reaction, with increased phagocytosis. Experience is necessary to judge the proper duration of the application and the degree of pressure. Excellent abstracts of the literature of the subject, with references, may be found in *International Medical Annual,* 1910, p. 550, pp. 306, 577; 1912, p. 486.

(10) **Hemophilia.** *Etiology.* (p. 99.) More recently it is considered due to defective coagulability of the blood. The nature of the blood-defect is in dispute. Addis (*Quar. Jour. Med.,* Oct., 1910) reaffirms that it is an inherited peculiarity of the prothrombin, its activation into thrombin being retarded. Sahli (*Brit. Med Jour.,* Nov. 5, 1910) claims defective coagulation is due to lack of thrombokinase and that in hemophilia there is a cellular anomaly not only of the corpuscles of the blood but of the endothelial cells of the vessels.

(11) **Hemophilia.** *Treatment by blood or blood serum.* (p. 99.) Transfusion of human blood may control the hemorrhage for the time being; it does not cure the tendency. Intravenous or even subcutaneous injection of human blood-serum have brought relief. The adult dose is 15 cc. of fresh serum (less than two weeks old) if injected intravenously, or 30 cc. subcutaneously. Diphtheria antitoxin or other serum may be used in emergency. Directions for transfusion are given in Appendix (4).

(12) **Rachitis.** *Treatment.* (p. 109.) Thyroid extract improves the general condition, growth and development of a number of rachitic children who are backward.

(13) **Syphilis.** *Symptoms.* (p. 118.) According to Graves the scaphoid type of scapula may be an indication of hereditary syphilis. See: "The Scaphoid Scapula a Frequent Anomaly in Development, of Hereditary Clinical and Anatomic Significance." (*Med. Rec.,* May 21, 1910.) "The Clinical Recognition of the Scaphoid Type of Scapula and Some of Its Correlations." (*Jour. Am. Med. Assn.,* July 2, 1910.)

(14) **Syphilis.** *Diagnosis.* (p. 120.) Since the discovery and acceptance of the spirochaeta pallida as the cause of syphilis, detection of the organism with the microscope is an important means of diagnosis. The simplest method is Burri's. The sore is washed with salt solution. Then the secretion, scraped from the sore, bloodfree, is mixed with equal quantities of distilled water and

Chinese ink. The mixture is smeared on a slide, allowed to dry, and examined with oil-immersion lens. The spirochætes show white against a dark background.

(15) Syphilis. *Treatment.* (p. 124.) Dioxydiamidoarsenobenzol, salvarsan or "606," which is an extraordinarily active remedy for improving the clinical condition, at least temporarily, in certain cases of lues in adults, appears to be dangerous in large doses in infants with the congenital form, in whom the spirochætes are so numerous that their destruction may lead to fatality by endotoxin; though many clinicians report excellent results when used, intravenously, in doses of about 0.01 gram per kilogram of body weight. Great caution should certainly be exercised in its employment. In older children, that is, in the late manifestations such as keratitis, untoward effects have not been so serious; nor have curative effects been so much more rapid than by mercury and iodides.

(16) Septicemia. *Opsonic power of infants' blood.* (p. 129.) According to Tunnicliff's experiments, the anti-infectious power of the blood (as measured by the opsonic index) and the phagocytic power of the leucocytes, in infancy is far below that of adult blood. (*Jour. Infect. Dis.,* Oct. 25, 1910.)

Vaccine Therapy. Da Costa: "The Routine Use of Autogenous Vaccines." (*Jour. Am. Med. Assn.,* May 28, 1910.) Martin: "Vaccine Therapy in Acute Infections." (*N. Y. Med. Jour.,* Dec. 10, 1910.)

(17) Operations Upon Tendons. *Open vs. subcutaneous tenotomy.* (p. 172.) There is no doubt that, to avoid the occasional instances of faulty union or subsequent stretching of the scar tissue, it is better to lengthen by open method, retaining tendon tissue throughout all tendons that are expected to functionate. Experience demonstrates occasional even if rare failure of union or later stretching of the fibrous tissue formed between the severed ends where no true tendon-tissue intervenes. In the Hibbs-Sporon method, redundant length of tendon after splitting does no harm. It is merely folded within the sheath and the sheath closed and sutured over it.

(18) Knock-knee. *Osteotomy.* (p. 186.) As to choice of inner or outer side of the limb, it is true that by cutting on the concave side (McCormac) the act of fracturing releases instead of tightening upon the osteotome; and that there is a lengthening rather than a shortening of the bone.

(19) Osteoclasis. (p. 193.) Osteoclasis may sometimes be performed by the manual strength of the surgeon by pressing the limb suddenly across the wedge-shaped wooden block of König, or better still the metal fulcrum of the author (see Fig. 287).

(20) Ankylosis, Arthroplasty. (Chap. viii, p. 198.) Utilizing certain

embryologic and pathologic facts concerning the formation of joints (see Section on Fasciæ and Fat Tissues) and the pioneer work of Verneuil, Ollier, Helferick, Lentz, Foederl, Nareth, and Chlumsky (see brief résumé by Neff: *Surg., Gynec. and Obst.*, Nov., 1912, p. 529), Murphy (*Jour. Am. Med. Assn.*, 1905, pp. 1573-1671; *Trans. Amer. Surg. Assn.*, 1906, xxii, p. 315) has succeeded in constructing joints both experimentally and clinically by opening the capsule, separating the articulating surfaces when ankylosed, rounding them to fit perfectly, shortening their ends enough to secure free room to prevent too much pressure, and then turning in flaps of fascia and fatty tissue ample to cover and separate the articulating surfaces. The flaps are sutured in position with chromic gut, or where not between articulating surfaces with fine phosphor-bronze wire of eight strands, and the wound is closed. The most rigid asepsis is necessary, the bones not being touched with hands; nor should the flaps be traumatized. The joint is immobilized for two weeks with sufficient extension to prevent pressure on the inter-articular flaps. Then passive and active movements are used, and systematic exercise persisted in for months. Arthroplasty has its best field in ankylosis from non-tubercular causes. A year or more should elapse after a positive cure of joint tuberculosis before it is attempted.

(21) Joint Tuberculosis. (p. 225.) Our views on the pathology of joint tuberculosis may have to undergo a change if the theories recently propounded by Ely are proven. As he says in the preface to his book (Joint Tuberculosis) after recounting his researches, "even many of the facts seemingly well established, such as the coagulation of fibrin in tuberculous joints appeared impossible." After reviewing the familiar teaching concerning the battle of the lymphocytes against the tubercle bacilli, he says (p. 37), "Viewed in this light, joint tuberculosis is the result of nature's effort to rid herself of the disease, and is essentially an excretory process; but on this theory many phenomena of tuberculosis cannot be satisfactorily explained — why, for instance, the tubercle bacillus can thrive in a tissue rich in cells which are supposed to be intended for its destruction, while in other tissue, such as yellow marrow and muscle, it cannot exist unless there be a secondary infection. On this theory, also, the cure of a tuberculous joint after operation would be hard to explain, for the very tissue that is supposed to be rich in elements for destroying tubercle bacilli disappears. Without seeming to be rash, I would propose the following hypothesis. The accepted relation of the lymphocyte to the tubercle bacillus is at least not invariable. If we may assume a different one, the whole problem of the occurrence of the tuberculosis in the joint and in some other tissues becomes a simple one. . . . Let us assume that the lymphocytes and certain other similar cells are not nature's defensive organism, but the natural food of the tubercle bacillus. The

bacilli, floating in the blood, are thrown out into the various tissues where, if the bacilli find cells suitable for their growth, they live; where they do not find these cells, they die. Nature's protective mechanism is only the elaboration of toxins and the production of fibrous tissue. The relation of the tubercle bacillus to the lymphocyte, in other words, is the same as that of the gonococcus to the polymorpho-nuclear or of the malarial plasmodium to the red cells. An operation that causes the disappearance of red or cellular or lymphoid marrow in the ends of the bones shuts off the food supply of the bacilli. The bacilli can find no food in yellow marrow, but, if a secondary infection be added, the resulting suppuration furnishes the supply of cells peculiarly adapted to the growth of the tubercle bacilli, and tuberculosis invades the yellow marrow also. I will carry the theory no further; to me it appears to explain almost everything. . . ."

(22) **Status Lymphaticus.** *Etiology.* (p. 323.) Basch, *Wien. Klin. Wochenschr.*, 1903, xvi, 893; *Zeitschr. f. exper, Path. u, Therap*, 1905-6, ii, 195; *Jahrb. f. Kinderheilk.*, 1906, lxiv, 285; 1908, lxviii, 649. Klose: *Arch. f. Kinderh.*, 1910, ix, 1. D'Oelsnitz: *Arch. de Medecine des Enfants,* Paris, March, xiv, No. 3, pp. 161-240.

Pathology. Marfan: *Archives de Medicine des Enfants,* Nov., 1910.

(23) **Status Lymphaticus.** *Diagnosis.* (p. 324.) Ferrand and Chatelin (*Bulletin de la Societe de Pediatrie,* Paris, April 13, 1911) show the value of radioscopy in the diagnosis of enlarged thymus. See, also, Boggs (*N. Y. Med. Jour.*, July 8, 1911) on percussion signs of persistent and enlarged thymus.

Treatment. Thymectomy is also now an established procedure. The Roentgen rays are used for reducing the size of the thymus.

(24) **Fractures of Skull.** (p. 342.) Nothing said in the text should be understood as favoring delay of operation in cases of depressed fracture or intracranial hemorrhage or compression.

(25) **Hydrocephalus.** *Drainage.* (p. 354.) Cushing drained into the subperitoneal space by trephining through the body of the fifth lumbar vertebra and entering the spinal canal. Half the length of the metal tube was then introduced. The spinal canal was then opened posteriorly and the other half of the tube joined to the first half. The tube was left in place to maintain a permanent opening.

Andrews used successfully a glass tube for drainage into the sub-dural space. (*Quar. Bull. N. W. Univ. Med. School,* Vol. xii, No. 4, April, 1911.

Ballance's operation (as illustrated on p. 359) is for permanent drainage of the lateral ventricle. The operation for permanent drainage of the fourth ventricle is Parkins' operation.

(26) **Operations Upon the Cranium.** *Wound infection and its preven-*

tion. (p. 364.) Crowe advises the administration of urotropin in all cases in which meningitis is a possible complication, or even if meningeal infection has already occurred. He claims the drug begins to appear in the cerebro-spinal fluid in a half to one hour after its administration; and that it is capable of deferring or preventing growth of organisms. (*Johns Hopkins Hosp. Bull.*, April, 1909.)

(27) **Deformities and Diseases of the Ear.** (Chap. xiv, p. 369.) *Syphilitic Disease of the Ear.* The exact pathology of the ear in hereditary lues is still under discussion as to whether it is a primary labyrinthitis, affecting both vestibule and cochlea; or hemorrhage into the labyrinth, secondary to syphilitic arteritis; or interstitial inflammation of the acoustic nerve, accompanying luetic inflammation of the meninges. (See an excellent article by Fraser, *Jour. Laryng.*, Aug., 1909.) Usually there are other characteristic manifestations such as interstitial keratitis and Hutchinson's teeth. (See Hereditary Syphilis.)

Symptoms appear from the sixth to the fifteenth year, with catarrh of the Eustachian tube and behind the tympanic membrane, which is lustreless and indrawn, and sudden and usually bilateral deafness. Treatment is that of hereditary syphilis.

(28) **Birth Palsies Non-central.** *Treatment.* (p. 395.) See, also, Clark, Taylor and Prout: "A Studyof Brachial Birth Palsy" (*Am. Jour. Med. Sci.*, Oct., 1905); Taylor: "Results from Treatment of Brachial Birth Palsy" (*Jour. Am. Med. Assn.*, Jan. 12, 1907.)

(29) **Poliomyelitis.** *Etiology.* (p. 395.) The causative agent has been proven to be an ultra microscopic organism of great virulence. It resists freezing, drying and glycerinization.

(30) **Poliomyelitis.** *Diagnosis.* (p. 398.) Examination of fluid obtained from the spinal canal by lumbar puncture may aid in the diagnosis. In poliomyelitis it shows an excess of lymphocytes, but no *Diplococci intracellularis* of Weichselbaum (the specific germ of cerebro-spinal meningitis).

(31) **Poliomyelitis.** *Treatment.* (p. 399.) Cushing and Crowe showed that hexamethylenamine may be recovered in the cerebro-spinal fluid in quantity having a degree of antiseptic power. Flexner and Clark, after suggestion by R. S. Morris and others, experimented with the drug in poliomyelitis, finding that in monkeys, it had power to prolong the incubation period (from 6 or 8 to 24 days) and the onset of paralysis was prevented. Power to restrain an already established infection has not been shown. (Flexner and Clark: *Jour. Am. Med. Assn.*, Feb. 25, 1911.)

(32) **Operations upon Nerves.** *Division of Posterior Nerve Roots.* (p. 416.) Förster has devised a method for relieving the spasticity by section of each alternate posterior root or even more of them,

in the affected area. Cutting the sensory root prevents the reflex contraction without diminishing the motor power; but as muscle groups are usually innervated from three segments of the cord the reflex tonus is not completely destroyed, but only lessened. The operation is more suitable and more successful in paralysis of the lower extremities, than higher. The nerve-division is made after unilateral or bilateral laminectomy. Operations on this plan have, in quite a number of instances, given very encouraging results. They should only be undertaken after careful study as to which nerves are implicated and their point of origin, which is higher than their point of emergence from the spinal canal. Each nerve should be identified by sterilized electrode before it is divided. (Förster u. Tietze: *Zeitsch f. Orth. Surg.*, Oct. 22, 1908, xxii; Mittheil a. d.: *Grenzgab. der Med. u. Chir.*, 1909, Vol. xx; Gottstein: *Berl. Klin. Woch.*, April 26, 1909; Spiller and Frazer: *Univ. Penn. Med. Bull.*, xxii, *Amer. Jour. Med. Sci.*, April, 1910; Clark and Taylor: *N. Y. Med. Jour.*, 1910, xci; Taylor: *Ann. Surg.*, 1910; Spitzy: *Wien. Klin. Woch.*, Nov. 18, xxii, No. 48, pp. 1585-1622; Large: *Arch. Pediat.*, Nov., 1910.)

(33) **Spine, Lateral Curvature.** *Classification.* (p. 427.) The foregoing description of the varieties, may, like that of some other writers, lack clarity, and difference of terms is confusing. Stated in other words, we have two general classes, (1) the functional, postural or habitual, and (2) the structural or fixed curvatures.

(34) **Lumbar Lordosis.** (p. 429.) Among the common causes should be placed paralysis, or more often simply weakness or relaxation of the abdominal muscles and their aponeuroses, and this sometimes associated with a general enteroptotic condition.

(35) **Pott's Disease.** *Paralysis.* (p. 441.) While usually paralysis does not occur until the disease is so far advanced as to present other symptoms including kyphos, it may in some cases precede any perceptible deformity.

(36) **Caries of Spine.** *Treatment. The Calot jacket.* (p. 446.) In applying a jacket by this method there is a sling of muslin under chin and occiput by which the child is raised so that his heels do not touch the floor. He wears one or two buttonless shirts, or preferably seamless stockinet tubes, one of which reaches over his head, having a hole cut for his nose. If there is to be a "military collar," felt of that shape and extending down onto shoulders is sewn onto the shirt and for the "grand" jacket felt is applied under the chin and occiput. A pad of cotton an inch thick protects sternum and anterior ribs, and felt is placed over iliac crests and sacrum. Plaster is now applied and molded carefully, especially about pelvis, shoulders, and neck, leaving the ears free. Not only are roller bandages used circularly, but aprons and extra pieces made of 3 or 4 thicknesses of crinoline, the meshes

filled with creamy plaster, are applied. The aprons are of the length of the trunk plus one-half, and in width, half the circumference of the trunk. The front apron is applied from sternum to pubes and then the lower end fold up over the lower abdomen. The back apron is split down nearly half way, making two tails, one of which goes over each shoulder, down in front of the shoulder and back under the axilla of same side. The "military" jacket has an extra neckpiece and the "grand" jacket has a neckpiece and one piece each for chin and occiput. Through a small hole cut over sternum the cotton pad there is removed. After 48 hours the jacket is cut out in front, exposing the lower two-thirds of sternum and the upper half and median one-third of the abdomen in one opening. A window of 6 by 3 inches is cut out of the back over the kyphosis, and the shirt is slit open by two cuts crossing in the middle. The skin is greased with vaseline and pieces of cotton batting about the size of the window are tucked in under the shirt by means of a spatula, thus pushing the kyphosis forward. The shirt is replaced and the opening covered with plaster bandages. The kyphosis is treated thus again after a couple of months. Calot claims to effect considerable straightening of the kyphosis. If the disease is located above the seventh dorsal vertebra or if at any point with paraplegia present, he uses the "grand" jacket, in other cases the "military" jacket. Whether or not straightening of the kyphosis is wisely or successfully attempted, this jacket certainly forms an effective apparatus for fixation.

Roberts' device for applying plaster jacket. Roberts has a simple and ingenious method of securing a degree of straightening while applying jacket, by placing the patient, supine, with the kyphosis in a muslin sling, and lifting him in the sling by means of an automobile jack having a horizontal bar above upon which the sling is hung. (*Jour. Am. Med. Assn.*, March 25, 1911.)

(37) **Thymic Asthma. Thymic Tracheostenosis.** *Pathology.* (p. 510.) For résumé see article by Warthin (*Arch. Ped.*, Aug., 1909), and discussion by Holt, Blake, Jacobi, Wyeth, Howland, Ewing, Norris, Northrup, Melzer and Kerley. Also Marfan (*Arch. de Medecine des Enfants*, Nov., 1910).

Treatment. Experimental studies give great promise of more successful treatment. Remarkable effects have been produced upon the thymus in rabbits by the Roentgen rays. See editorial (*Jour. Am. Med. Assn.*, Feb. 25, 1911) with reference to the work of Reedberg of Upsala in 1909. See, also, article by Rachford (*Trans. Assn. Am. Phys.*, 1910, xxv). Several operations for reducing the size of the thymus have been reported by Siegel, König, Perrucker, and Eberhard. Rehn made a transverse incision in the suprasternal notch through which expiratory efforts pushed out the gland. Rehn, and also König, stitched the gland to the manubrium sterni. Marfan intubates with a long tracheal

canula. An increasing number of successful thymectomies are reported.

Diagnosis. On the diagnosis by radiography see Ferrand and Chatelin: *Bulletin de la Societe de Pediatrie, Paris,* April, xiii, No. 4. It has usually been taught that the dyspnea is worse in the erect position, but D'Oelsnits claims that it is worse in the recumbent position. (*Arch. de Med. des Enfants, Paris,* March, xiv, No. 3.)

It is not advisable to remove the gland entirely. Although almost complete thymectomy seems to have had no deleterious late effects, its entire removal might have. Basch (*Wien. Klin. Wochens.,* 1903, xvi, 893; *Zeitsch. f. exper. Path. u. Therap.,* 1905-06, ii, 195; *Jahrb. of. Kinderli.,* 1906, lxiv, 285; 1908, lxviii, 649) and Klose (*Arch. f. Kinderh.,* 1910, iv, 1) have demonstrated in young animals extensive changes in the nutrition, especially of the skeleton, and of the nervous system, following complete removal of the thyroid.

(38) **Empyema.** *Treatment.* (p. 521.) Murphy advocates as curative, following aspiration in either hydro- or pyothorax without bronchial or external communication, injection into the pleural sac of 2 per cent. solution of formalin in sterile glycerine mixed 24 hours before using. A few drachms to 4 ounces are injected and this repeated every 3 to 6 days. (*Jour. Am. Med. Assn.,* Dec. 18, 1909.)

(39) **Thoracotomy.** (p. 524.) The author's "rib-stripper" is a most convenient instrument for separating the periosteum from the under side of the rib. "It is made of a strip of flexible copper, 18 or 20 gauge in thickness, 9 inches long, a quarter-inch or more wide, bevelled at edges, and silver-plated."

"It is awkward to puncture the abscess prematurely in the act of removing the periosteum from the under side of the rib, and have the wound flooded with pus blown out forcibly at every breath and cough before one has completed the removal of the bone. This may be avoided and the work facilitated by the use of this small instrument.

"The periosteum is readily pushed off the outer side of the rib. Then the 'rib-stripper,' with a little beak or elbow bent near one end, is slipped under the rib between periosteum and bone until it emerges at the other edge of the rib and is drawn half its length through. Both ends of the instrument are then brought together with a slight pull, which bends it around the rib, and the looped instrument is slid first to one angle of the wound and then the other, stripping the periosteum from the under side of the rib." ("Drainage of Acute Pleural Empyema in Children." Kelley: *Am. Jour. Surg.,* Jan., 1912.) If ordinary drainage tubes are used, they should be carefully secured from slipping into the cavity. Siphons, pumping apparatus or suction

with Bier's cups are advised by some, but are seldom if ever necessary in children.

(40) **Fetor.** (p. 525.) Irrigation is used only in case of gangrene. Fetor usually calls for freer opening or counter opening at the lowest point of the cavity, and search for pockets or lung abscess. Large open cavities can be packed dry with formidine gauze.

(41) **Empyema.** *Bismuth paste.* (p. 531.) Blanchard (*N. Y. Med. Rec.*, May 18, 1912) uses a substitute for bismuth paste which is non-toxic and in his experience equally efficient. The formula is white wax, 1 part; vaseline, 8 parts; mix while boiling. In badly infected cases iodine is added. For radiography he uses 33⅓ per cent. of iron carbonate in white vaseline.

(42) **Acute Peritonitis.** *Treatment.* (p. 540.) Children, particularly young children, are not always easily maintained in the Fowler or any other position constantly, nor do they usually submit peaceably to the apparatus for Murphy's saline proctoclysis. Consequently the prevention or the treatment of diffuse septic peritonitis by these means is apt to be more difficult to manage in young children than in patients of mature years.

(43) **Chronic or Recurrent Appendicitis.** *Operation.* (p. 551.) The wet antiseptic compress is no longer used in the interval between the scrubbings, but a dry, sterile protective dressing used instead; and the second scrubbing may, if preferred, be replaced by a coating of tincture of iodine applied to the dry skin just before the operation. Iodine thus used is an efficient antiseptic. It can be used alone, that is without previous scrubbing, in emergency operations. But I prefer scrubbing. Its use before laparotomy has been objected to for the reason that if the intestines come in contact with it in the course of the operation their peritoneal coat may be irritated sufficiently to produce subsequent adhesions.

(44) **Chronic Non-tubercular Peritonitis.** *Treatment.* (p. 556.) In tapping the abdomen for this or any other form of ascites the puncture is made in midline above the bladder. Local anesthesia with quinine and urea hydrochloride is useful. A tiny cut is made through skin and fascia with a sharp-pointed tenotome or cataract knife. The trochar and canula are introduced, not with a sudden plunge but slowly with a slight boring motion.

(45) **Tubercular Peritonitis.** *Treatment.* (p. 561.) Bradshaw has reported (*Arch. Ped.*, April, 1911) a cure following two operations in a case of dry non-exudative tuberculous peritonitis. The patient was eighteen months old and extremely ill. After operation he improved greatly, but after five weeks relapsed. A second laparotomy was performed, resulting in a cure which had lasted three years at the time of writing. Judd reports (*N. Y. Med. Jour.*, June 24, 1911) operating successfully on twenty-two patients, three of whom were children, using a modification of

Lloyd's technique. An incision is made in the right rectus muscle. The patient is eviscerated so far as possible. The intestines, enveloped in hot moist towels, are thoroughly washed with a solution of 50 per cent. of commercial hydrogen peroxide. The abdominal cavity is then flushed with the same solution. The peroxide gives the tubercles a frosted appearance. The cavity and the intestines are then thoroughly washed with normal saline solution, and the latter replaced in their proper position. The abdomen is closed with three layers of sutures. I have no experience with this use of hydrogen peroxide.

(46) **Pyloric Stenosis.** *Treatment. Hints on Food and Drugs.* (p. 567.) Speaking generally, some modification of milk best sustains the babe that must be fed artificially; and whey is the portion of the milk most useful, as the irritating curd has been removed, leaving certain other albumins and globulins, sugar, and some fat. Additional sugar, fat, or proteid may be borne in some cases. Each case of feeding is a problem by itself. The intervals of feeding should not be shorter than the time necessary for the stomach to empty itself. Hyperacidity, causing too rapid coagulation of proteids, should be counteracted by the addition of limewater or sodium bicarbonate to the food. (For excellent and explicit directions on feeding see Cotton, Holt, Rotch, Morse, Tuley, Fischer, Pisek, Chapin, and others.) The most useful drugs are opium in small doses, and belladonna or, better, atropine. Various forms of opiates may be used. My own preference is for the deodorized tincture, minims $\frac{1}{40}$ to $\frac{1}{32}$.

Operations other than gastro-enterostomy. (p. 568.) Of pylorodiosis there are two principal methods, Hahn's and Loreta's. Hahn's method seeks to effect divulsion without any incision into pylorus or stomach. The wall of the stomach is invaginated with the end of a finger, and the invagination upon the end of the finger is gradually thrust through the pylorus. This method is impracticable on account of the small size of the parts. In Loreta's method a small incision is made in the stomach-wall near the pylorus. The finger, or a bougie, or a forceps is passed through the wound and on through the pylorus, which is thereby dilated. The incision into the stomach is then sutured and the abdominal wound closed. This seems a simple if rather unsurgical procedure and has had some good results. But it is not without considerable danger of peritonitis, is not by any means certain of opening the passage sufficiently, and is apt to fail of permanence.

Finney's operation has been advised by some. It is simply a gastro-duodenostomy without resection of the pylorus. It obviates the possibility of "the vicious circle," which occasionally occurs after gastro-enterostomy. The lower wall of the pylorus is folded up and joined to the stomach and the fold cut through. Of this operation, and also of Nicoll's ingenious operation of

pyloroplasty, it may be said that the attachments of the stomach and of the duodenum are usually so short that it is difficult or impossible to bring them into working reach, while the small size of the parts and the thickened wall of the pylorus render these operations impracticable for such cases.

(47) **Malformations of Colon.** (p. 570). For a good account of idiopathic dilatation of colon (Hirschsprung's disease) see Groves: *Lancet,* Dec. 11, 1909; Wilkie: *Edin. Med. Jour.,* Sept., 1909; Duval: *Rev. de Chir.,* Sept. 10, 1909. For an abstract of the same, see *International Medical Annual,* 1910.

(48) **Intussusception.** *Methods of reduction.* (p. 583.) Zahorsky (*Arch. Ped.,* May, 1911) describes a method of treatment by repeatedly alternating taxis and succussion, under anesthesia. After taxis the thighs are flexed on the abdomen and with rapid up and down movement the lower part of the trunk is vigorously shaken for several seconds.

(49) **Inguinal Hernia.** (p. 616.) The use of the gypsum spica has been abandoned in most cases. When used it should be cut out so as to give access to the wound in case of soiling.

(50) **Hydronephrosis and Hydroperinephrosis.** (p. 655.) Recent cases in which the fluid has the characteristics of urine are sometimes termed "uronephrosis," reserving "hydronephrosis" for old cases in which the fluid has lost these characteristics.

(51) **Tumors of the Bladder.** *Diagnosis.* (p. 670.) The bladder of the child may be examined by cystoscope if one has an instrument small enough. The technic is similar to that used in adults, though anesthesia is more frequently necessary, especially in boys. Also as the bladder is rather an abdominal than a pelvic organ in the very young and is comparatively narrow and pointed at its lower end, it is necessary to depress the ocular end of the cystoscope to secure a good view of the trigone and posterior wall. Always, of course, the rectum should be thoroughly emptied beforehand, and a few ounces of fluid (boracic solution) should be introduced into the bladder. Beer (*Am. Jour. Surg.,* March, 1911) has presented an improved cystoscope for use in children. It is made in two sizes with shafts 9½ cm. and 12 cm. in length, and 15 and 18 millimeters in circumference, respectively. Each instrument is made so that the single catheter tunnel can be detached, thus having a catheterizing and an examining cystoscope in one. Both instruments admit a small catheter, 4-5, French. The optical parts are like the Nitze instrument.

(52) **Bladder. Foreign Body.** (p. 675.) Instances are on record of foreign bodies which had been swallowed entering the bladder from the intestine by perforation.

(53) **Undescended Testis.** (p. 686.) Ferguson, in his work on hernia, describes a method of dealing with undescended testis by incising

the walls of the canal (tying the deep epigastrics) to below the level of the pubic bone and bringing the cord out at the lowest angle of the wound.

(54) **Ovarian Tumors.** (p. 696.) See, also, an excellent article on "Malignant Disease of the Uterus, Ovary and Vagina in Children," by W. A. Edwards (*Am. Jour. Med. Sci.,* July, 1909).

(55) **Vulvo-Vaginitis.** (p. 698.) I have seen a case of malignant growth in vagina in a child of 21 months treated by several physicians as vulvo-vaginitis because there was a discharge. The possibility of neoplasm in this region should not be forgotten.

(56) **Anomalies and Deformities of Skull.** (p. 399.) All the fontanelles should be closed at or about the eighteenth month of life. Closure of the fontanelles may be hastened in microcephaly or in hereditary syphilis; or delayed in rachitis, hydrocephalus, myxœdema, mongoloid, or micromelia. Increased tension of fontanelles is physiological during crying or straining; or is due to hemorrhage (see also pp. 408, 409), hyperemia, hydrocephalus, intracranial tumor, meningitis, trombosis of longitudinal sinus. In a less degree it may be present in meningismus during acute infections.

Certain peculiarities of the infant's skull are mentioned in the Section on Operation upon the Cranium. Other abnormalities are handled in subsequent sections of the Chapter on the Head and Brain.

(57) **Paralyses of Infancy and Childhood.** (p. 393.) Among the large variety of these may be mentioned hereditary ataxic paraplegia (Friedreich's ataxia), the paralysis of amyotrophic lateral sclerosis, progressive muscular atrophy (Duchenne's paralysis, Cruveilhier's atrophy), acute ascending paralysis (Landry's paralysis), the paralyses of tumor of the spinal cord and of syringomyelia, myotonia congenita (Thomson's disease), diphtheritic paralysis, the birth palsies, acute anterior poliomyelitis and the cerebral paralyses, ischemia and the various forms of paralysis from pressure or other traumatism to peripheral nerves or nerve trunks.

Pseudohypertrophic muscular paralysis is classed with the myopathies. Compression myelitis will be discussed under spinal caries.

(58) **Hydropericardium and Pyopericardium.** (p. 531.) Like the pleura the pericardium may require aspiration, incision, or drainage. Aspiration is made at the left border of the sternum, preferably in the sixth intercostal space or in the fifth space by inclining the needle slightly downward. The internal mammary artery should be carefully avoided. In pyopericardium drainage is required in the same place, by open dissection resecting the sixth costal cartilage and fifth and fourth too if necessary. The internal mammary artery should be tied, the muscles divided, the pericardium nicked, then opened, and drainage tube inserted.

(59) **Malformations of Rectum and Imperforate Anus. Presence of other malformations.** (p. 620.) In one case with its anus closed by a membranous septum the infant's forehead was wedge-shaped. The occluding membrane had been opened by Dr. F. J. Morton and the rectum was patulous. But the babe vomited whatever was given it, though it never vomited meconium, and never passed meconium from the bowels. Probably there existed other occlusion in the intestinal tract. No further operation was allowed. It died on the sixth day after birth. No post mortem.

(60) **Specific vulvovaginitis. Dosage of Vaccines.** (p. 700.) A series of three to ten or more injections may be necessary. The average dose is 5,000,000, increasing 5,000,000 to 10,000,000 at a dose. If the dose does not produce an abatement in the symptoms a larger one may be tried. The interval begins at five days, and is gradually lengthened to eight or fifteen days, as the discharge lessens and becomes serous.

(61) **Branchial Fistulæ. König's Expedient in operation.** (p. 721.) So difficult is the complete removal of the end of a fistula located in the depths near or behind the pharynx that the ingenious expedient of Fritz König is very useful. König separates the fistula to a point above the digastric muscle, and then proceeds by blunt dissection until he reaches the near neighborhood of the pharyngeal mucous membrane. The mouth is then held open with a Whitehead gag and a stout probe threaded near its end with silk is passed into the wound and made to bulge into the pharyngeal membrane in front of the tonsil. A small incision made through the mouth at the bulging point admits the end of the probe and silk. The outer end of the silk is tied to the fistulous tract and the latter easily pulled through into the pharynx and retained there by a few stitches which close the wound in the mucosa. The free end of the fistula is then cut off. The external wound being now closed, there remains only a short bit of fistula which opens into the pharynx and does no harm.

(62) **Supernumerary Auricles.** These are rudimentary auricles usually in the form of small projections or appendages composed of cartilaginous or fibrous tissue or skin. They are generally just in front of, or below the ear, or along the line of the anterior margin of the sternomastoid. They are branchiogenous and may accompany fistulæ. They may be removed by clipping or dissection.

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American Journal of Clinical Medicine, August, 1914, Reviewing Kelley's "Surgical Diseases of Children," published by E. B. Treat & Co., New York.

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When the first edition of this work appeared in 1909, it represented the first attempt, by an American author, at least, to treat the subject of surgery as applied to children in a manner commensurate with the degree of importance to which it is entitled, and the book received a well-merited and unusually enthusiastic reception. Previous to this time one had to search through almost innumerable journal articles, text-books and treatises, devoted mostly to adult surgery, and to cull what was applicable in handling surgical diseases as they occur in children. This was particularly true for those whose reading had to be confined to books and journal articles written in English; while even those whose accomplishments included a reading knowledge of French and German often had to form their own conclusions as to the applicability of certain procedures common enough in adult practice but of comparatively unknown value when applied in the treatment of infants and children.

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The New York *Medical Record*, reviewing Kelley's "Surgical Diseases of Children," published by E. B. Treat & Co., New York.