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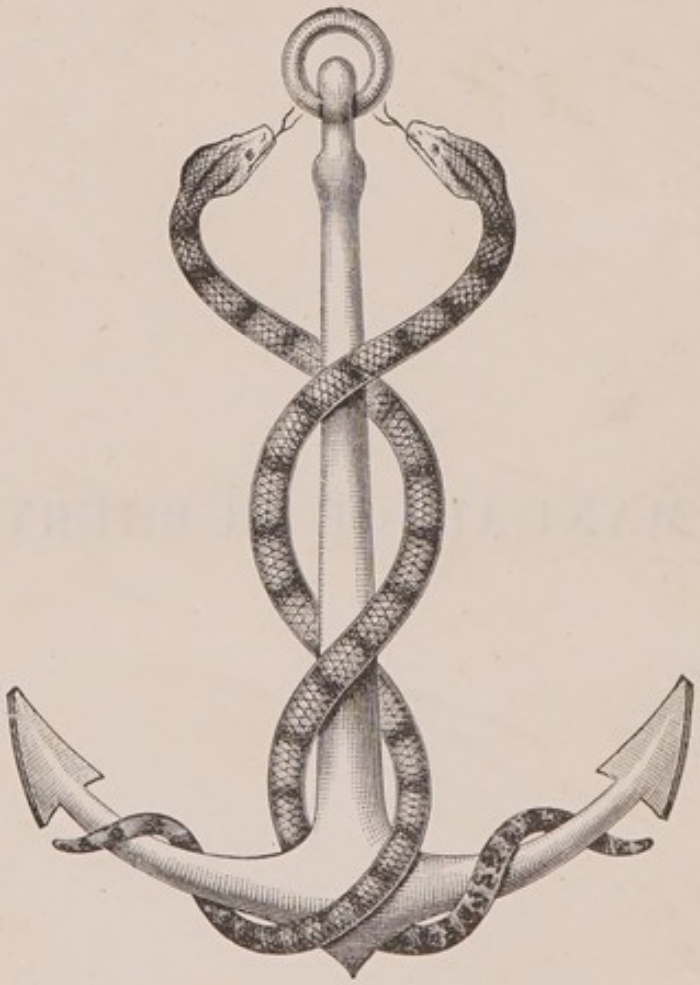

NUNQUAM ALIUD NATURA, ALIUD SAPIENTIA DICIT.

MANUAL OF SURGERY

BY

ALEXIS THOMSON, M.D., F.R.C.S.Ed.

ASSISTANT SURGEON EDINBURGH ROYAL INFIRMARY; SURGEON TO THE DEACONESS HOSPITAL, EDINBURGH

AND

ALEXANDER MILES, M.D., F.R.C.S.Ed.

ASSISTANT SURGEON EDINBURGH ROYAL INFIRMARY; SURGEON TO LEITH HOSPITAL

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CONTENTS.

CHAPTER I.

PAGE

THE SCALP 1

CHAPTER II.

THE CRANIUM AND ITS CONTENTS 8

CHAPTER III.

INJURIES OF THE SKULL 33

CHAPTER IV.

DISEASES OF THE BRAIN AND MEMBRANES . . . 43

CHAPTER V.

DISEASES OF THE CRANIAL BONES 67

CHAPTER VI.

THE SPINE AND CORD 70

CHAPTER VII.

DISEASES OF THE SPINE AND CORD 87

CHAPTER VIII.

PAGE
DEVIATIONS OF THE SPINAL COLUMN 106

CHAPTER IX.

THE FACE, ORBIT, AND LIPS 113

CHAPTER X.

THE MOUTH, FAUCES, AND PHARYNX 131

CHAPTER XI.

THE JAWS, INCLUDING THE TEETH AND GUMS 141

CHAPTER XII.

THE TONGUE 160

CHAPTER XIII.

THE SALIVARY GLANDS 174

CHAPTER XIV.

THE EAR 182

CHAPTER XV.

THE NOSE AND NASO-PHARYNX 197

CHAPTER XVI.

THE NECK 212

CHAPTER XVII.

THE THYROID GLAND 227

CHAPTER XVIII.

PAGE

THE ŒSOPHAGUS 236

CHAPTER XIX.

THE LARYNX, TRACHEA, AND BRONCHI 249

CHAPTER XX.

THE CHEST 262

CHAPTER XXI.

THE BREAST 284

CHAPTER XXII.

THE ABDOMEN AND PELVIS 307

CHAPTER XXIII.

THE PERITONEUM 319

CHAPTER XXIV.

APPENDICITIS 340

CHAPTER XXV.

HERNIA 355

CHAPTER XXVI.

THE STOMACH 389

CHAPTER XXVII.

THE INTESTINES 410

CHAPTER XXVIII.

PAGE

THE LIVER, GALL-BLADDER, AND BILE-DUCTS 456

CHAPTER XXIX.

THE PANCREAS AND SPLEEN 478

CHAPTER XXX.

PELVIC SWELLINGS IN THE FEMALE 488

CHAPTER XXXI.

THE RECTUM AND ANUS 501

CHAPTER XXXII.

THE KIDNEY AND URETER 540

CHAPTER XXXIII.

THE URINARY BLADDER 583

CHAPTER XXXIV.

THE PROSTATE 614

CHAPTER XXXV.

THE URETHRA 626

CHAPTER XXXVI.

THE MALE GENITAL ORGANS 650

APPENDIX.

ANÆSTHETICS 694

INDEX 705

LIST OF ILLUSTRATIONS.

FIG.		PAGE
1.	Diagram of the Course of Motor and Sensory Nerve Fibres,	10
2.	Chiene's Method of Cerebral Localisation,	12
3.	Chiene's Method of Cerebral Localisation,	13
4.	Laceration of the Brain,	24
5.	Extra-dural Clot resulting from hæmorrhage from the anterior branch of Middle Meningeal Artery,	27
6.	Extra-dural Clot resulting from hæmorrhage from posterior branch of left Middle Meningeal Artery,	28
7.	Fracture of Skull produced by an oval stone fired from a gun,	35
8.	Transverse Fracture through Middle Fossa of Base of Skull,	39
9.	Diagram illustrating Sequence of Paralysis caused by abscess in temporo-sphenoidal lobe. (After Macewen),	49
10.	Hernia Cerebri,	53
11.	Attitude of Upper Extremities in Traumatic Lesions of the Sixth Cervical Segment	77
12.	Compression Fracture of Bodies of Third and Fourth Lumbar Vertebræ,	83
13.	Traumatic Spondylitis,	84
14.	Fracture Dislocation of Ninth Dorsal Vertebra,	85
15.	Tuberculous Osteomyelitis at Dorso-lumbar Junction,	88
16.	Osseous Ankylosis of Bodies of Dorsal Vertebræ following Pott's Disease,	89
17.	Attitude of Patient suffering from Tuberculous Disease of the Cervical Spine,	92
18.	Left Psoas Abscess,	95
19.	Right Iliac Abscess from disease of the lumbar spine,	96
20.	Arthritis Deformans of Spine,	99
21.	Advanced Degree of Arthritis Deformans of Spine,	99
22.	Spina Bifida,	101
23.	Spina Bifida in Cervical Region,	102
24.	Meningo-myelocele of Cervical Spine,	102
25.	Tail-like Appendage over Spina Bifida Occulta,	104

LIST OF ILLUSTRATIONS.

FIG.		PAGE
26.	Adolescent Scoliosis,	108
27.	Scoliosis,	109
28.	Head of human embryo about 29 days old. (After His),	114
29.	Simple Hare-lip,	115
30.	Unilateral Hare-lip with Cleft Alveolus,	115
31.	Double Hare-lip,	116
32.	Double Hare-lip with Projection of Premaxillary Bone,	116
33.	Cicatricial Contraction following burn,	121
34.	Sarcoma of Orbit,	125
35.	Dermoid Cyst at outer angle of orbital margin,	126
36.	Macrocheilia,	128
37.	Advanced Epithelioma of Lower Lip,	129
38.	Sarcoma of Upper Jaw,	148
39.	Dentigerous Cyst of Upper Jaw,	149
40.	Dentigerous Cyst of Lower Jaw,	150
41.	Osseous Shell of Myeloma of Lower Jaw,	151
42.	Sarcoma of Lower Jaw,	151
43.	Four-tailed Bandage applied for Fracture of Lower Jaw,	154
44.	Unilateral Dislocation of Lower Jaw,	156
45.	Tuberculous Ulceration which has destroyed the Tip of the Tongue,	164
46.	Epithelioma of Tongue,	166
47.	Thyro-glossal Cyst,	171
48.	Mixed Tumour of the Parotid,	180
49.	Acute Suppurative Mastoiditis,	194
50.	Outer wall of left Nasal Chamber. (After Logan Turner),	200
51.	Transient Wry-neck,	214
52.	Permanent Wry-neck,	215
53.	Pedunculated Lipoma growing from supra-clavicular region,	224
54.	Parenchymatous Goitre,	229
55.	Exophthalmic Goitre,	234
56.	Malignant Stricture of Pharynx and Upper End of Œsophagus,	244
57.	Oblique Fracture of the Body of the Sternum,	266
58.	Surgical Emphysema of Neck, Face, and Arm,	268
59.	Cold Abscess of Chest Wall,	272
60.	Tuberculous Disease of Right Breast with Cold Abscess and Sinus near Nipple,	295
61.	Cystic Adenoma of Right Breast,	298
62.	Scirrhous Cancer of the Breast in a Man,	301
63.	Advanced Ulcerating Cancer of Breast,	302
64.	Diagram of Subphrenic Abscess on Right Side,	336
65.	Diagram of Subphrenic Abscess on Left Side,	337
66.	Gangrene of Distal Portion of Appendix,	342
67.	Richter's Hernia,	356
68.	Irreducible Inguinal Hernia,	358

FIG. PAGE
69. Double Oblique Inguinal Hernia, ... 368
70. Single Spiral Truss for Right Oblique Inguinal Hernia, . 371
71. Double Spiral Truss for Inguinal Hernia, ... 372
72. Double Congenital Inguinal Hernia,. 374
73. Femoral Hernia, ... 376
74. Umbilical and Inguinal Hernia, ... 379
75. Irreducible Umbilical Hernia, ... 380
76. Strangulated Epigastric Hernia, ... 382
77. Lumbar Hernia, ... 383
78. Strangulated Obturator Hernia, ... 384
79. Lembert's Suture, interrupted, ... 390
80. Czerny-Lembert Suture, continuous, ... 391
81. Purse-string Suture, ... 391
82. Perforated Duodenal Ulcer, ... 396
83. Perforated Gastric Ulcer, ... 396
84. Hour-glass Contraction of the Stomach following Gastric Ulcer, ... 404
85. End-to-end Suture of Small Intestine, ... 413
86. Lateral Implantation of Intestine, ... 413
87. Lateral Anastomosis of Intestine, ... 413
88. Short Circuiting of Intestine, ... 414
89. Complete Rupture of Small Intestine with Tearing of Mesentery, ... 414
90. Acute Obstruction of Small Intestine (Strangulated Obturator Hernia), ... 416
91. Diaphragmatic Hernia, ... 421
92. Meckel's Diverticulum, ... 422
93. Strangulation of Small Intestine, ... 422
94. Ileo-cæcal Intussusception, ... 427
95. Gall-stone Obstruction of Jejunum, ... 432
96. Boy, æt. 10, suffering from "idiopathic dilatation of the colon," 437
97. "Idiopathic dilatation of the colon" as seen on *post-mortem* examination, ... 437
98. Malignant Stricture of Pelvic Colon, ... 438
99. Portion of Small Intestine, showing Multiple Strictures following on Tuberculous Ulcers, ... 448
100. Formation of Artificial Anus in Pelvic Colon—First Stage, . 450
101. Completed Artificial Anus in Pelvic Colon, ... 450
102. Fæcal Fistula of Small Intestine, ... 451
103. Fæcal Fistula of Small Intestine with track of Suppuration between the Bowel and the Abdominal Wall, . . 451
104. Rupture of Right Lobe of Liver, ... 457
105. Hydatid Cysts of Liver, ... 460
106. The connections of the Biliary and Pancreatic Ducts. (After Zuckerkandl), ... 464

FIG.		PAGE
107.	Gall-Stones,	465
108.	Pancreatic Cyst between Stomach and Colon,	482
109.	Pancreatic Cyst between Liver and Stomach,	482
110.	Pancreatic Cyst below the Stomach,	483
111.	Complete absence of the Anus. (After Tuttle),	503
112.	Complete absence of Rectum. (After Tuttle),	504
113.	Imperforate Anus. (After Tuttle),	504
114.	Imperforate Anus—Rectum communicating with Vagina. (After Tuttle),	505
115.	Congenital Communication between the Rectum and Urethra,	505
116.	Diagram of Ischio-rectal and Pelvi-rectal Abscesses,	515
117.	Diagram of complete Fistulæ,	518
118.	Diagram of Horse-shoe Fistula,	518
119.	Diagram of Blind External Fistulæ,	519
120.	Diagram of Blind Internal Fistulæ,	519
121.	Colloid Cancer of Rectum,	531
122.	Complete Prolapse of Rectum,	536
123.	Outline Diagram of Kidneys as viewed from the front. (After Stiles, *Cunningham's Text Book*),	541
124.	Outline Diagram of Kidneys as seen from behind. (After Stiles, *Cunningham's Text Book*),	542
125.	Contusion and Rupture of Kidney,	552
126.	Diagrammatic Section of Hydronephrosis. (After Israël),	556
127.	The Renal Pelvis laid open to show valve at outlet. (After Israël),	557
128.	Hydronephrosis,	558
129.	Bilateral Pyonephrosis,	563
130.	Section of Pyonephrosis,	564
131.	Branching Uratic Calculus from Kidney,	567
132.	Fibro-lipomatous Kidney with Stone in Pelvis,	567
133.	Advanced Tuberculous Kidney,	574
134.	Cancer originating in Parenchyma of Kidney,	577
135.	Solitary Cyst at Upper Pole of Kidney,	580
136.	Polycystic Kidney,	580
137.	Over-distended Bladder forming an Abdominal Tumour,	584
138.	Extroversion of the Bladder,	586
139.	Deposition of Phosphates upon a portion of Catheter,	591
140.	Fasciculated Bladder,	593
141.	Cathcart's Apparatus for Drainage of the Bladder,	596
142.	Uric Stone,	600
143.	Oxalate of Lime or Mulberry Calculus,	601
144.	Faceted Phosphatic Stones from a case of septic cystitis,	601
145.	Hour-glass Stones,	602
146.	Section of Bladder, showing uniform enlargement of Prostate and lengthening of Prostatic Urethra,	618

FIG. PAGE
147. Enlargement of Prostate, showing middle lobe, . . 619
148. Stricture of Urethra complicated by Chronic Septic Cystitis and Pyonephrosis, ... 641
149. Tropical Elephantiasis of Scrotum, ... 652
150. Paraffin Cancer of Scrotum, ... 653
151. Retained Testis on left side, and imperfectly descended Testis on right, ... 656
152. Large Hydrocele of left Tunica Vaginalis, . . . 680
153. Moderate-sized Hydrocele of the Tunica Vaginalis, . . 680
154. Preputial Calculi, ... 686
155. Paraphimosis, ... 687
156. Cancer of the Penis, ... 691

MANUAL OF SURGERY

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CHAPTER I.

THE SCALP.

Surgical anatomy—Injuries : *Contusion; Hæmatoma; Cephal-hæmatoma; Wounds; Avulsion*—Diseases : *Inflammatory conditions;* Cystic and solid tumours ; Air-containing swellings ; Vascular tumours.

Surgical Anatomy. — Between the dense, hair-bearing *skin*, and the *epicranial aponeurosis*, or tendinous expansion of the occipito-frontalis muscle, is a network of firm, fibrous tissue, in the meshes of which lies some dense granular fat. So intimate is the connection between these structures that they practically constitute a single layer, and move together as one. The occipito-frontalis muscle with its aponeurosis extends from the superciliary ridge in front to the superior curved line of the occipital bone behind, and laterally to the level of the zygoma, where it blends with the temporal fascia. It moves freely on the subjacent *pericranium*, from which it is separated by a quantity of loose areolar tissue.

The *vascular supply* of the scalp is derived from the supra-orbital, temporal, posterior auricular, and occipital arteries, the terminal branches of which ramify freely in the subcutaneous tissue before entering the dense integument of the scalp. The main branches all run towards the vertex of the skull, and incisions should, as far as possible, be directed parallel to them.

The *venous return* is through the frontal, temporal, and occipital veins. These have free communications, through the *emissary veins*, with the intra-cranial sinuses, and by these routes infective conditions of the scalp may readily be transmitted to the interior of the skull.

The supra-trochlear, supra-orbital, and auriculo-temporal branches of the fifth nerve, together with the great and small occipital nerves, supply the scalp with sensation, while the muscles of the scalp are supplied from the seventh cranial nerve.

The *lymphatic vessels* pass to the parotid, occipital, mastoid, and sub-maxillary groups of glands, the different areas of drainage being ill-defined.

Injuries of the Scalp.

Subcutaneous Injuries.—Extravasations of blood may take place into the tissues of the scalp as a result of a crush, or a blow from a blunt weapon. A *simple contusion* of the superficial layers, for example, may follow a blow or fall, and owing to the density of the tissues the blood effused is small in quantity and comparatively limited. The part is tender, firm to the touch, swollen, and discoloured, being at first dark blue, and later becoming greenish-yellow. So long as the skin remains intact, no treatment is called for, though the disappearance of the swelling may be hastened by elastic pressure and massage. Arterio-venous aneurysm sometimes develops as a result of such injuries.

Hæmatoma of the scalp results when lacerated vessels bleed into the sub-aponeurotic space. Owing to the laxity of the connective tissue in this area, the effused blood tends to diffuse itself widely, and, according to the position assumed by the patient, gravitates to the region of the eyebrow, the occiput, or the zygoma. The extent of a hæmatoma and the rapidity with which it forms depend upon the size of the injured vessels. It sometimes happens, when a large artery is torn, that the swelling pulsates. Owing to the fact that the margins of the effusion are often raised and of a very resistant character, a hæmatoma of the scalp may readily be mistaken for a depressed fracture of the skull. A differential diagnosis can usually be made by observing that the swelling is on a higher level than the rest of the skull; that the raised margin can to a large extent be dispersed by making firm, steady pressure over it with the finger; and that, on doing so, the smooth and intact surface of the skull can be recognised. When a fracture exists, the finger sinks into the depression, and the irregular edge of the bone can be felt. In doubtful cases, and particularly if cerebral symptoms are present, an exploratory incision should be made.

Even large hæmatomata are usually completely absorbed, but the dispersion of the clot may be hastened by massage and elastic pressure. Any small excoriation or wound of the skin must be carefully disinfected and dressed.

Sometimes blood-cysts, consisting of a connective tissue capsule filled with a yellowish-red fluid, remain, and may be treated by incision or excision.

These effusions are to be distinguished from the *cephal-hæmatoma*, in which the blood collects between the pericranium and the

bone. This is oftenest seen in newly-born children as a result of pressure on the head during delivery, and is characterised by its limitation to one particular bone—usually the parietal—the further spread of the blood being checked by the attachment of the periosteum at the sutures. Occasionally a permanent thickening of the edges of the bone remains after the absorption of the extravasated blood. This condition is to be diagnosed from traumatic cephal-hydrocele.

Wounds of the Scalp.—The factors which determine the clinical importance of scalp wounds are their *septicity* and their *depth*. So long as a scalp wound, however extensive, is kept free from bacteria, it involves comparatively little risk to the patient; but the introduction of septic organisms into even the most trivial wound is fraught with danger, on account of the ease and rapidity with which infection may spread along the emissary veins to the meninges and intracranial sinuses.

The deeper the wound, the greater is the risk. If the epicranial aponeurosis be divided, the "dangerous area" between it and the pericranium is opened, and the greatest care is necessary to prevent bacterial infection, which, if it occur, may lead to widespread and dangerous suppuration. Should the wound extend through the pericranium, septic infection is more liable to spread to the bone and to the cranial contents.

The usual varieties of wounds—incised, punctured, contused, and lacerated—are met with in the scalp, and they vary in degree from a simple superficial cut to complete avulsion of the whole scalp. For medico-legal purposes it is important to remember that a scalp wound produced by the stroke of a blunt weapon, such as a stick or baton, may closely simulate a clean-cut wound.

Scalp wounds present certain clinical peculiarities; for example, on account of the density of the integument and its close connection with the aponeurosis, they do not gape, unless the epicranial aponeurosis is widely divided. This facilitates union in clean incised wounds, but interferes with drainage in the long narrow tracts which result from punctures, and which are so liable to be infected and to implicate the sub-aponeurotic space, the periosteum, or even the bone. It also favours the inclusion of a foreign body, such as the broken point of an instrument, in the wound. Bleeding is profuse and difficult to control, because the vessels, fixed as they are in the dense subcutaneous tissue, cannot retract and contract so as to bring about the natural arrest of hæmorrhage, and it is difficult to apply forceps or ligatures to their cut ends. On

account of the free arterial anastomosis in the deeper layers of the integument, large flaps of scalp may be replaced, even if badly bruised and torn. It is a safe rule never to cut away scalp tissue, however badly it may be lacerated, or however narrow may be the pedicle which unites it to the head.

Gunshot wounds of the scalp are usually associated with damage to the skull and brain. A spent shot, however, may pierce the scalp, and then, glancing off the bone, may lodge in the soft parts.

Complete avulsion of the scalp is sometimes met with in women as a result of the hair being caught in revolving machinery. The portion removed, as a rule, consists of integument and aponeurosis with portions of muscle attached. In a few cases the pericranium has also been torn away. So long as any attachment to the intact scalp remains, the parts should be replaced, and, if asepsis be maintained, a satisfactory result may be expected. When the scalp is entirely separated, primary skin-grafting by Thiersch's method should be had recourse to.

Treatment of recent Scalp Wounds.—The primary object is to ensure asepsis. The hair should be shaved round the wound, which is then thoroughly purified. Gross dirt ground into the edges of lacerated wounds is best removed by paring with scissors. Undermined flaps must be further opened up and drained—by counter-openings if necessary. Foreign bodies should be carefully sought for when there is reason to suspect their presence. Hæmorrhage is controlled by ligature, suture, or pressure. The wound is stitched with horse-hair or sterilised silk, and, except in very small and superficial wounds, it is best to insert a drainage tube. An antiseptic dressing is then applied and securely fixed by a light but firm bandage. The wound should be dressed every second or third day—the drainage-tubes being removed at the second dressing, and the stitches in from five to eight days.

Complications of Scalp Wounds.—The most common complications are those due to infection by pyogenic bacteria, which not only aggravate the local condition, but are apt to lead to spreading cellulitis, osteomyelitis, meningitis, or to inflammation of the intra-cranial venous sinuses. These dangerous sequelæ are liable to follow infection of any scalp wound, but more especially such as implicate the sub-aponeurotic area, or the pericranium. In the integument a small localised abscess, attended with pain and œdema of surrounding parts, may form. Pus forming under the aponeurosis is liable to spread widely, pointing above the eyebrows, in the occipital region, or in the

line of the zygoma. Suppuration under the pericranium tends to be limited by the inter-sutural attachments of the membrane. Necrosis of the outer table, or even of the whole thickness of the skull, may follow, although it is by no means uncommon for large denuded areas of bone to retain their vitality.

The onset of sepsis in these wounds is indicated by throbbing pain and heat in the wound, a feeling of chilliness or the occurrence of a rigor, and tension of the stitches from œdematous swelling of the surrounding tissues.

The *treatment* is carried out on the principles guiding the treatment of suppuration elsewhere. The risks of intra-cranial complications demand that the measures taken shall be prompt and thorough.

Erysipelas of the scalp may originate even in wounds so trivial as to be almost invisible, or from suppurative processes in the region of the frontal sinuses or nasal fossæ. On the head erysipelas tends to be limited by the attachments of deep fasciæ, and seldom spreads to the neck or cheeks. Cerebral complications in the form of noisy delirium or coma are common, and symptoms of meningitis may supervene. Cellulitis from mixed infection is a common sequel of erysipelas of the scalp, and adds materially to the gravity of the condition. The original wound may heal in spite of the erysipelas, but it often breaks down later. When cellulitis develops, free and numerous incisions are urgently called for.

Diseases of the Scalp.

The surgical diseases of the scalp may be conveniently studied in two groups—those which are *inflammatory* in nature, and tumours and other swellings of a *non-inflammatory* kind.

Inflammatory Conditions.—*Suppuration* following upon injuries has already been discussed. It is not uncommon, however, for *localised abscesses* to occur in the scalp in the absence of any discoverable injury. Such collections, as a rule, form in the cellular tissue in delicate children, and are not infrequently associated with chronic eczema, impetigo, or pediculi. These abscesses are slow in their development, are comparatively painless, and are only covered by a thin bluish pellicle of skin. It is not improbable that they result from a mixed infection by pyogenic and tuberculous organisms. As a rule they heal quickly after incision and drainage, but sometimes tedious superficial ulcers result. Localised abscesses may also form in connection with one or other of the diseases which affect the cranial bones.

Boils and carbuncles are not common on the hairy part of the scalp, but they frequently occur on the brow and nape of the neck.

Lupus rarely originates on the scalp, but may spread thither from the face.

Syphilitic eruptions and ulcers occur on the scalp as elsewhere, but present no features of special interest. Gummata may develop in the soft parts of the scalp, but more commonly take origin in the periosteum or bone.

Eczema capitis is of surgical importance only in so far as it often forms the starting-point of infection of lymphatic glands by pyogenic and other organisms.

Cystic and Solid Tumours.—A great variety of tumours and other non-inflammatory conditions have been met with in the scalp, but the majority of them are of extreme rarity.

Sebaceous cysts or *wens* are of frequent occurrence, and have already been described.

Dermoid cysts of the scalp are usually situated over the anterior fontanelle or in the region of the occipital protuberance. They may be connected by a pedicle with the dura mater, and are liable to be mistaken for meningoceles.

Serous cysts are occasionally found in the occipital region. They are believed to be meningoceles which have become isolated before birth.

Adenomata originating in the sebaceous or sweat glands are met with in the scalp. They are sometimes multiple, are of a purplish colour, and the skin covering them is thin and glistening. They show a tendency to ulcerate and fungate, and give rise to a fœtid discharge. They are treated by excision.

Large, flat *papillomata*, or warts, are sometimes met with on the scalp. They may be single or multiple, are of slow growth, and may become the starting-point of epithelioma.

The *plexiform neuroma* forms a loose soft tumour situated in the course of one or more branches of the fifth nerve, especially the supra-orbital branch. In its most aggravated forms the tumour hangs over the face or neck in large pendulous masses, and is described as a *pachydermatocele*.

Sarcomata usually have their origin in the bones of the skull, and only implicate the scalp secondarily.

Epithelioma of the scalp may originate in relation to a wart, an ulcerated wen or sebaceous adenoma, or the cicatrix of a burn. It may affect comparatively young persons, may spread over a wide area, or pass deeply and involve the bone. Free and early removal is indicated.

Rodent cancer may originate on the scalp, but usually spreads thither from the face.

In operating for extensive tumours of the scalp the hæmorrhage is sometimes very formidable. It may sometimes be controlled by an elastic tourniquet applied horizontally round the head, or if, on account of the position of the tumour or from other causes, this is not practicable, by ligature or temporary clamping of the external carotid on one or on both sides. Skin-grafting is often useful in covering in the defect left after the removal of these tumours.

Air-containing Swellings.—*Pneumatocele Capitis.*—A number of cases have been recorded where, as a result of pathological or traumatic perforations of the mastoid, and less frequently of the frontal cells, air has passed under the pericranium, and has given rise to a small rounded tumour, resonant on percussion, and capable of being emptied by firm pressure. Such swellings are painless, and, as they give rise to almost no inconvenience, do not call for treatment.

Emphysema of the scalp may follow fractures implicating any of the air sinuses of the skull, the air infiltrating the loose cellular tissue between the pericranium and the aponeurosis, and on palpation yielding the characteristic crepitation. It usually disappears in a few days.

Vascular Tumours.—*Nævi* may occur on the scalp, where they present the same features as on the face. If placed over one of the fontanelles, they may derive a pulsation from the dura.

Cirsoid aneurysm is met with in the course of the temporal artery, and may involve the greater part of the scalp. Large, distended, tortuous, bluish vessels are seen and felt pulsating synchronously with the heart. They can be emptied by pressure, but fill up again at once on removal of the pressure. Ulceration of the skin over the dilated vessels, leading to fatal hæmorrhage, may take place. The patient complains of dizziness, headache, and a persistent rushing sound in the head.

They may be treated by excision, after dividing and ligaturing the larger vessels entering the swelling. Ligature of the main afferent vessels, or of the external or common carotid, has not been attended with much success. In some cases electrolysis has yielded good results.

Traumatic aneurysm of the temporal artery was comparatively common in the days when arteriotomy was in vogue.

Aneurysmal varix, *varicose aneurysm*, and *cirsoid aneurysm* may also occur in the course of the temporal artery.

CHAPTER II.

THE CRANIUM AND ITS CONTENTS.

Anatomy and physiology—Cerebral localisation—Operation of trephining. HEAD INJURIES—Concussion—Cerebral irritation—Compression—Contusion and laceration—Traumatic intra-cranial hæmorrhage: *Middle meningeal hæmorrhage; Hæmorrhage from internal carotid and venous sinuses*—Cerebral œdema—Wounds of brain—After-effects of head injuries—Traumatic epilepsy and insanity—Septic complications.

Surgical Anatomy.—The bones of the skull consist of an *outer* table which is thick, smooth, and elastic; an *inner* "vitreous" table which is thin and fragile; and an *intermediate*, open, porous, and highly vascular layer—the diploë. The outer table is nourished chiefly from the pericranium, and transmits, by oblique or tortuous channels, the emissary veins. It varies greatly in thickness in different skulls, and in different parts of the same skull. The vitreous layer is smooth on its inner aspect, and is grooved by the middle meningeal and other arteries of the dura mater, and by the large venous sinuses. In the porous substance of the diploë branches of the middle meningeal artery anastomose freely with branches derived from the pericranial vessels. Some of its veins open into the external veins, and others into the intra-cranial sinuses, and they communicate with the emissary veins as these pass through the bone. This free intercommunication of veins explains the facility with which infective processes pass between the structures outside the skull and those within.

The existence of the emissary veins permits of the withdrawal of blood from the interior of the skull by leeching, bleeding or cupping.

The *pericranium* is thick and vascular, and is chiefly concerned in nourishing the outer table of the skull. It is firmly bound down along the lines of the sutures.

The *cranium* is an irregularly ovoid cavity, the floor of which is broken up by various projections so as to form three separate fossæ—the anterior, middle, and posterior—in which rest respectively the frontal, temporal, and occipital lobes of the brain. The posterior fossa also contains the cerebellum, the pons, and the medulla.

The Membranes of the Brain.—The inside of the skull is lined by the vascular *dura mater* which constitutes the internal periosteum, and in it run the large intra-cranial venous sinuses. Under the dura, and separated from it by a narrow space—the *sub-dural space*—lies the

arachno-pial membrane, which consists of a thick outer (arachnoid) layer, and a thinner, highly vascular, inner layer (pia mater). The pia mater lies in contact with the surface of the brain and passes into the larger fissures. The space between these layers—the *sub-arachnoid space*—is traversed by a network of fine fibrous strands, in the meshes of which the cerebro-spinal fluid circulates. Each nerve trunk as it leaves the brain or spinal cord carries with it a prolongation of each of these membranes and their intervening spaces. The membranes gradually become lost in the fibrous sheaths of the nerves, and the sub-dural and sub-arachnoid spaces become continuous with the lymph spaces of the nerves.

The *cerebro-spinal fluid* occupies the meshes of the sub-arachnoid space, the ventricles of the brain, and surrounds the intra-cerebral blood-vessels down to their minutest branches. Each nerve cell is surrounded by this fluid. Through the foramen of Magendie, in the roof of the fourth ventricle, the sub-arachnoid fluid of the cranial cavity communicates with that of the spinal canal. It has already been mentioned that each nerve as it leaves the central cerebro-spinal axis is surrounded by this fluid. The whole nervous system, therefore, lies bathed in the cerebro-spinal fluid—a point of great physiological and pathological importance. The main function of the cerebro-spinal fluid seems to be to compensate for changes in the size of the brain resulting from increase or diminution of its vascular supply. An increased flow of blood to the brain, such as occurs with each cardiac systole, is accompanied by a recession of cerebro-spinal fluid into the spinal canal and nerve-sheaths, while during diastole, as the blood leaves the brain, the intra-cranial pressure is maintained by the cerebro-spinal fluid again entering the cranial cavity. In cases of cerebral hæmorrhage, abscess, tumour, or depressed fracture, room is made, up to a certain point, for the extraneous matter by displacement of the cerebro-spinal fluid. Its rôle in concussion of the brain will be referred to later.

The Brain.—It is convenient here to consider briefly such points as have a direct bearing upon surgical diagnosis and treatment.

Motor Function and Mechanism.—Grouped around the fissure of Rolando, in what are known as the central convolutions of the brain, are certain cortical nerve centres which together make up the *motor area*, and govern the voluntary muscular movements of the body. Each group of muscles has its own regulating centre, and these have been localised on the surface of the brain with approximate accuracy. For example, the upper third of the ascending frontal and parietal convolutions is occupied by the centres governing the inferior extremity, and the middle third of the same convolutions contains the centres for the superior extremity. Still lower lie the centres for the facial muscles, the tongue, the pharynx and the larynx. In the inferior frontal (Broca's) convolution is the centre governing the muscular movements concerned in speech. This centre is located on the left side of the brain in right-handed persons.

The motor fibres pass from the cortex through the centrum ovale towards the base of the brain. They converge at the internal capsule, and pass through the anterior two-thirds of its posterior limb. The fibres for the eyes, face, and tongue lie further forward, and next in order from before backward, those for the arm and leg.

From the internal capsule the motor fibres pass as the *pyramidal tract* through the crusta of the crura cerebri, the pons and medulla.

At the *decussation of the pyramids* in the lower third of the medulla

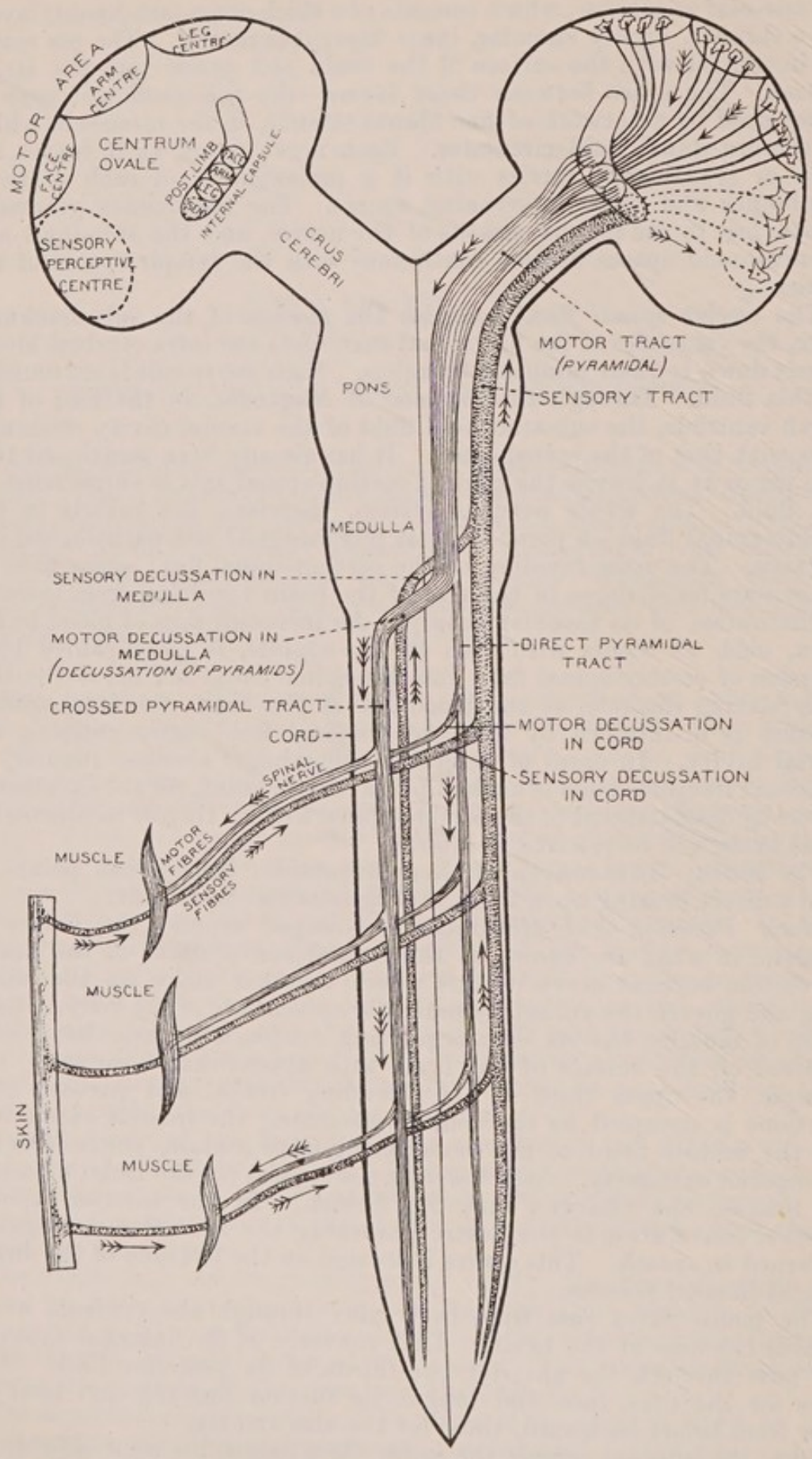

FIG. 1.—Diagram of the Course of Motor and Sensory Nerve Fibres.

the main mass of the motor fibres crosses the middle line and enters the lateral column of the spinal cord as the *crossed pyramidal tract*. The remaining fibres pass on in the anterior column of the same side as the *direct pyramidal tract*.

In the cord the fibres of the pyramidal tracts terminate at different levels by breaking up into fine branches around the multipolar nerve cells of the grey matter of the anterior horns, the axis cylinders of which leave the cord as the anterior nerve-roots to supply the voluntary muscles.

Sensory Functions and Mechanism. — The sensory nerve fibres pass from their peripheral distribution in the sense organs of the skin, muscles, tendons, and other structures through the posterior nerve-roots into the spinal cord. Some of the fibres ascend the cord in the posterior and lateral columns of the same side, passing upward to the medulla, where most of them enter the nuclei gracilis and cuneatus; the axis cylinders of the cells of these nuclei cross the middle line at the *decussation of the fillet*, which is situated just above the motor decussation in the medulla, and there unite with sensory fibres which have ascended in the lateral column of that side, having decussated in the cord soon after their entry. Thence the sensory fibres pass through the dorsal portion of the medulla and pons to reach the tegmentum of the crura cerebri. They then enter the posterior third of the internal capsule, some of them terminating in the optic thalamus, others passing to the cortical sensory centres, which are situated in the Rolandic region and in the parietal lobes immediately posterior to it.

Effects of Lesions of the Motor and Sensory Mechanisms.—Localised *cortical lesions* of an irritative kind, for example, a patch of meningitis, a tumour, meningeal hæmorrhage, or a spicule of bone, produce spasms in those groups of muscles on the opposite side of the body which are supplied by the centres implicated (Jacksonian epilepsy). The cortical discharge may overflow into neighbouring centres and cause more widespread convulsive movements, or, if strong and long-continued, may even lead to general convulsions.

If an area of the cortex is destroyed by such a lesion, paralysis is produced on the opposite side of the body, the seat and extent of the paralysis depending upon the area of the cortex destroyed.

Lesions situated in the centrum ovale, which destroy the fibres proceeding from the overlying cortex, produce a corresponding paralysis on the opposite side of the body. No irritative phenomena are associated with a lesion limited to this situation.

Lesions in the region of the internal capsule often produce complete hemiplegia of the opposite side of the body. When the posterior part of the capsule is involved there are, in addition, hemianæsthesia and hemianopia.

A lesion of the crus may in like manner produce hemiplegia and hemianæsthesia of the opposite side, often associated with paralysis of the third nerve of the same side. The symptoms produced by lesions of the pons and medulla vary according to the position of the lesion. If it is unilateral, there may be hemiplegia and hemianæsthesia of the opposite side; if it is situated in the lower part of the pons or in the medulla, there is often also paralysis of one or more of the cranial nerves on the same side as the lesion (crossed paralysis).

A unilateral lesion of the spinal cord causes paralysis and wasting of the muscles supplied from the cord at the level of the lesion, with paralysis of motion on the same side of the body, and of sensation on the opposite side, below the level of the lesion.

Other special Centres.—The cortical centres which are related to the different forms of aphasia are of importance. Thus Broca's convolution is the seat of the *motor speech centre*, and lesions of it result in "motor aphasia." The *auditory speech centre*, through which spoken words are appreciated, occupies the posterior part of the first, and probably also of the second, temporo-sphenoidal convolutions. Lesions of this centre produce "word deafness," that is, the patient is unable to understand spoken words, although he may be able to read, write, and speak intelligently. A special centre for the appreciation of written words—the *visual speech centre*—is located in the angular gyrus, and lesions in this region cause "word blindness," a condition in which the patient cannot read words although he may be able to speak, to understand spoken language, and to write. A special centre for *writing* is supposed to lie

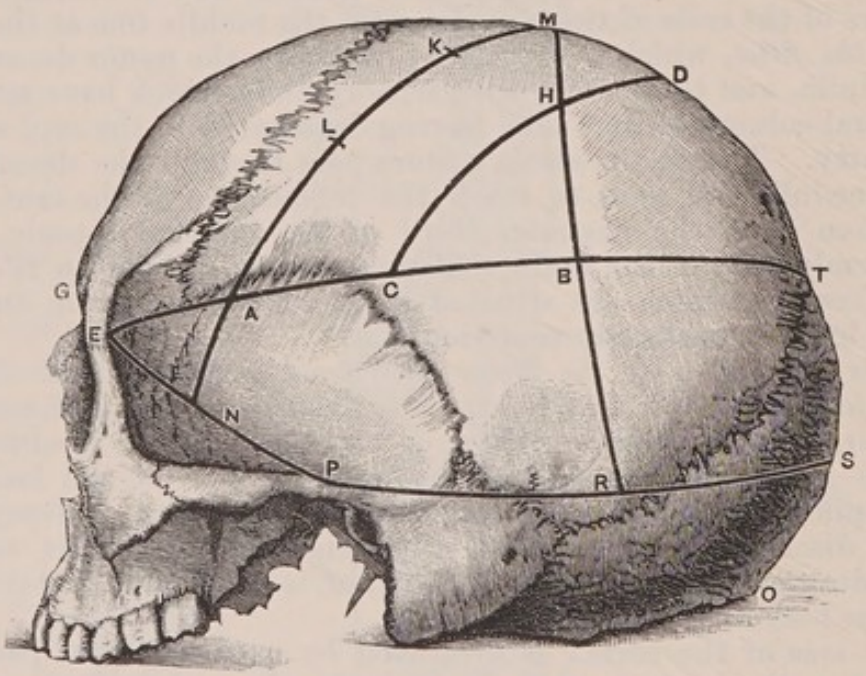

FIG. 2.—Chiene's Method of Cerebral Localisation.

in the posterior part of the middle frontal convolution, and "agraphia," or inability to write, results from its destruction.

All the above-mentioned special centres are situated in the left cerebral hemisphere in right-handed people.

The half-vision centres, or cortical centres for vision, lie in the occipital lobes, in the neighbourhood of the calcarine fissure. Each half-vision centre, for there is one in each occipital lobe, receives the fibres from the same side of both retinæ. Destruction of one half-vision centre produces the condition known as homonymous hemianopia, in which there is an inability to see objects which are situated on the side opposite to the lesion.

Lesions of the prefrontal lobes may be associated with disturbance of the higher psychical functions.

Disturbances of equilibration and co-ordination occur especially in connection with lesions of the cerebellum and its peduncles. Ataxia, vertigo, and nystagmus are frequently due to cerebellar lesions.

Relation of Cerebral Centres to the Surface.—Numerous attempts have been made to formulate rules for locating the different parts of the brain in relation to the surface of the head. The method devised by

Chiene is free from many of the difficulties and fallacies common to most other methods inasmuch as the results obtained do not depend upon making definite measurements in inches, or determining particular angles. Certain fixed and easily recognised bony landmarks—the glabella, the external occipital protuberance, the external angular process, and the root of the zygoma—are taken, and connected by lines, which are further subdivided—*always being bisected*. Figs. 2, 3 explain the method. The head being shaved, a line (GO) is drawn along the vertex from the glabella (G) to the external occipital protuberance (O). This line is bisected in M, which constitutes the "mid-point." The posterior half of the line MO is bisected in T, constituting the "three-quarters point," and the posterior half of TO is bisected in S—the "seven-eighths point." The external angular process (E) is next connected to the root of the zygoma (P) by a line EP, and the root of the zygoma with the seven-eighths point by PS; the line EPS thus forms the base line. The

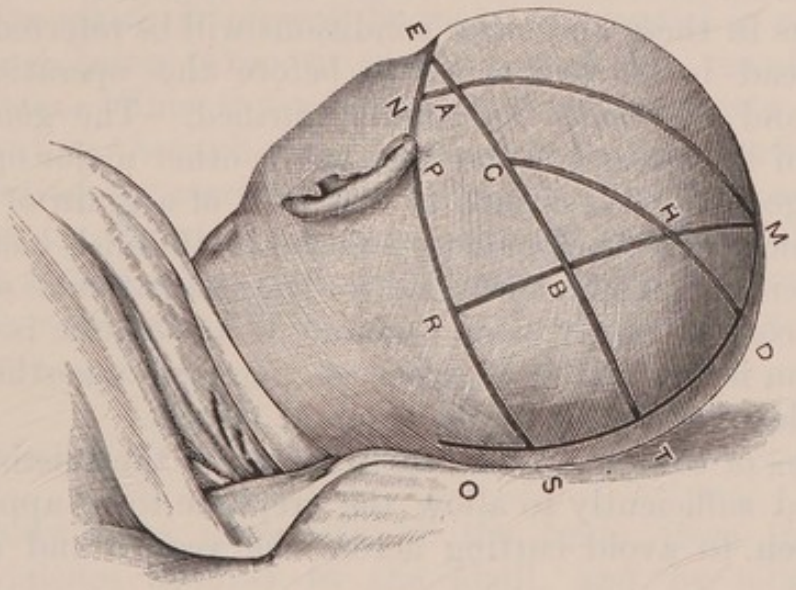

FIG. 3.—Chiene's Method of Cerebral Localisation.

external angular process is now joined to the three-quarters point by ET. The two segments of the base line EP and PS are bisected in N and R respectively, and these points connected with the mid-point (M) by lines NM and RM. These lines cut off a part of ET—AB, which is now bisected in C, and from C the line CD is drawn parallel to AM.

In this way practically all the points of the brain which are wanted for operative purposes may be mapped out. Thus the quadrilateral MDCA contains the Rolandic area. MA represents the precentral sulcus, and, if it be trisected in K and L, these points will correspond to the origins of the superior and inferior frontal sulci. The pentagon ABRPN corresponds to the temporo-sphenoidal lobe. The apex of the temporo-sphenoidal lobe extends a little in front of N. The supra-marginal convolution lies in the triangle HBC. The angular gyrus is at B. A is over the anterior branch of the middle meningeal artery, and the bifurcation of the Sylvian fissure; AC follows the horizontal limb of the fissure of Sylvius. The lateral sinus at its highest point touches the line PS at R.

The *fissure of Rolando* may be marked out by taking a point half an inch behind the mid-point (M) (Fig. 3), and drawing a line downwards

and forwards for a distance of about three and a half inches, at an angle of 67·5° with the line CO. The angle of 67·5° can be readily determined by folding a square piece of paper on itself so as to make a triangle. The angle at the fold equals 45°. By folding the paper again upon itself in the same direction the right angle of the paper is divided into four angles of 22·5° each. Three of these angles taken together make up the 67·5°. If the straight edge of the paper be placed along the sagittal suture with the angle of folding over the upper end of the fissure of Rolando, the folded edge falls over the line of the fissure (Chiene).

Operation of Trephining.

The operation of opening the skull, or trephining, is called for in certain cases of fracture, of Jacksonian epilepsy, and in the treatment of cerebral abscesses and tumours. The special indications in these and other conditions will be referred to later.

The head is shaved the day before the operation, when possible, and the scalp thoroughly purified. The general preparation of the patient is the same as for other major operations. Some surgeons give one-sixth to one-third of a grain of morphin hypodermically just before the operation to diminish hæmorrhage by contracting the arterioles, and to dull the patient's sensations so that a comparatively small amount of anæsthetic is required. Chloroform is preferable to ether as a general anæsthetic, as it produces less congestion of the cerebral vessels.

In cases of compound fracture of the skull the existing wound is enlarged sufficiently to allow the trephine to be applied, care being taken to avoid cutting across the vessels and nerves of the scalp.

When the scalp is intact, a horse-shoe shaped flap is raised, with its base below and its rounded apex above.

The incision is carried down to the bone, and the pericranium is reflected along with the scalp. The trephine is then applied, and a disc of bone removed from the skull. As the thickness of the bone varies greatly at different parts of the skull, care must be taken to avoid perforating at one part sooner than at another. For this purpose the depth of the groove made by the trephine should be tested from time to time by means of a sterilised toothpick or probe. The opening may be enlarged if necessary by means of rongeur or gouge forceps or by a Hey's saw.

If bleeding from the vessels of the diploë persists, it may be controlled by crushing with strong forceps, or by the application of Horsley's antiseptic putty, which consists of carbolic acid one part, oil two parts, and wax seven parts.

When a large opening in the skull is required, for example in exploratory operations, or for the removal of extensive tumours,

some modification of Wagner's operation, which consists in raising a segment of bone along with the periosteum and scalp, should be performed. An omega-shaped incision is made through the scalp and pericranium, and at each of the four angles of the area of bone so delimited a three-quarter inch disc is removed by the trephine. The openings thus made are united by means of the chisel or saw—Gigli's wire saw is very suitable for this purpose—and the flap of bone, still attached to its periosteum, is raised. In cutting this osseous flap Cotterill lays stress on the importance of applying the saw obliquely so that the part to be lifted up is bevelled at the expense of its under surface. By attending to this detail it is possible to replace the flap without fear of its sinking below the level of the surrounding bone.

The dura mater is opened by making a crucial or semilunar incision, care being taken to secure any visible vessels before dividing them. This is sometimes most conveniently done by passing a suture through the dura so as to include the vessel.

In operating for cerebral tumours it is sometimes advisable, with a view to diminishing shock, that the operation should be carried out in two stages, the dura mater being exposed at the first sitting, and a day or two later an attempt made to remove the tumour.

HEAD INJURIES.

The comparative immunity of the brain from injury by external violence applied to the skull, and by jolting and shaking, depends upon various physical and architectural arrangements, among which are the density and mobility of the scalp, the dome-like shape of the skull, and the elasticity of the outer table. The numerous bones of which the skull is composed, and the buffer-like sutural membrane which unites them, the overlapping of certain of these bones, and the internal ribs and osseous projections, with the membranes attached to them, all tend to diminish vibration. The external buttresses formed by the zygoma and the malar bone, the thick muscular pads related to these processes, act in the same direction. The mobility of the skull upon the spine, and lastly the water-bed of cerebro-spinal fluid in which the brain floats, also protect it from external injury.

In all cases of injury to the head the questions which dominate the whole clinical outlook are whether or not the brain is directly damaged, and whether it is likely to become involved by septic infection.

It is impossible to consider separately in their clinical aspects injuries of the cranium and injuries of the brain. It seldom happens that one is seriously damaged without the other suffering to a greater or less extent. Sometimes the skull suffers comparatively little while the brain is severely damaged, but it is very rare for a serious injury to the bone to be unaccompanied by definite brain lesions. In any case it is the damage to the brain, however slight, which gives to the injury its clinical importance. It is an old and a true saying that "no injury of the head is so trivial as to be despised or so serious as to be despaired of." Injuries at first sight apparently slight may prove fatal from hæmorrhage or sepsis, while, on the other hand, recovery has followed injuries of great severity—for example, the famous "American crow-bar case," in which a bar of iron three and a half feet long and one and a half inches thick passed through the head, and yet the patient recovered.

It is convenient to consider the injuries of the brain before those of the skull.

Concussion and Compression of the Brain.

The clinical manifestations of cerebral injury are embraced under the two terms "concussion" and "compression" of the brain. No true pathological significance attaches to these terms; they are essentially clinical. As the conditions which they indicate do not occur as separate and independent entities, separate descriptions of them are of necessity more or less arbitrary.

The symptoms associated with concussion of the brain are to all intents and purposes those of shock, and the term "cerebral shock" is sometimes employed as synonymous with concussion.

Compression is a general term used to indicate the presence of increased intra-cranial tension from whatever cause resulting —it may be from hæmorrhage due to injury, an abscess, or a tumour. The only pathological idea the term conveys is that there is more inside the skull than it can conveniently hold.

Concussion of the Brain.—As has been said, a patient suffering from concussion of the brain is practically in a condition of shock—shock induced by violence directly inflicted on the brain tissue. The symptoms characteristic of shock may be the only evidence of injury, or they may accompany such gross lesions as fracture of the skull, or contusion and laceration of the brain.

The *clinical features* vary according to the severity of the violence. In the slightest cases the patient does not lose

consciousness, but merely feels giddy, faint, and dazed for a few seconds. His mind is confused, but he rapidly recovers, and, perhaps after vomiting, feels quite well again, save for a slight weakness in his limbs.

In more severe cases, immediately on receiving the blow the patient falls to the ground unconscious. Sometimes he suffers from a general tetanic seizure, associated with arrest of respiration, which may prove fatal. This convulsion is usually of short duration, and is frequently overlooked. The pulse is slow, small, and feeble, and is sometimes irregular in force and frequency. The respirations are short, shallow, slow, and frequently sighing in character. The temperature falls to 97° F., or even lower. The skin is cold and pallid and covered with clammy sweat. The features are pinched and pale.

In uncomplicated cases the pupils are usually equal, moderately dilated, and react sluggishly to light. The patient can be partially roused by shouting or by other forms of external stimulation, but he soon subsides again into a lethargic condition. Although voluntary movement and the deep reflexes are abolished, there is no true muscular paralysis.

After a period, varying from a few minutes to several hours, he rallies, the first evidence often being vomiting, which is usually repeated. Sometimes reaction is ushered in by a mild epileptiform seizure. He then turns on his side, the face becomes flushed, and gradually the symptoms pass off and consciousness returns. The temperature rises to 99° or 100° F., and in some cases remains elevated for a few days. In most cases it falls again to 97° or 97·5°, and remains persistently subnormal for one or two weeks. During reaction the pulse becomes quick and bounding, but after a few hours it again becomes slow, and usually remains abnormally slow (40 to 60) for ten or fourteen days. Very commonly the patient complains of pain in the head for some days after the return of consciousness. There is sometimes a tendency to constipation, and the patient is liable to allow the bladder to become distended, although he has no difficulty in making water. Children often sleep a great deal during the first few days, but sometimes they are very fretful.

In cases complicated by gross brain lesions the symptoms of concussion imperceptibly merge into those of compression.

Pathology.—It is probable that in all cases in which the patient loses consciousness there is some definite damage of the cerebral tissue. On microscopic examination we have found [1]

[1] Miles, *Laboratory Reports, Royal College of Physicians, Edinburgh*, vol. iv.

numerous minute petechial hæmorrhages scattered widely throughout the brain substance. Colloid bodies, patches of miliary sclerosis, and pigmentary degeneration of nerve cells were found in a majority of the cases examined.

Three theories have been put forward to explain the clinical features of concussion :—(1) That which supposes that the brain is thrown into a state of vibration which causes a temporary suspension of its functions, is on anatomical and physical grounds untenable. (2) It has been suggested that the capillary hæmorrhages which are found throughout the brain substance produce the symptoms. The majority of observers reject this theory also, on the grounds that the number and extent of such hæmorrhages bear no relation to the severity of the concussion symptoms, and that the lesions persist long after the symptoms have passed off. (3) The view of Duret is that most generally accepted. He ascribes the symptoms to stimulation of the restiform bodies by a fluid wave of cerebro-spinal fluid driven towards the base of the brain by the impact of the blow on the skull. This sudden stimulation of the restiform bodies induces a profound anæmia of the brain, to which the symptoms are directly attributable. The momentary increase in the tension of the cerebro-spinal fluid in every part of the brain accounts for the various pathological lesions already referred to. We have experimentally confirmed Duret's observations, and agree with his conclusions.

After-Effects of Concussion.—The majority of patients recover completely. A number complain for a time of headache, languor, muscular weakness, and incapacity for sustained effort. Sometimes there is a condition of mental instability, the patient is easily excited, and is unduly affected by alcohol or other stimulants. Occasionally there is permanent mental impairment. It is not uncommon to find that the patient has entirely forgotten the circumstances of the injury and of the events which immediately preceded it. In some instances the memory is permanently impaired. On the other hand, it has occurred that a patient, after concussion, has recovered his memory of a foreign language long since forgotten.

As it is never possible to determine the precise extent of the damage to the brain, the immediate prognosis, even in the mildest cases of concussion, should always be guarded. If the patient has been actually unconscious, the condition should be looked upon as a serious one, and treated accordingly.

Treatment.—The immediate treatment consists in the application of warmth, and the administration of stimulants when

necessary. Absolute rest and quietness are called for. When the symptoms begin to pass off, the head should be raised on pillows to prevent congestion and to diminish the risk of bleeding from damaged blood-vessels in the brain. The application of an ice-bag or of Leiter's tubes is sometimes recommended with a view to arresting hæmorrhage inside the skull, but its value is more than doubtful. Venesection and the application of leeches over the temple or behind the ear are sometimes employed with benefit. The use of small doses of atropin and ergotin is recommended by von Bergmann. The bowels should be thoroughly opened by calomel, croton oil, or Henry's solution. A light milk diet should be given. The patient is kept in a dull room, and should be confined to bed for from fourteen to twenty-one days. It is often difficult to convince the patient of the necessity for such prolonged confinement, but the responsibility for curtailing it must rest upon him or his friends. Reading, conversation, and argument must be avoided to ensure absolute rest to the brain.

Cerebral Irritation.—In some cases of injury to the head—particularly of the anterior part and the parietal regions—as the symptoms of concussion are passing off, the patient begins to exhibit a peculiar train of symptoms, which has been graphically described by Erichsen under the name of cerebral irritation. "The attitude of the patient is peculiar, and most characteristic: he lies on one side and is curled up in a state of general flexion. The body is bent forwards and the knees are drawn up on the abdomen, the legs bent, the arms flexed, and the hands drawn in. He does not lie motionless, but is restless, and often, when irritated, tosses himself about. But, however restless he may be, he never stretches himself out nor assumes the supine position, but invariably maintains an attitude of flexion. The eyelids are firmly closed, and he resists violently every effort made to open them; if this be effected, the pupils will be found to be contracted. The surface is pale and cool or even cold. The pulse is small, feeble, and slow, seldom above 70. The sphincters are not usually affected, and the patient will pass urine when the bladder requires to be emptied; there may, however, though rarely, be retention.

"The mental state is equally peculiar. Irritability of mind is the prevailing characteristic. The patient is unconscious, takes no heed of what passes, unless called to in a loud tone of voice, when he shows signs of irritability of temper or frowns, turns away hastily, mutters indistinctly, and grinds his teeth. It appears as if the temper, as much as or more than the

intellect, were affected in this condition. He sleeps without stertor.

"After a period varying from one to three weeks, the pulse improves in tone, the temperature of the body increases, the tendency to flexion subsides, and the patient lies stretched out. Irritability gives place to fatuity; there is less manifestation of temper, but more weakness of mind. Recovery is slow, but, though delayed, may at length be perfect. . . ."

The *treatment* consists in keeping the patient quiet, in a darkened room, on much the same lines as for concussion.

Compression of the Brain.—This term is used clinically to describe the train of symptoms which follows a marked increase of the intra-cranial tension produced by such causes as hæmorrhage, œdema, the accumulation of inflammatory products, or the growth of tumours within the skull.

Clinical Features.—The following description refers to cases of compression resulting from injury. In a majority of traumatic cases the symptoms of cerebral compression supervene on those of concussion. In a certain proportion there is an interval, during which the patient regains complete consciousness; but in others the symptoms of concussion gradually and imperceptibly merge into those of compression. The rapidity of onset of the symptoms and the course and duration of the illness vary widely according to the nature and extent of the brain lesion. Death may occur in a few hours, or recovery may take place after the patient has been unconscious for several weeks.

The first symptoms are of an irritative character—dull pain in the head, restlessness, and hypersensitiveness to sensory stimuli. The face is suffused, and the pupils at first are usually contracted. The temperature falls to 97°, or even to 95° F. Vomiting is not infrequent.

As the pressure increases, paralytic symptoms ensue. The patient gradually loses consciousness, and passes into a condition of coma. The pulse becomes slow, full, and bounding; the respiration slow and deep, and eventually stertorous or snoring in character from paralysis of the soft palate. The lips and cheeks are puffed out from paralysis of the muscles of these parts. The temperature, which at first falls to 97° or even 95° F., in the course of three or four hours usually rises (100·5° or 102·5° F.) If the temperature reaches 104° F., or higher, the condition usually proves fatal. Sometimes it rises as high as 106° or 108° F.—*cerebral hyperpyrexia.* Retention of urine from paralysis of the bladder, and involuntary defecation from paralysis of the sphincter ani, are commonly present.

During the progress of the symptoms there is frequently evidence of direct pressure upon definite cortical centres or cranial nerves, giving rise to *focal symptoms*. Definite groups of muscles on the side opposite to the lesion may first show spasmodic jerkings or spasms (unilateral monospasm), and later the same groups become paralysed (monoplegia). The paralysis frequently affects the whole of one side of the body (hemiplegia). The oculo-motor nerve is often paralysed at the same time.

The pupils vary so widely in different cases that their condition does not form a reliable diagnostic sign. Perhaps it is most common for the pupil on the same side as the lesion to be contracted at first and later to become fully dilated, while that on the opposite side remains moderately dilated. As a rule, they are irresponsive to light. On ophthalmoscopic examination, blurring of the disc is often to be made out.

In cases which go on to a fatal termination the coma deepens, and the muscular and sensory paralyses become general and complete. The vital centres in the medulla gradually become involved, and death results from paralysis of the respiratory centre. The fatal issue is often hastened by the onset of hypostatic pneumonia. Not infrequently a modified type of Cheyne-Stokes respiration is observed for some time before death ensues.

Pathology of Compression.—When any addition is made to the bulk of material inside the cranial cavity, room is gained in the first instance by the displacement into the vertebral canal of a certain amount of the cerebro-spinal fluid. The capacity of the spinal sheath, however, is limited, and as soon as the tension oversteps a certain point, the pressure comes to bear injuriously on the cerebral capillaries, diminishing the freedom of the circulation, and so interfering with the nutrition of the brain tissue. As the intra-cranial tension still further increases, the pressure gradually begins to affect the cerebral tissue itself, and so the extreme symptoms of compression are produced. The vagus and vaso-motor centres are irritated and this causes slowing of the pulse, contraction of the small arteries, and increase of the arterial tension.

The parts of the brain directly pressed upon become anæmic, while the other parts become congested, and the nutrition of the whole brain is thus seriously interfered with. Different parts of the brain show varying powers of resistance to this circulatory disturbance. The cortex is the least resistant part, and next in order follow the corona radiata, the grey matter of the spinal

cord, the pons, and last the medulla. Hence it is that the respiratory and cardiac centres hold out longest.

Depressed Bone as a Cause of Compression.—It is more than doubtful if a depressed portion of bone is of itself capable of inducing symptoms of compression of the brain. When such symptoms accompany depressed fracture, they are to be attributed either to associated hæmorrhage, or to interference with the circulation and consequent œdema which the displaced bone produces. Fragments of bone may, however, aggravate the symptoms by irritating the cerebral tissue on which they impinge.

Foreign Bodies.—The *rôle* of foreign bodies, such as bullets, in the production of compression symptoms is very similar to that of depressed bone. That foreign bodies of themselves are not a cause of compression seems evident from the fact that it is not uncommon for them to become permanently embedded in the brain substance without inducing any symptoms whatever. Not only have bullets, the points of sharp instruments, and other substances remained embedded in the brain for years without doing harm, but in many cases the patients have continued to occupy important and responsible positions in life.

After head injuries, the *results of bacterial infection* in the form of cerebritis, meningitis or abscess may manifest themselves, and be accompanied by symptoms of compression, the characters of which will be described later.

Differential Diagnosis.—It not infrequently happens that a patient is found in an insensible condition under circumstances which give no clue to the cause of his unconsciousness. He is usually removed to the nearest hospital, and the house-surgeon into whose care he comes must exercise the greatest care and discretion in dealing with him. In attempting to arrive at the cause of the condition, numerous possibilities have to be borne in mind, but it is often impossible to make a definite diagnosis. The chief of these causes are trauma, apoplexy or cerebral embolism, epileptic coma, alcohol and opium poisoning, uræmic and diabetic coma, sunstroke, and exposure to cold. The commonest error is to mistake a case of cerebral compression for one of drunkenness. It is scarcely necessary to say that a man who smells of alcohol is not necessarily intoxicated. The drink may have been given with the object of reviving him. In many cases one or other of the above-named conditions has caused the patient to fall, and in his fall he has sustained head injuries. Wherever there is the least doubt, therefore, the patient should be admitted to hospital.

In the first instance careful search should be made for any sign of injury, especially on the head. The discovery of a scalp wound or a fracture of the skull, in association with the symptoms of concussion or compression already described, will in most cases clear up the diagnosis.

In the absence of evidence of a head injury, the stomach should be washed out and its contents examined. The urine also should be drawn off and examined for albumin and sugar.

In *apoplexy and cerebral embolism* the symptoms are essentially those of compression, and, in the absence of a definite history of injury to the head, it is seldom possible to arrive at an accurate diagnosis as to the cause of the patient's condition. The history that the patient has previously had "an apoplectic shock," and the fact that he is up in years and shows signs of arterial degeneration or of cardiac disease, which would favour such conditions, are presumptive evidence that the lesion is not traumatic.

In *epileptic coma* the diagnosis is very largely dependent on the previous history of the patient.

In *alcoholic poisoning* the nature of the stomach contents will furnish evidence. The patient is not completely unconscious, nor is he paralysed. The pupils are usually contracted, but react. The temperature is often markedly subnormal. Improvement soon takes place after the stomach has been emptied.

In *opium poisoning* the general condition of the patient is much the same as in poisoning by alcohol. The pupils, however, are markedly contracted, and do not react to light. When the poison has been taken in the form of laudanum, it may be recognised by its odour.

In *uræmic* and in *diabetic coma* there is no true paralysis, nor is there stertor. There may be œdema of the feet and legs, and the urine contains albumin or sugar.

Prognosis.—The prognosis depends so much on the nature and extent of the injury to the brain, that it is impossible to formulate any reliable statements with regard to it. In a general way it may be said, however, that the symptoms which indicate a bad prognosis in compression are immediate rise of temperature, particularly if it goes above 104° F., the early onset of muscular rigidity, extreme and persistent contraction of the pupils, with loss of the reflex to light, conjugate deviation of the eyes, and the early appearance of bed-sores.

In the majority of cases compression ends fatally in from two to seven days. On the other hand, recovery may ensue after the stuporous condition has lasted for several weeks.

Contusion and Laceration of the Brain.

Contusion and laceration of the brain are present to a greater or less extent in almost every injury to the head in which brain symptoms appear. These lesions are usually most severe and dangerous when the skull is fractured and the fragments driven in upon the brain, but they may exist—indeed they may be very extensive—in the absence of any fracture.

It has already been mentioned that the symptoms of cerebral concussion are almost invariably associated with the presence of numerous *petechial hæmorrhages* scattered widely throughout the brain substance. In such cases, after the initial shock has passed off, the pulse and respiration are usually accelerated for a time and the temperature raised.

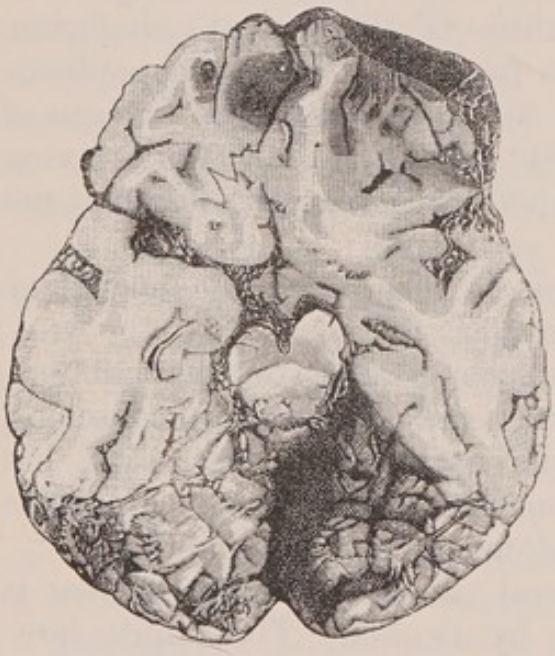

Fig. 4. — Laceration of the Brain, showing sub-arachnoid and cortical hæmorrhages.

In more severe cases there are often several *visible areas of extravasation*, most commonly into the grey matter of the cortex (Fig. 4). These foci vary in size from a split-pea to a hazel-nut, and consist of a central zone of extravasated blood, surrounded by an area of red softening of the brain matter, beyond which are numerous minute capillary hæmorrhages. These intra-cerebral lesions may be accompanied by an effusion of blood into the meshes of the arachno-pial membrane, and they may occur either at the part of the head struck, or at the opposite pole of the axis of percussion—the so-called point of *contre-coup*. Such effusions are sometimes the origin of hæmorrhagic cysts. The symptoms vary with the size and site of the extravasations. It is probable that the phenomena of "cerebral irritation" are due to this condition when the hæmorrhages are widely scattered through the cerebral cortex. Effusions into the cortical motor centres give rise to irritation or paralysis of the muscles affected. Different forms of aphasia, interference with vision or with hearing, follow implication of the centres governing these functions. In the pre-frontal, and in the lower temporal convolutions no special symptoms seem to

follow such hæmorrhages. When the hæmorrhages are extensive and numerous, symptoms of compression may ensue. This is specially liable to occur when cerebral œdema is superadded.

Localised hæmorrhages also occur, although less frequently, in the crura cerebri, the pons, the floor of the fourth ventricle, and the cerebellum. In these situations they usually prove fatal by causing rapidly advancing coma and interference with the respiratory and cardiac centres. The temperature immediately rises to 106° or even 108° F., and a modified form of Cheyne-Stokes respiration is present.

Still more gross lesions, in the form of distinct *lacerations*, are comparatively common at the tips of the frontal, temporo-sphenoidal, and occipital lobes, on the surface of the cerebellum, and at the base of the brain. These are usually associated with symptoms of compression in its most typical form. The grey matter is torn and infiltrated with blood-clot, and extensive effusion of blood takes place on to the surface, filling up the sulci, and infiltrating the white matter (Fig. 4). In the case of a compound fracture or penetrating wound, brain matter may be extruded through the opening in the skull. These cases usually prove fatal.

The extravasated blood may burst into the lateral ventricles, in which case the pulse becomes small and rapid—130, 160, or even 170. The respiration also is rapid—45 to 60—and greatly embarrassed, and the temperature suddenly rises to 103° or 104° F., and continues to rise till death ensues.

Cases are on record in which fatal hæmorrhage has taken place into the brain substance some days, or even weeks, after an injury which at the time was only attended with symptoms of concussion—a point of medico-legal importance. This condition is known as "traumatic apoplexy."

The occurrence of these widespread and variable hæmorrhages is explained by the disturbance of the cerebro-spinal fluid which accompanies an injury of the head. It has already been mentioned that this fluid not only surrounds the brain and fills the ventricles, but that it also permeates its substance in every direction, so that any increase in the tension of the fluid affects, by hydrostatic pressure, every portion of the brain. The momentary depression of the skull caused by a blow on the head suddenly increases the pressure throughout the whole brain, and so may lacerate vessels at any point. Hence it is that the lesion is not always at the seat of impact, but may be at the opposite side of the skull or at other remote points.

Traumatic Intra-cranial Hæmorrhage.

Hæmorrhage from rupture of intra-cranial vessels may take place (1) between the dura mater and the bone, (2) on to the surface of the brain, (3) into the cerebral substance, or (4) into the ventricles.

Middle Meningeal Hæmorrhage.—The commonest cause of extra-dural hæmorrhage is laceration of the middle meningeal artery. This artery—a branch of the internal maxillary—after entering the skull through the foramen spinosum, crosses the anterior inferior angle of the parietal bone, and divides into an anterior and a posterior branch which supply the meninges and calvaria. Either branch may be injured in association with fractures, or from incised, punctured, or gun-shot wounds. The vessel may be ruptured without the skull being fractured, and sometimes it is the artery on the side opposite to the seat of the blow which is torn. The most common situations for rupture are over the anterior inferior angle of the parietal bone (Fig. 5) (90 to 95 per cent.), and on the inner aspect of the temporal bone (5 to 10 per cent.).

It is probable that the size of the hæmorrhage depends on the nature, extent, and severity of the injury to the head. The recoil of the skull after the blow separates the dura from the bone, and if the meningeal artery is lacerated, or punctured, the blood is effused into the space thus formed. A localised blow therefore results in a small area of separation and a correspondingly small clot; while a diffuse blow is followed by more extensive lesions. It is believed that once the dura is partially separated, the force of the blood poured out from the lacerated artery is—on the principle of the hydraulic press—sufficient to continue the separation.

Clinical Features.—The typical characteristics of middle meningeal hæmorrhage are only met with when the bleeding takes place between the dura and the bone. Under these conditions the symptoms of concussion are usually most prominent at first, and those of compression only ensue after a varying interval during which the patient as a rule regains consciousness. In some cases, indeed, he is able to continue his work, or to walk home or to hospital, before any evidence of intra-cranial mischief manifests itself. This interval of consciousness helps to distinguish the symptoms due to middle meningeal hæmorrhage from those of laceration of the brain substance, as in the latter the symptoms of concussion merge directly into those of compression.

A few hours after the accident the patient experiences severe pain in the head, and he usually vomits repeatedly. For a time he is restless and noisy, but gradually becomes drowsy, and the stupor increases more or less rapidly until coma supervenes. The pulse usually becomes slow and full. The respiration is rapid (30 to 50) and becomes greatly embarrassed and stertorous. The temperature progressively rises, and before death may reach 106° F., or even higher. Monoplegia, usually beginning in the face or arm, gradually comes on, and is followed by hemiplegia, from pressure on the motor areas underlying the clot. Death usually ensues in from twenty-four to forty-eight hours unless the pressure within the skull is relieved by operation.

When the hæmorrhage takes place from the anterior branch, the clot may spread towards the base (Fig. 5), and may press upon the cavernous sinus, causing congestion and protrusion of the eye, with paralysis of the third nerve and wide dilatation of the pupil.

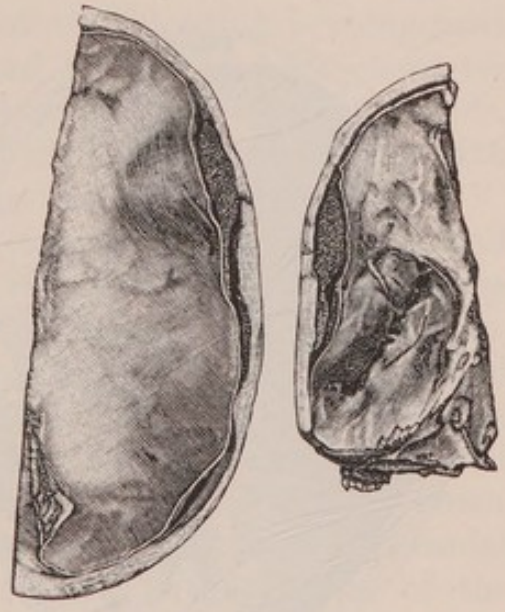

FIG. 5.—Extra-dural Clot resulting from hæmorrhage from the anterior branch of Middle Meningeal Artery. Clot extends to base of skull in anterior and middle fossæ.

In most cases of middle meningeal hæmorrhage there is no gross injury to the brain. It is merely compressed and emptied of blood. On the brain being exposed, it is found flattened, or may even be deeply indented by the blood-clot (Fig. 6). On the clot being removed, the brain soon regains its normal contour, and its pulsation returns.

If the fracture is compound, the blood can escape, and therefore the pressure symptoms are less evident or are entirely absent.

It is a fact of some importance in medico-legal cases that hæmorrhage from the middle meningeal may not take place till two or three weeks after the injury.

The *prognosis* is grave in all cases, especially when operation is delayed beyond twelve or eighteen hours. Even after removal of the clot, death may ensue from laceration of the brain or hæmorrhage at the base.

Treatment.—Immediate operation is imperatively called for.

When a wound already exists, it is enlarged as far as is necessary to secure the bleeding vessel and to remove all clots. When there is no external wound, the point at which the skull is to be opened is determined by the symptoms. If the symptoms fail to indicate which branch of the artery is torn, an opening should first be made over the anterior inferior angle of the parietal bone (Fig. 2, A), and if nothing is found there, a second opening is made over the parietal bone a little above and behind the external ear. Should no blood be found outside the dura, this membrane should be incised, as there may be a clot inside it.

Sometimes there is considerable difficulty in securing the

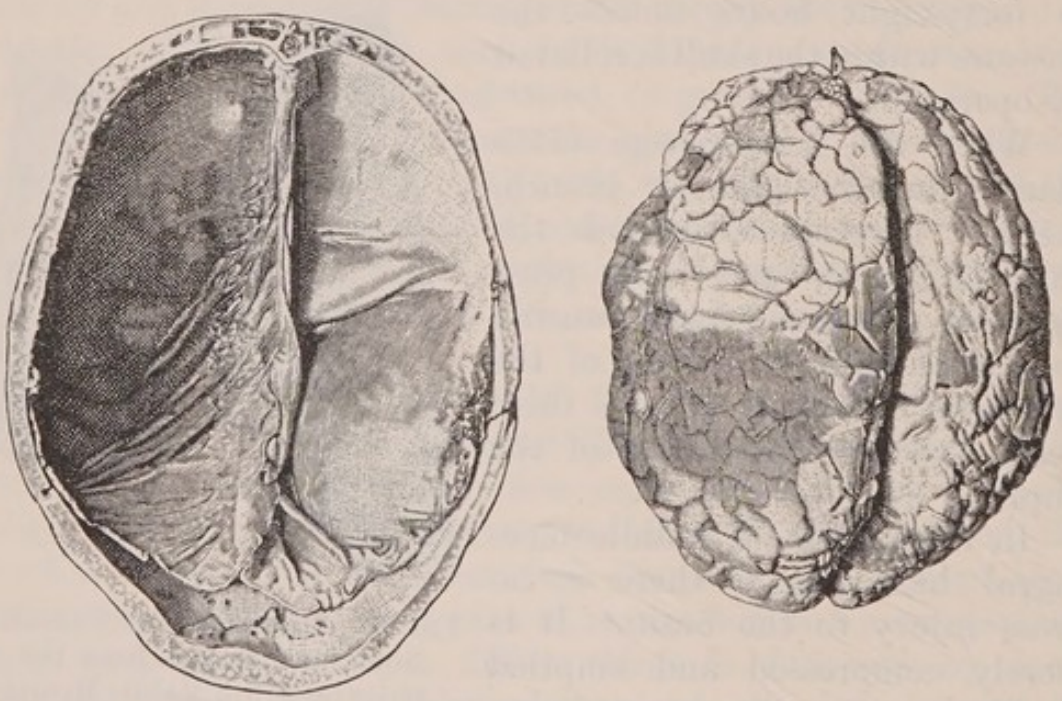

FIG. 6.—Extra-dural Clot resulting from hæmorrhage from posterior branch of left Middle Meningeal Artery. Note fissured fracture of skull and depression on surface of brain caused by clot.

bleeding vessel, and the hæmorrhage may assume serious proportions. It may be necessary to enlarge the trephine opening downwards with rongeur forceps to enable a ligature to be passed round the vessel. In some cases the artery runs in a canal in the bone, and the bleeding can only be arrested by inserting a small wooden peg into the opening, or by plugging it with antiseptic wax. It has even been found necessary to ligature the external carotid artery.

Injury to the **internal carotid** artery within the skull may result from penetrating wounds, or may be associated with a fracture of the base. It is almost invariably fatal. In some cases a communication is established between the artery and the cavernous sinus, and an arterio-venous aneurysm is thus

produced. Ligature of the internal carotid in the neck or of the common carotid is the only feasible treatment.

Injuries of the **venous sinuses** sometimes result from fractures of the skull and from penetrating wounds. The lateral, superior longitudinal, and cavernous sinuses are those most frequently damaged. On account of the low pressure in the sinuses, spontaneous arrest of the hæmorrhage usually takes place, and recovery ensues. In some cases, however, symptoms simulating those of meningeal hæmorrhage develop. If the dura mater is torn, the blood passes into the sub-arachnoid space and may spread over the whole surface of the brain. In the presence of an open wound, the venous source of the bleeding is recognised by the dark colour of the blood and the continuous character of the stream. It is readily arrested by pressure with gauze pads. A small puncture in the outer wall of the sinus may be closed with sutures. Signs of increasing compression call for trephining.

Cerebral Œdema.—After severe injuries to the head, as well as in inflammatory conditions, it is not uncommon for a diffuse œdematous infiltration of the brain substance or of the arachno-pial membrane to take place in the vicinity of the injured portion of brain. This serous exudation, on account of the natural adhesions of the arachno-pia, usually remains limited to the damaged area, but it may become general. In the former case, in addition to the symptoms of increased intra-cranial tension, there are focal symptoms varying with the site of the lesion. When situated over the motor area, the symptoms may simulate those of middle meningeal hæmorrhage, from which it is only diagnosed with difficulty. The main points of difference are, that in œdema the unconsciousness and coma are less marked and are not steadily progressive, headache is very severe, and on percussion over the head there is marked tenderness, which may be elicited even after the patient has ceased to answer questions or to take notice of his surroundings. The tenderness may extend down over the cervical spine. The knee jerks are usually diminished or absent. The condition is most common in children, and, as it tends to spontaneous cure, operation is seldom called for.

Wounds of the Brain.—*Incised* wounds of the brain usually result from sabre-cuts, and are met with chiefly in military practice. A portion of the scalp and cranium may be raised along with a slice of brain matter, and in some cases the whole flap is severed. The extent of the injury, the conditions under which it is received, and the occurrence of septic infection, render such wounds extremely dangerous.

Punctured wounds may be inflicted on the vault by stabs with a knife or dagger, or by the sharp spikes of a railing. More frequently a pointed instrument, such as a fencing foil, the end of an umbrella, or a knitting needle, is thrust through the orbit into the base of the brain. Occasionally the base of the skull has been perforated through the back wall of the pharynx, for example, by the stem of a tobacco-pipe. All such wounds are of necessity compound, and, as the point of the instrument is very liable to break off and remain inside the skull, the risk of septic infection is considerable. The septic complications of such injuries are described later.

Bullet wounds have many features in common with punctured wounds. There is more contusion of the brain substance, disintegrated brain matter is usually found in the wound of entrance of the bullet, and the bullet often carries in with it pieces of bone, cloth, or wad, thus adding to the risk of septic infection.

In a number of cases, aseptic foreign bodies, especially bullets, remain embedded in the brain without producing symptoms.

The *treatment* of punctured wounds consists in opening up the wound, removing any foreign body which may be in it, purifying its track, and establishing drainage.

After-effects of Head Injuries.—Various after-effects may follow on injuries of the head. Thus, for example, *chronic interstitial changes* (sclerosis) may spread from an area of cicatrisation in the brain and cause gradually increasing functional disturbance; or *cerebral softening* may ensue, either in the form of pale areas of necrosis (white softening) or of hæmorrhagic patches (red softening). The symptoms vary with the area implicated. *Adhesions* between the brain and its membranes may produce attacks of vertigo and pain, especially on the patient making sudden movements.

Traumatic epilepsy is a comparatively common sequel of such injuries as cause the symptoms of concussion or compression. The disease is due to some circumscribed cortical lesion, such as a spicule of bone driven into the cortex, the presence of adhesions between the membranes and the brain, or of a hæmorrhagic cyst in the membranes or cerebral tissue. Cicatrices in the brain tissue leading to sclerosis have also caused Jacksonian epilepsy. The *rôle* of cicatrices in the scalp in the production of traumatic epilepsy is more than doubtful.

The convulsive attacks are of the Jacksonian type, beginning in one particular group of muscles and spreading thence to neighbouring groups till the whole body is affected. The disease

may manifest itself soon after the injury, for example, when the cause is a fragment of bone irritating the cortex. In other cases it may be several years before the symptoms appear. The onset is usually sudden, and the "signal symptom," for example, jerking of the thumb, conjugate deviation of the eyes, or motor aphasia, indicates the seat of the lesion. At first the attacks only recur at intervals of, it may be, weeks or months, but as time goes on they become more and more frequent, until there may be as many as forty or fifty in a day. Sometimes the patient loses consciousness during the fit; sometimes he remains partly conscious. As the disease progresses, certain groups of muscles may become paralysed and the patient may pass into a state of idiocy. Finally he passes into what is known as the "status epilepticus," in which the fits succeed one another without remission, the breathing becomes stertorous, the temperature rises, the pulse becomes very rapid, coma supervenes, and the patient dies.

Treatment.—The administration of bromides is only palliative. Operation is indicated in all cases in which the "signal symptom" indicates a limited and accessible portion of the brain as the seat of the lesion, and also in cases where there is a depression of the skull or other definite evidence of cranial injury. The more recent the injury the better is the prospect, as secondary changes are less likely to have taken place, and the peculiarly irritable state of the brain—sometimes referred to as the "epileptic habit"—has not developed. The operation consists in trephining the skull, and removing the irritant—depressed bone, thickened and adherent membranes, a cyst, or sclerosed patch of cortex. The point at which the skull is opened is determined by the seat of the injury and the focal brain symptoms. After exposure of the brain, stimulation of the cortex by electricity has been employed as a means of recognising the diseased area. The clinical value of this procedure, however, is very slight. To prevent adhesions forming afresh, some surgeons insert plates of gold or silver between the brain and the overlying parts. Kocher has pointed out that it is not advisable to replace the bone after operating for Jacksonian epilepsy. After operation the patient must abstain from work, especially manual labour, for several years.

The return of fits within a few days of the operation does not necessarily mean failure, as they often pass off again. Complete and permanent cure is not common, but the number and severity of the attacks are usually so far diminished that the patient's life is bearable. The prognosis is less favourable in alcoholic subjects.

Operation has also proved beneficial in some cases of Jacksonian epilepsy in which there was no history of injury.

Traumatic insanity may follow brain injuries, either immediately or after an interval. It may or may not be associated with epilepsy. Any form of insanity, except perhaps general paralysis of the insane, may occur. Cases occurring within a few days of the injury usually recover within a month or two. The later the condition is in developing, the worse is the prognosis. Surgical treatment by trephining has not been conspicuously successful.

After severe head injuries the patient's whole mental attitude is sometimes changed, so that he becomes irritable, unstable, and incapacitated for brain work. In some cases self-control is lost, and alcoholic and drug habits are developed.

Meningitis, sinus thrombosis, and cerebral abscess may follow upon any form of head injury. The clinical features—save for the history of a traumatism—correspond so closely with those of the same conditions occurring apart from injury, that they are considered together.

CHAPTER III.

INJURIES OF THE SKULL.

Contusions—Fractures—Of the vault: *Varieties*—Of the Base: *Anterior fossa—Middle fossa—Posterior fossa.*

The bones of the skull may be contused or fractured. These injuries are not in themselves serious: their clinical importance is derived from the involvement of the brain, by which they are liable to be complicated.

Contusion of the bones of the skull may result from falls, blows, or gunshot injuries. In the vast majority of cases the damage to soft parts—scalp or brain—overshadows the osseous lesion, which of itself is comparatively unimportant.

FRACTURES OF THE SKULL.

While it is convenient to consider separately fractures of the vault and fractures of the base of the skull, it is to be borne in mind that it is not uncommon for a fracture to involve both the vault and the base. Fractures in either situation may be produced by direct or by indirect violence, and may be simple or compound.

Fractures of the Vault.

Mechanism.—When the skull is fractured by *direct* violence, the break takes place at the seat of impact, and its extent varies with the nature of the impinging object, and the degree of violence employed. If, for example, a pointed instrument, such as a bayonet, a foil, or a spike, is forcibly driven against the skull, the weapon simply crashes through the bone, disintegrating it at the point of entrance, and cracking or splintering it for a

variable, but limited, distance beyond. On the other hand, when the head is struck by a "blunt" object—for example, a batten falling from a height or a horse's hoof—the force is applied over a wider area and the elastic skull bends before it. If the limits of its elasticity be not exceeded, the bone recoils into its normal position when the force ceases to act. If, however, the bone is bent beyond the point from which it can recoil, a fracture takes place. The bone gives way over a wide area, the affected portion may be comminuted, and one or more of the fragments may remain depressed below the level of the rest of the bone. Cracks and fissures spread widely in different directions—frequently extending into the base of the skull. The brittle, inelastic character of the inner or "vitreous" table renders it less able to resist bending than the comparatively open and porous outer table. Hence it is that in almost all fractures of the vault the inner table splinters over a wider area than the outer. Von Bergmann reports thirty cases in which the inner table alone was fractured.

Fractures by *indirect* violence—that is, fractures in which the bone breaks at a point other than the seat of impact—are almost always due to violence inflicted with a blunt instrument, and acting over a wide area—such, for example, as a fall on the head. Much discussion has taken place as to the method of their production. It has been shown that when the skull is depressed at one point by a force impinging on it, it bulges at another, so that its whole contour is altered. But the elasticity of the bone varies at different parts of the skull, owing to differences in thickness and in structure. If therefore the part which is depressed—that is, the part directly struck—happens to be less elastic than the part which bulges, it gives way, and a fracture by direct violence results; but if the bulging part is the less elastic, a fracture by indirect violence or by "bursting" takes place. The term "fracture by *contre-coup*" has been incorrectly applied to such fractures when the area of bulging happens to be opposite to the seat of impact. *Contre-coup*, properly so-called, is only possible in a perfectly symmetrical body, which, of course, the skull is not.

Repair.—The repair of fractures of the skull is usually attended with an exceedingly small amount of callus, doubtless because there is practically no movement between the fragments. Except in the presence of sepsis, separated fragments live and become reunited. They may unite in such a manner as to project towards the brain and cause traumatic epilepsy. In comminuted fractures the lines of fracture remain permanently visible on the

bone, but fissured fractures may leave no trace. Gaps left in the skull by injury or operation are, after a time, filled in by a fibrous membrane, ossification takes place from the margin, but the aperture is seldom completely closed by bone.

The new bone which forms is derived from the dura mater and pericranium at the margins of the opening. The existence of permanent defects in the skull may cause the patient to become giddy when he stoops or exerts himself unduly, and may thus seriously interfere with his occupation.

Varieties.—For descriptive purposes fractures of the vault are divided into the fissured, the punctured, the depressed, and

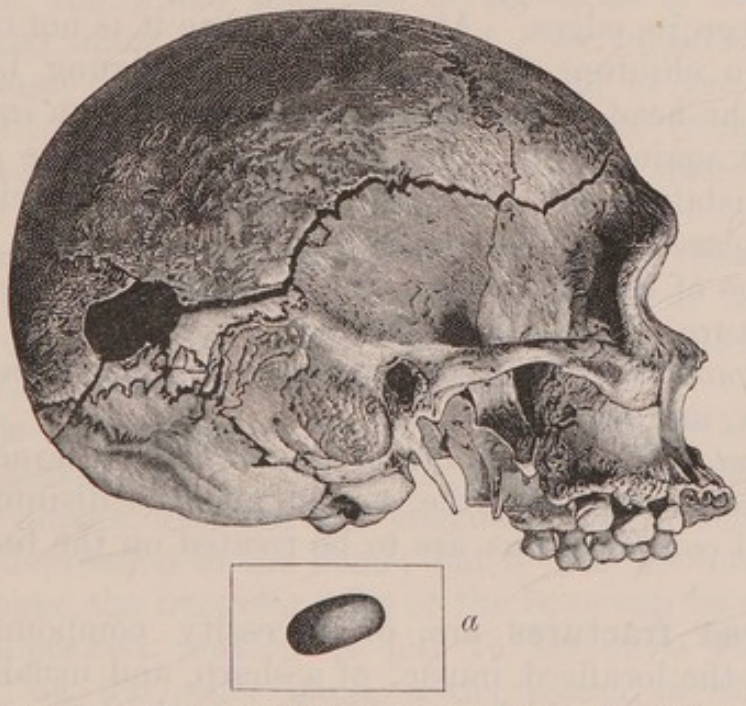

FIG. 7.—Fracture of Skull produced by an oval stone (*a*) fired from a gun. Note fissures radiating from point of entrance of missile.

the comminuted varieties. Clinically, however, these different varieties are often combined. The practical importance of a given fracture depends upon whether it is simple or compound, rather than upon the exact nature of the damage done to the bone. Compound fractures which open the dura mater are the most serious. Simple fractures result, as a rule, from diffuse forms of violence, and are liable to spread far beyond the seat of impact. Compound fractures result from severe and localised violence—for example, the kick of a horse or the blow of a hammer, and tend to be limited more or less to the seat of impact.

Fissured fractures generally result from blows by blunt objects or from falls, and they usually extend far beyond the area struck, in many cases passing into the base of the skull. The

fissure may pass through the bone vertically or obliquely, and it may implicate one or both tables. So long as the fracture is simple, it can scarcely be diagnosed except by inference from the associated symptoms of meningeal or cerebral injury. When compound, the crack in the bone can be seen and felt. It is recognised by the eye as a narrow split in the bone, filled with red blood, which, as often as it is sponged away, oozes again into the gap. Sometimes tufts of hair are caught between the edges of the fracture and add to the difficulty of purifying the wound.

Diagnosis.—A normal suture may be mistaken for a fissured fracture. A suture, however, may generally be recognised by its position, the irregularity of its margins, and the absence of blood between its edges. At the same time it is not uncommon, especially in children, for a suture to be sprung by violence applied to the head, or for a fissured fracture to run into a suture and leave it again. The edges of a clean cut in the periosteum may be mistaken for a fissure in the bone, especially when reliance is placed upon the probe for diagnosis. With the finger-nail the edge of the periosteum can be raised from the bone, and the true nature of the lesion revealed.

The *prognosis* depends upon associated meningeal hæmorrhage, brain injury, and septic infection.

Treatment.—Fissured fractures as such call for no active treatment. When compound, the wound must be disinfected; and intra-cranial complications are to be treated on the lines already described.

Punctured fractures are of necessity compound. They result from the localised impact of a sharp, and usually infected object, the point of which is not infrequently left either in the bone or inside the skull. Fragments of bone are often driven into the brain, and short fissures frequently pass in various directions from the central aperture.

Diagnosis.—When the instrument impinges on the head obliquely, after piercing the scalp it may pass for some distance under it before perforating the skull, so that on its withdrawal a valvular wound is left, and it appears at first sight that only the scalp is involved. Sometimes a foreign body left in the gap so fills it up that it is difficult to detect the fracture with a probe or even with the finger. In all doubtful cases the scalp wound should be sufficiently enlarged to exclude such fallacies.

The *prognosis* is always grave on account of the risks of septic infection of the brain and its membranes.

Treatment.—The scalp wound must be thoroughly purified, being opened up as far as is necessary for this purpose. In

almost every case the infected portion of bone should be removed to render possible the purification of the membranes and brain, and to permit of drainage.

Depressed and Comminuted Fractures.—As in practice these varieties almost always occur in combination, they are best considered together. The terms "indentation fracture," "gutter fracture," "pond fracture," have been applied to different forms of depressed fracture, according to the degree of damage to the bone and the disposition of the fragments.

These fractures may be simple or compound; non-penetrating or penetrating.

As a rule the whole thickness of the skull is broken, and, as usual, the inner table suffers most. In infants the bones may be merely indented, the fracture being of the greenstick variety. All degrees of severity are met with, from a simple, localised indentation of the bone, to complete smashing of the whole skull into fragments.

Diagnosis.—When compound, the nature of these fractures is readily recognised on exploring the wound, but their extent is not always easy to determine. It is not uncommon for extensive fissures to pass into the base.

A simple hæmatoma of the scalp may readily be mistaken for a depressed fracture. The condensation of the tissues round the seat of impact, and the soft coagulum in the centre closely simulate a depression in the bone; but if firm pressure be made with the finger, the irregular edge of the bone can be recognised, and the depressed portion is felt to be on a lower level. Sometimes, on the other hand, a depression in the bone is obscured by an overlying hæmatoma, and unless great care is taken the fracture may be overlooked.

Treatment.—All are agreed that compound depressed and comminuted fractures—whether associated with cerebral symptoms or not—should be operated on, to enable the wound to be purified, and the normal outline of the skull to be restored by elevating or removing depressed or separated fragments. Except in the case of young children, in whom considerable degrees of depression are frequently righted by nature within a very short period, most surgeons recommend operative interference even in simple fractures with the object of elevating the depressed bone, and to anticipate subsequent complications such as persistent headache, attacks of giddiness, traumatic epilepsy, or insanity. Others, including von Bergmann and Tillmanns, consider that the risk of such sequelæ ensuing is not sufficient to justify a prophylactic operation.

The operation consists in exposing the fractured area by enlarging the wound in cases of compound fracture, or by throwing down a horseshoe-shaped flap in cases where no wound exists. Fragments which are still connected with the pericranium or dura mater should be placed in position and left to unite; when entirely separated, they should, as a rule, be removed. There is often considerable difficulty in elevating the depressed fragments, and it is necessary to remove a portion of the intact bone by means of the trephine or Hey's saw to enable the elevator to be inserted under them. The raising of the fragments is sometimes followed by hæmorrhage from torn vessels of the dura which have been compressed by the depressed portions of bone.

Drainage of the wound is usually necessary, and sutures should be sparingly employed.

Fractures of the Base.—The base of the skull may be fractured by a pointed object, such as a fencing foil, a knitting-pin, or the end of an umbrella, being forced through the orbit, nasal cavities, or pharynx. These injuries will be referred to in describing fractures of the anterior fossa.

The majority of basal fractures result from such accidents as a fall from a height, the patient landing on the vertex or on the side of the head, or from a heavy object falling on the head. The violence is therefore indirect in so far as the bone breaks at a point other than the seat of impact.

In other cases the base is broken by the patient falling from a height and landing on his feet or buttocks, the force being transmitted through the spine to the occiput. Sometimes the condyle of the lower jaw is driven through the base of the skull by a blow or fall on the chin. It is usual to describe these also as fractures by indirect violence, but as the skull gives way at the point where it is struck, they are really fractures by direct violence.

In the consideration of the mode of production of basal fractures by indirect violence, the irregular shape of the cavity, the varying strength and thickness of its different parts, and the existence of the foramina through the bone are to be borne in mind. The force acting on the skull tends to increase one diameter of the cavity, and to diminish the opposite diameter. The resulting fracture, therefore, is due to bursting of the skull, and tends to take place at the part which has least elasticity—that is, at the base. It has been found that the site and direction of basal fractures bear a fairly constant relation to the direction of the force by which they are produced. When, for example, the

skull is compressed from side to side, the line of fracture through the base is usually transverse, and it may implicate one or both sides (Fig. 8). When the pressure is antero-posterior, on the other hand, the fracture tends to be longitudinal, and when oblique it tends to be diagonal.

When the force acts in a line from the occiput to the vertex, in a fall on the buttocks for example, the usual fracture is a more or less circular fissure around the foramen magnum. Von Bergmann, Bruns, and Messerer have done much to elucidate the mechanism of basal fractures.

Fractures of the base usually take the form of a single fissure, or series of fissures, which, as a rule, run through the foramina in their track. Small portions of bone are sometimes completely separated. It is very common for a fissure through the base to be continued for a considerable distance into the vault.

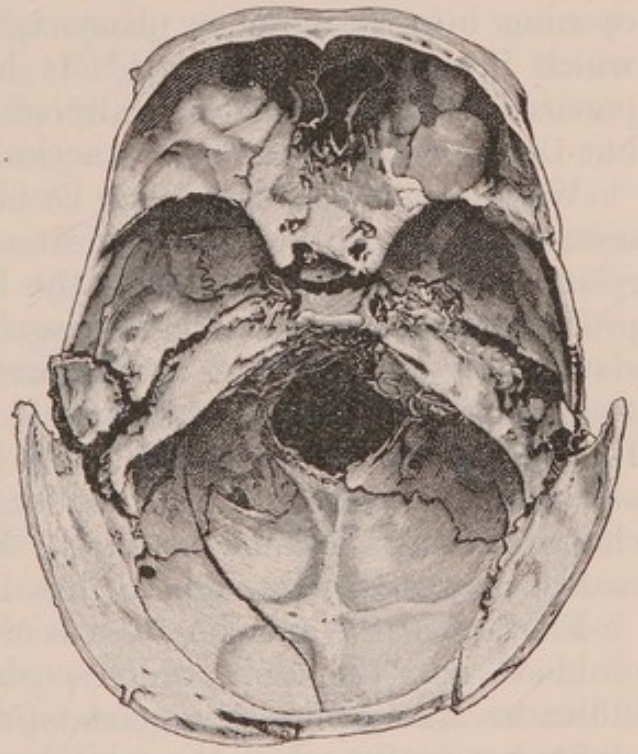

FIG. 8.—Transverse Fracture through Middle Fossa of Base of Skull, with fissures radiating into anterior and posterior fossæ.

The fracture may involve only one fossa, but as a rule fissures radiate into two or all of them (Fig. 8). Fractures of the anterior and middle fossæ are usually compound through opening into the pharynx, nose, or ear.

Basal fractures are very frequently associated with contusion and laceration of the brain, and also with injuries of one or other of the cranial nerves.

It must be admitted that in a large proportion of cases which end in recovery the diagnosis of fracture of the base is little more than a conjecture. The external evidence of damage to the bone is so slight and so liable to be fallacious that little reliance can be placed upon it. The associated cerebral and nervous symptoms also are only presumptive evidence of fracture of the bone. In all cases, however, in which there is reason to suspect that the base is fractured, the patient should be treated on this assumption. It is often found that, when there are no

cerebral symptoms present, it is very difficult to convince the patient of the necessity for undergoing treatment, and of the risk involved in his leaving his bed and resuming work.

Fracture of the anterior fossa may result from a blow on the forehead, nose, or face; or from a punctured wound of the orbit, nasal cavity, or pharynx. Often the injury is at first considered trivial, and it may be only when septic complications develop, in the form of meningitis or cerebral abscess, that its true nature is recognised. This fossa may also be implicated in fractures of the vault, fissures extending from the vertex to the base.

Clinical Features.—Unless the fracture is compound through opening into the nose or pharynx, there are few symptoms by which it may be recognised.* It has been observed that the percussion note is sometimes altered when the skull is fractured, but this sign is not of much practical value.

When compound, there may be bleeding from the pharynx or nose from tearing of the periosteum and mucous membrane related to the fracture. When the hæmorrhage is profuse, it is probable that the meningeal vessels or even the longitudinal sinus have been torn. Cerebro-spinal fluid may escape along with the blood, but it is seldom possible to recognise it. If long continued, the patient may be conscious of a persistent salt taste in the mouth, due to the large proportion of sodium chloride which the fluid contains. In very severe injuries brain matter may escape through the nose or mouth.

Fracture of the anterior fossa is often accompanied by effusion of blood into the orbit, which pushes forward the eyeball and infiltrates the conjunctiva (*subconjunctival ecchymosis*). This occurs especially when the orbital plate of the frontal bone is implicated. The blood which infiltrates the conjunctiva passes from behind forwards, appearing first at the outer angle of the eye and spreading like a fan towards the cornea. Later it spreads into the upper eyelid. When the orbital ridge is chipped off, without the cavity of the skull being opened into, the hæmorrhage shows at once both under the conjunctiva and in the upper lid. If the frontal sinus is opened, air may infiltrate the scalp.

The olfactory, optic, oculo-motor, pathetic, ophthalmic division of the trigeminal, and the abducens nerves are all liable to be implicated.

Diagnosis.—It is scarcely necessary to state that bleeding from the nose or mouth may occur after a blow on the face without the occurrence of a fracture of the skull. It is only

when long continued and profuse that the bleeding suggests a fracture. Similarly the effusions of blood in the region of the orbit may be due to a simple contusion of the soft parts ("black eye"), or to gravitation of blood from the forehead or temple. Subconjunctival ecchymosis also may occur independently of a fracture implicating the anterior fossa, for example in association with an ordinary black eye, or with fracture of the orbital ridge or of the malar bone.

Finally, paralysis of the cranial nerves may result from pressure of blood-clot, or from the nerves being torn without the skull being fractured.

Fracture of the middle fossa is usually the result of severe violence applied to the vault, as, for example, when a man falls over a window or is thrown from a horse and lands on his head. Less frequently it is produced by the patient falling from a height and landing on the feet or buttocks.

Clinical Features.—The most conclusive sign of fracture of the middle fossa is the escape of dark-coloured blood in a steady stream from the ear, followed by oozing of cerebro-spinal fluid. The bleeding from the ear may go on for days, the blood gradually becoming lighter in colour from admixture with cerebro-spinal fluid. Finally the blood ceases, but the clear fluid continues to drain away—sometimes for weeks. In our experience, the escape of cerebro-spinal fluid is much less common than is generally supposed. In most cases the tympanic membrane is ruptured. When it is intact, the blood and cerebro-spinal fluid may pass down the Eustachian tube into the pharynx. The escape of brain matter from the ear is exceedingly rare. Emphysema of the scalp may result if the fracture passes through the mastoid cells. The facial and auditory nerves and the second and third divisions of the trigeminal are frequently implicated.

Diagnosis.—Care must be taken not to mistake blood which has passed into the ear from a scalp wound, or which has its origin in a fracture of the wall of the external auditory meatus, or a laceration of the tympanic membrane, for blood escaping from a fracture of the base. Under such conditions the blood is usually bright red, is not accompanied by cerebro-spinal fluid, and the flow soon stops. It is on record[1] that blood and cerebro-spinal fluid may escape along the sheath of the auditory nerve without the bone being broken.

Fracture of the posterior fossa is produced by the same forms of violence as cause fracture of the middle fossa.

Clinical Features. — Sometimes a comparatively limited

[1] Miles, *Edinburgh Medical Journal*, 1895.

fracture of the occipital bone results, and in the course of a few days blood infiltrates the scalp in the region of the occiput and mastoid, or may pass down in the deeper planes of the neck. As a rule, however, there is no immediate external evidence of fracture. The patient is generally unconscious, and shows signs of injury to the pons and medulla, causing interference with respiration, which soon proves fatal. The rapidly fatal issue of these cases usually prevents the manifestation of any injury to the posterior cranial nerves.

Prognosis in Basal Fractures.—The prognosis depends almost entirely on the occurrence of intra-cranial complications. Many cases prove fatal within a few hours from the associated injury to the brain, the patient dying from cerebral compression due to hæmorrhage. It is possible that the free escape of blood from the nose or ear may in some cases prevent compression, and to a certain extent render the prognosis more favourable. Punctured fractures are very frequently fatal from septic complications—meningitis, sinus thrombosis, and cerebral abscess. These complications are also liable to occur in fractures rendered compound by opening into the nose, pharynx, or ear, but they are less common than might be expected.

The *repair* of basal fractures is attended with very little callus formation, probably because there is no movement between the fragments.

Treatment.—The general treatment includes that for all head injuries. In a few cases benefit has followed trephining for the relief of intra-cranial tension due to hæmorrhage.

Local treatment is directed towards preventing septic infection from the mucous surfaces implicated. This is exceedingly difficult in fractures opening into the pharynx and nose. Owing to the general condition of the patient it is usually impossible to employ nasal douching or mouth washes, but antiseptic sprays and atomisers may be employed with benefit. In fractures of the middle fossa the ear should be washed out, care being taken not to force the fluid through the fracture. The meatus is then plugged with iodoform gauze or antiseptic wool, retained in position by adhesive plaster or a bandage. When there is an escape of blood or cerebro-spinal fluid, the dressing requires to be changed very frequently.

CHAPTER IV.

DISEASES OF THE BRAIN AND MEMBRANES.

PYOGENIC DISEASES—Meningitis: *Varieties*—Encephalitis—Abscess: *Varieties*—Sinus phlebitis and thrombosis—Clinical manifestations of intra-cranial infection—Hernia cerebri. CEPHALOCELES—Meningocele—Encephalocele—Hydrencephalocele—Traumatic cephalhydrocele—Hydrocephalus: *Varieties*—Microcephalus. CEREBRAL TUMOURS. SURGICAL AFFECTIONS OF CRANIAL NERVES—Cervical sympathetic.

PYOGENIC DISEASES.[1]

THE diseases resulting from infection of the cranial contents by pyogenic bacteria are meningitis, encephalitis, cerebral abscess, and phlebitis of the large venous sinuses.

The organisms most frequently found in these conditions are the staphylococcus aureus and the streptococcus. It is not uncommon, however, to meet with mixed infections in which other bacteria are present—for example, the pneumococcus, the bacillus fœtidus, and the bacillus pyocyaneus.

By far the most common source of intra-cranial infection is chronic suppuration of the middle ear and mastoid antrum. The organisms may pass from these cavities to the interior of the skull directly through a perforation of the tegmen tympani or of the wall of the sigmoid groove, or they may be carried in the blood-stream by way of the emissary veins. Infection is believed to have travelled in some cases along the sheath of the facial and auditory nerves.

Among other sources of infection may be mentioned septic wounds of the scalp, infective diseases of the head and neck—such as, for example, erysipelas, anthrax, boils, and carbuncles—and septic conditions of the nasal cavity and its accessory air

[1] We desire here to acknowledge our indebtedness to Sir William Macewen's work on *Pyogenic Infective Diseases of the Brain and Spinal Cord*.

sinuses. Compound fractures of the skull, particularly punctured fractures, are liable to be followed by intra-cranial complications.

Pathology. **Meningitis.**—When an infective bone lesion is of a mild and slowly progressive character, and remains localised to a small portion of the skull, its effects may be limited to the outer surface of the overlying dura mater, which becomes inflamed and thickened (*localised external pachymeningitis*). The inflammatory process may slowly spread to the inner surface of the dura, and thence to the other membranes (*localised lepto-meningitis*), causing them to adhere to one another. So long as suppuration does not occur, these processes are of little clinical importance, being largely protective in their nature. If, on the other hand, the bacteria are of a virulent character, and are introduced in large numbers, the resulting inflammation is of a diffuse nature, and constitutes an *acute general lepto-meningitis*, which may be either serous or purulent.

In acute *serous* lepto-meningitis the fluid in the subarachnoid space and cavities of the ventricles is greatly increased in amount. Symptoms of compression ensue, and the disease may speedily prove fatal.

In acute *suppurative* lepto-meningitis the initial hyperæmia is quickly followed by the formation of pus, which, on account of the open structure of the arachno-pial membrane, readily finds its way into its utmost recesses. This condition is invariably fatal in from three to four days.

Encephalitis.—Infection of the brain tissue may take place either apart from, or, more frequently, along with inflammation of the membranes, and may result in purulent encephalitis or in necrosis of brain tissue. There is a copious exudation of serum and extravasation of leucocytes and red corpuscles into the brain tissue, producing a diffuse swelling of the affected area, and ending in pus formation—*purulent encephalitis.*

Necrosis of the cerebral tissue, resulting in the formation of sloughs, may take place from infective embolism or thrombosis of a large artery or vein, or from the intensity of the inflammation set up by virulent organisms.

Abscess.—Pus may form inside the skull either between the bone and the dura mater (extra-dural abscess); between the dura mater and the brain (sub-dural abscess); or in the brain tissue itself (cerebral and cerebellar abscess).

Extra-dural abscess usually occurs in association with chronic middle ear disease, and follows a localised suppurative pachymeningitis resulting from erosion of the tegmen tympani or of the sigmoid groove.

A sub-dural abscess is usually an extension of an extra-dural abscess, and the limitation of the suppuration is due to the adhesions which have resulted from a localised lepto-meningitis. The suppurative process often spreads and implicates the superficial layers of the overlying brain tissue.

Cerebral and Cerebellar Abscess.—The most common cause of abscess in the brain is chronic middle ear disease, and the majority of cerebral abscesses are therefore situated in the temporo-sphenoidal lobe. Some are due to the direct spread inwards of a sub-dural abscess formed in relation to an erosion of the tegmen tympani. In other cases the infection is carried by the blood-vessels, and in this way the infective material reaches the white matter. Less frequently infection from the middle ear takes place along the perivascular lymph spaces or by the lymphatics. Cerebral abscess is much more frequently met with in the white matter than in the cortex.

Cerebellar abscess is usually due to spread of infection from a septic thrombosis of the sigmoid sinus, either directly from a sub-dural abscess formed in relation to the walls of the sinus, or by extension of the thrombotic process along the cerebellar veins.

Perforating wounds and compound fractures of the skull may be followed by cerebral or cerebellar abscess. The abscess usually forms at the seat of the brain injury, but in some cases it is found at a considerable distance from it.

In the majority of cases the abscess is single. Pyæmic abscesses, however, are often multiple, and may occur both in the cerebrum and cerebellum.

The *pus* from a cerebral abscess is often of a greenish-yellow colour, or it may be dark brown from admixture with broken-down blood-clot. In some cases it is thin and serous and contains sloughs of brain matter. It has frequently an exceedingly fœtid odour. In quantity it varies from a few drops to several ounces.

The arachno-pia over an abscess usually has a turbid and milky appearance.

The *brain tissue* surrounding an acute abscess shows the appearances of acute purulent encephalitis. In a chronic abscess, on the other hand, it may become condensed, and by the growth and organisation of granulation tissue the pus may be encapsulated. In this condition the abscess may remain "latent" for many weeks or even months. At any time, however, it may again become active, or a fresh abscess may develop in the surrounding tissue.

After the evacuation of the abscess the resilient brain tissue at once fills up the gap, so that it is often difficult to retain or

even to introduce a drainage tube. Adhesions may form between the brain and the dura mater over the point at which an abscess is opened, and may subsequently give rise to Jacksonian epilepsy.

Sinus Phlebitis and Thrombosis. — The anatomical construction of the cerebral sinuses, and the conditions of the circulation in them, tend to retard the blood flow and so to favour coagulation.

Two forms of sinus thrombosis are met with—the marasmic and the bacterial. The bacterial form alone will be described here, as the marasmic form is of little surgical importance.

Bacterial phlebitis and thrombosis are due to the spread of organisms from a local focus of suppuration, and most commonly affect the lateral sinus. Any of the general sources of intra-cranial infection may be the starting-point of this condition, but by far the most frequent is middle ear suppuration.

The organisms may reach the sinus directly by continuity of tissue, as, for example, when the lateral sinus becomes infected from a focus of suppuration in the mastoid process, or they may reach it by the spread of thrombosis in a tributary vein, for example, when the longitudinal sinus is infected from an anthrax pustule of the lip which has caused thrombosis of the emissary vein which passes through the foramen cæcum.

The soft clot which forms adheres to the inflamed wall of the sinus, and, being infected with pyogenic bacteria, soon undergoes purulent disintegration.

The thrombotic process may spread backward along tributary vessels, and so give rise to cerebral or cerebellar abscess, or to purulent meningitis, or it may spread into the internal jugular vein and lead to the development of a diffuse purulent cellulitis along its course.

General pyæmic infection may take place by the pus or bacteria passing in the blood-stream, either directly or by reversed flow through tributary veins. The organisms may also spread through the vessel walls into neighbouring lymphatics. Septic emboli are liable to lodge in the lung or pleura and set up pulmonary abscess, gangrene of the lung, or empyema.

Clinical Manifestations of Intra-cranial Infection.

At the bedside there is often great difficulty in discriminating between the various diseases which result from pyogenic infection, partly because many of the symptoms presented by the patient are common to all the diseases of this group, but still more because the different conditions are not infre-

quently associated with one another in various combinations. Thus we may have a localised meningitis spreading to the brain and setting up a cerebral abscess; a sinus thrombosis giving rise to a purulent lepto-meningitis; or a cerebral abscess bursting into the subarachnoid space and producing meningitis. The symptoms of one condition blend with and obscure those of another, and thus lead to difficulties in diagnosis.

Clinical Features of Diffuse Septic Meningitis. — The earliest and most prominent symptom is violent pain in the head, often referred to the frontal region, or, in cases starting from middle ear disease, to the temporal region. When the membranes at the base are affected, retraction of the head and neck is common. The patient, especially if a child, is extremely irritable, all his sensations are hyperacute, and he periodically utters a peculiarly sharp, piercing cry.

Vomiting of the cerebral type — that is, unattended with nausea, and not related to the taking of food, or to gastric disturbances — is common, and persists all through the disease. The bowels are usually constipated. The pulse is small and rapid. The temperature rises early,—usually without an antecedent rigor—and remains persistently elevated (102° to 105° F.).

There may be erratic rigidity of the limbs, or clonic spasms. The third nerve is sometimes paralysed; the pupils are at first equally contracted, but later become dilated and fixed. There is often temporary squinting. The patient gradually becomes unconscious and dies within three or four days.

Treatment.—As a rule little can be done directly for the meningitis. The treatment consists in removing the source of infection when this is possible. For example, when the condition results from a sub-dural abscess which has formed in relation to a compound fracture, a septic sinus thrombosis, or an erosion of the tegmen tympani, attempts have been made by trephining to drain and purify the meningeal spaces, but without encouraging results.

Clinical Features of Cerebral Abscess.—The clinical course of a cerebral abscess has been described by Macewen as embracing three distinct stages: the initiatory stage, the stage of the fully-formed abscess, and the terminal stage.

The *initiatory stage*, which may last for from twelve hours to two or three days, rarely comes under the observation of the surgeon. He is usually able, however, to elicit a history of the presence of one or other of the sources of infection already mentioned, and in the great majority of cases this is chronic purulent middle ear disease.

The patient is somewhat suddenly seized with intense pain, located mainly in the ear and temporal region, but radiating in different directions through the head. He has a rigor, varying in intensity from a slight feeling of chilliness to a severe fit of shivering, and lasting from a few minutes to half an hour. In uncomplicated cases the shivering is not repeated. There is well-marked cutis anserina. During this stage attacks of cerebral vomiting are common. The temperature and pulse rate are somewhat higher than normal. The tongue is foul and coated. The patient may complain of pains in the limbs. Coincidently with the onset of these symptoms the discharge from the ear usually diminishes, or may even cease.

Second Stage—Fully-formed Abscess.—In the course of from one to three days the patient gradually passes into a stuporous condition, which at first bears a close resemblance to that of opium poisoning. The pain in the region of the ear becomes less intense, but the whole of the mastoid and temporal areas are tender on percussion as compared with the unaffected side. Although the patient is quite conscious, his cerebration is slow, he seems unable to sustain his attention for any length of time, and he answers questions "slowly, briefly, but, as a rule, correctly."

At the same time, while there is no actual paresis, there is a "gradual diminution of the ability to apply his strength."

The temperature falls, and as a rule becomes persistently subnormal. Rigors are unusual in this stage of the disease, their occurrence generally indicating the development of some complication, such as sinus phlebitis. The pulse is slow (40 to 60) and full. Further slowing indicates an increase in the size of the abscess. The respiration is slow and regular when the abscess is in the cerebrum, but it is often irregular and of the Cheyne-Stokes type in cases of cerebellar abscess.

The gastro-intestinal functions are disturbed, and there is anorexia, obstinate constipation, and occasionally vomiting—especially when the abscess is in the cerebellum. There may be retention of urine, and albuminuria.

The site of the lesion is usually indicated by localised paralysis. Convulsions are not common, and are of little diagnostic value. Optic neuritis is an inconstant and often misleading symptom. "The face is expressionless, passive, and cloudy. It may assume a meaningless smile with which the features are not lit: it is too mechanical" (Macewen).

The pressure symptoms bear no direct proportion to the size of the abscess: they depend more upon its site than upon its size.

In making a diagnosis, examination of the ear, as to the character and amount of discharge, and the condition of the membrana tympani and middle ear, must never be neglected.

Terminal Stage.—If left to itself, a cerebral abscess usually ends fatally by causing gradually increasing stupor and coma, or by bursting, either into the ventricles or into the subarachnoid space, and setting up a diffuse purulent lepto-meningitis.

Symptoms of Abscess bursting into the Ventricles.—When this happens, the patient suddenly becomes much worse, and dies within a few hours. "The pupils become widely dilated, the face livid, the respiration greatly hurried, and either shallow or stertorous. The temperature rises within a few hours with a bound from subnormal to 104° or 105° F.; the pulse from 40 or 50 per minute quickly reaches 120 and over. There are muscular twitchings all over the body, possibly associated with convulsions and tetanic seizures, and these are followed by coma and speedy death" (Macewen).

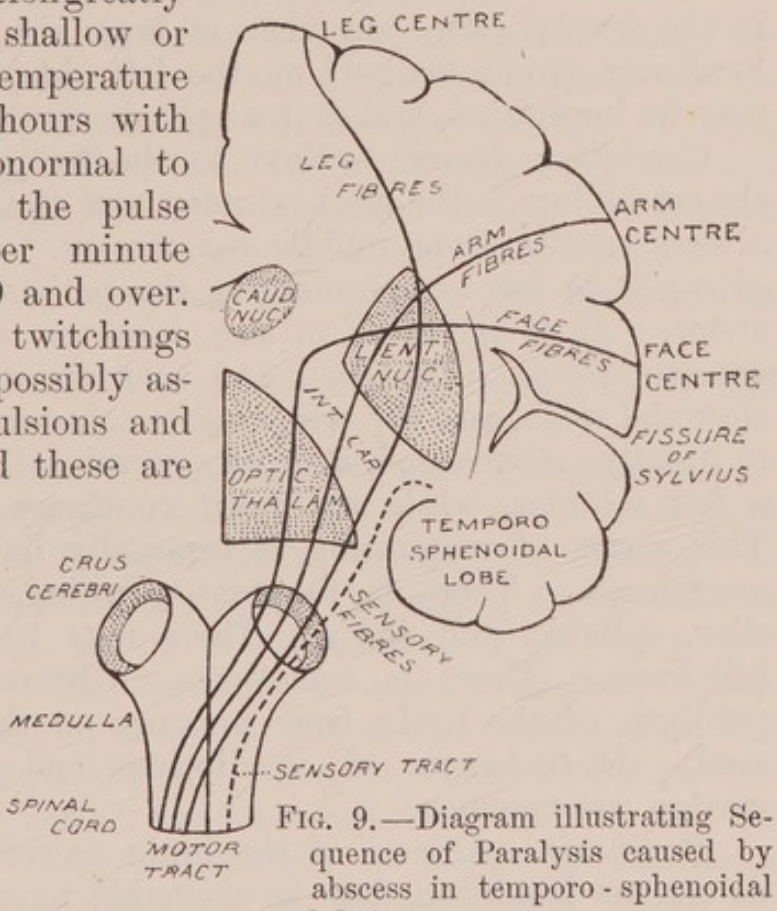

FIG. 9.—Diagram illustrating Sequence of Paralysis caused by abscess in temporo-sphenoidal lobe.

(After Macewen.)

Localisation of Cerebral Abscess.—The presence of a cerebral abscess having been established, the next question is to determine its situation.

Temporo-sphenoidal Abscess.—The existence of middle ear disease is always presumptive evidence that the abscess is in the temporo-sphenoidal lobe. Small abscesses in this lobe may produce no localising symptoms. Those of large size may press indirectly on the motor cortex, the fibres passing through the internal capsule, or on individual cranial nerves.

It is important to observe the order in which paralysis of the opposite side of the body comes on. When it begins in the face and passes successively to the arm and leg, the pressure is on the cortical centres. When the paralysis progresses in the

opposite direction—leg, arm, face—the pressure is on the nerve fibres passing through the internal capsule (Fig. 9).

Motor aphasia may result from pressure on the left inferior frontal convolution, while auditory aphasia may result from abscess in the posterior part of the first superior temporal convolution. Ptosis, external squint, with a fixed and dilated pupil, may indicate pressure on the third nerve of the same side.

Abscess in the *parietal lobe* is usually of traumatic origin, and gives rise to paralysis of the opposite side of the body. Abscess in the *occipital lobe* is almost always pyæmic in origin, and produces interference with the visual functions. An abscess in the *frontal lobe*, even when of large size, may give rise to no localising symptoms. If on the left side, Broca's convolution may be implicated, and motor aphasia result.

Cerebellar Abscess.—Next to the temporo-sphenoidal lobe, the cerebellum is the most common seat of abscess. This almost always results from middle ear disease. When small, it may give rise to few symptoms, and the patient may be able to go about. As it increases in size, however, the patient becomes exceedingly ill. The head and neck are retracted, the pulse is slow and weak, and the temperature subnormal. The respiration is greatly embarrassed, and may occasionally be interrupted for a few minutes, while the heart continues to beat vigorously. This arrest of respiration is especially liable to occur during anæsthesia. There is frequent yawning, and the speech is slow, syllabic, and jerky. There may be optic neuritis and blindness. There is sometimes unilateral or even bilateral paralysis of the limbs from pressure on the upper part of the cord. Disturbances of equilibrium and co-ordination, with vertigo, are common.

Prognosis.—Abscess of the brain or cerebellum is always a dangerous condition, but is amenable to surgical treatment if this is carried out early and thoroughly. Spontaneous evacuation of a temporo-sphenoidal abscess may take place through the middle ear. Less frequently a frontal abscess bursts through the cribriform plate. These abscesses, however, are much more likely to burst into the sub-dural space or ventricles and set up general meningitis, which proves fatal.

Treatment.—The abscess having been localised, the skull is trephined in the usual way, and the pus evacuated. Macewen recommends that for *temporo-sphenoidal abscess* the centre-pin of the trephine should be placed at a point in line with the posterior osseous wall of the external auditory meatus, three-quarters of an inch above the posterior root of the zygoma.

The dura is opened near the centre of the trephine circle. The brain is explored by means of a pair of sinus forceps, or a cannula with a blunt point and lateral apertures, passed downwards, inwards, and forwards towards the tegmen tympani. When pus is struck, the blades of the forceps are expanded to admit of its escape and to facilitate the withdrawal of the sloughs which are frequently present. The cavity may be very gently flushed with sterilised salt solution. As the resilient brain soon obliterates the cavity, it is seldom possible to retain a drainage-tube in position. Iodoform gauze is placed in the wound, and a dressing applied and changed daily.

For cerebellar abscess, in order to avoid the lateral sinus, the trephine is applied about an inch and a half behind and half an inch below the centre of the external auditory meatus. During operations on the cerebellum there is often a temporary cessation of respiration, although the heart continues to act. As soon as the skull is opened, the breathing is re-established. It is necessary, therefore, to carry out this part of the operation as rapidly as possible.

A *frontal abscess* may be reached either through the frontal bone or through the temple according to its situation.

Clinical Features of Sinus Phlebitis and Thrombosis.—It has already been pointed out that in a majority of cases sinus phlebitis occurs as a complication of middle ear disease. In all cases pain in the head, referred to the region of the affected sinus, and so severe as to prevent sleep, is an early and prominent feature. The patient is usually excited, hypersensitive, and irritable in the early stages, and becomes dull and even comatose towards the end. Rigors, followed by profuse perspiration, occur early, and increase in frequency as the disease progresses. The temperature is markedly remittent, varying from 103° to 106° F. The pulse is rapid, small, and thready. Loss of appetite, vomiting, and diarrhœa are almost constant symptoms.

Phlebitis and Thrombosis of Individual Sinuses.—The *superior longitudinal sinus* is liable to be infected from pathogenic lesions of the scalp. There are no symptoms which are pathognomonic, but œdema of the scalp with turgescence of its veins, epistaxis, and convulsions followed by paralysis are those most likely to be met with.

The *cavernous sinus* is usually implicated by spread of the process from other sinuses—for instance, from the petrosal or lateral sinuses—or from the ophthalmic veins in cases of orbital cellulitis. Although at first unilateral, the thrombosis usually

spreads across the middle line to the sinus of the opposite side. The special symptoms—exophthalmos, œdema of the eyelids, and paralysis of the ocular nerves—are due to pressure on the structures entering the orbit.

The *lateral or sigmoid sinus*, on account of its proximity to the middle ear and mastoid air cells, is that most commonly affected, especially in young adults. With the onset of the phlebitis the discharge from the ear stops. There is severe pain in the ear and violent headache. The temperature rises, but shows marked remissions, and rigors are common. Vomiting is frequently present. Turgescence of the scalp veins draining into this sinus, and œdema over the mastoid, are occasionally observed, but are of little diagnostic value, as they accompany various other conditions. Not infrequently thrombo-phlebitis spreads to the internal jugular vein, which may then be felt as a firm, tender cord running down the neck.

Three clinical types of sinus phlebitis are recognised—pulmonary, abdominal, and meningeal—but it is often impossible to relegate a particular case to one or other of these groups. Many cases present symptoms characteristic of more than one of the types.

In the *pulmonary type* evidence of septic infection of the lungs appears towards the end of the second week, in the form of dyspnœa, cough, and pain in the side, coarse, moist rales, and dark fœtid sputum. Death usually takes place from gangrene of the lung. The brain functions may remain active and acute to the end.

In the *abdominal type* the symptoms closely resemble those of typhoid fever, for which the condition may be mistaken. The absence of a rash and the co-existence of septic middle ear disease are important factors in diagnosis.

When the disease is of the *meningeal type*, symptoms of general purulent lepto-meningitis assert themselves, and soon come to dominate the clinical picture. The mind is at first clear, but the patient is irritable, and later becomes comatose.

The *prognosis* is always grave on account of the risk of general systemic infection.

Treatment.—The primary focus of infection must first be removed. This usually involves clearing out the middle ear and mastoid process. The sigmoid sinus is then exposed either by extending the opening in the mastoid region backwards, or by making a second opening about three-quarters of an inch behind the external auditory meatus. Granulation tissue and pus are frequently found occupying the sigmoid groove and

surrounding the sinus, and should be removed. If on palpation the sinus feels firm and tense, it is probably occupied by a disintegrating thrombus, and this should be removed by opening the vessel. To enable this to be done efficiently it is necessary to expose at least an inch of the sinus. The septic material having been removed, the cavity is purified and stuffed with iodoform gauze. Should hæmorrhage occur, it is readily controlled by the pressure of a pad of gauze.

With the object of preventing the dissemination of septic material, Horsley recommends that a ligature should be applied to the internal jugular vein in the neck before the sinus is opened.

If the phlebitis is accompanied by cerebral abscess or meningitis, these conditions are of course treated at the same time.

Operative interference is seldom feasible in phlebitis of the longitudinal or cavernous sinuses.

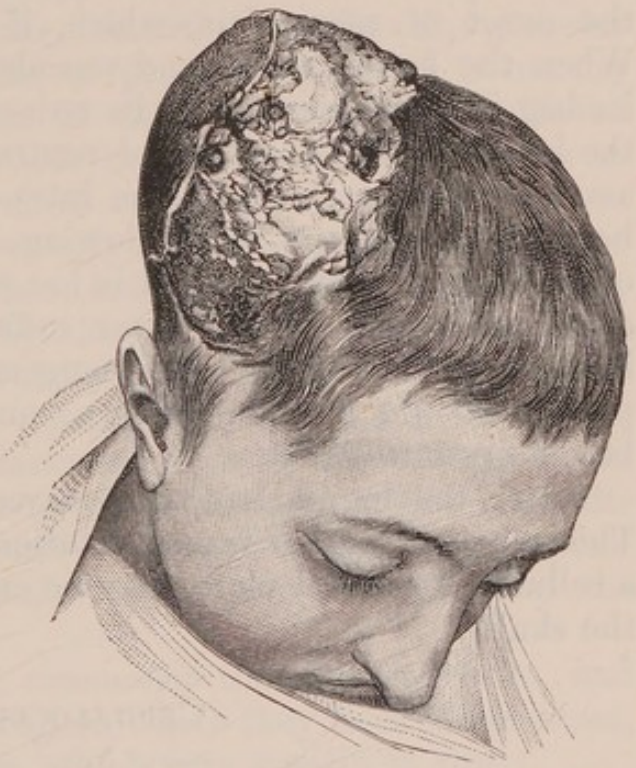

Fig. 10.—Hernia Cerebri after operation for cerebral abscess. The patient recovered.

(Mr. J. M. Cotterill's case.)

Hernia Cerebri.—This term is applied to a protrusion of brain substance through an acquired opening in the skull and dura mater. Such an opening may be the result of a compound fracture, a gunshot wound, or a surgical operation. The protrusion is essentially due to increased intra-cranial tension, which increased tension may result from the presence of a tumour within the cranium, or may be associated with septic infection of the brain and its membranes. Other things being equal, a hernia is more likely to occur through a small than through a large opening in the skull.

When the increased tension inside the skull is due to the growth of an irremovable tumour, much relief of pain and other pressure symptoms usually follows the development of a hernia cerebri. In such cases the removal of a large segment of bone to admit of the brain expanding is an operation which often affords great relief to the patient.

When the extruded portion of brain matter is small, it pulsates, but as it increases in size and is pressed upon by the edges of the opening through which it escapes, the pulsation ceases, and the herniated portion may become strangulated and slough.

In cases of compound fracture, and in other conditions associated with necrosis of bone, masses of redundant granulation tissue growing from the soft parts may simulate a hernia cerebri.

The *treatment* consists in removing, when possible, the cause of the increased intra-cranial tension. When this is of such a nature that it cannot be removed, steps must be taken to prevent the onset of meningitis, which, if it occur, is usually fatal. When the hernia is soft and vascular, the application of a small ice-bag is sometimes useful in reducing its size. Pressure over the hernia, with the object of returning it to the skull, is to be avoided, as this increases the intra-cranial tension, and induces headache, giddiness, and slowing of the pulse. When the original opening in the skull is too small to admit of the escape of an amount of brain matter sufficient to reduce the tension, it may be enlarged with rongeur forceps. The herniated portion should not be cut away unless it is sloughing, or has become pedunculated.

After the hernia has disappeared and the wound is aseptic, Thiersch-grafting, the transplantation of bone, or the insertion of a celluloid or metal plate, may be employed to cover the gap in the skull.

Cephaloceles.

The term cephalocele is applied to a protrusion of a portion of the cranial contents through a congenital deficiency in the bones of the skull. This malformation is believed to be due to an irregularity in development, whereby a portion of the primary cerebral vesicle remains outside the mesoblastic layer of the embryo. It is usually associated with adhesion of the membranes in the region of the fourth ventricle and with internal hydrocephalus. In many cases the condition is quite incompatible with life. Cephaloceles are covered by the scalp, and are most commonly met with in the occipital region and at the root of the nose; less frequently at the anterior inferior angle of the parietal bone, and in the line of the sagittal suture. Very rarely they occur at the base of the skull and project into the pharynx, the mouth, or the nose, where they are liable to be mistaken for polypi. Cephaloceles vary greatly in size, some

being so small as almost to escape detection, while others are larger than a child's head.

Several varieties are recognised. They are known as (1) *meningocele*, which consists of a protrusion of a cul-de-sac of the membranes containing cerebro-spinal fluid; (2) *encephalocele*, in which a portion of the brain is protruded in addition to the membranes; and (3) *hydrencephalocele*, in which the protruded brain includes a portion of one of the ventricles in its interior.

Clinical Features.—The *meningocele* is commonest in the occipital region, where it escapes through a cleft in the bone which extends from the foramen magnum to the occipital protuberance. It forms a tense, smooth, translucent, globular swelling, which may be sessile or pedunculated, and is usually covered by thin, smooth skin in which the vessels are dilated and nævoid. The tumour does not pulsate, but increases in size and tension when the child cries or coughs. It may be diminished in size or even entirely reduced by pressure, and so permit of the opening in the bone being felt. This manipulation, however, may be followed by slowing of the pulse, vomiting, loss of consciousness, or convulsions.

Small meningoceles may remain stationary for a long time, or may even undergo spontaneous cure. Those of larger size usually progress till they eventually burst, and death results from septic meningitis, or from the escape of the cerebro-spinal fluid. Septic infection may also occur from excoriation of the overlying skin or eczema.

Encephaloceles are much commoner than meningoceles, and usually occur in the frontal region, where they form broad-based, elastic, and pulsatile tumours, which vary greatly in size.

The *hydrencephalocele* is usually met with in the occipital region, and is generally so large and associated with such great cerebral deformity, as to be inconsistent with life. It does not as a rule pulsate.

Cephaloceles have to be diagnosed from dermoid cysts, nævi, cephal-hydrocele, and cephal-hæmatoma. Their recognition is seldom attended with difficulty. If the margins of the gap in the skull can be distinctly felt, the diagnosis is greatly simplified.

Treatment.—It is only small cephaloceles that are amenable to surgical treatment. Those which are large and contain brain substance are best left alone. They should, however, be protected from irritation and septic infection by soft antiseptic dressings.

When surgical interference is deemed advisable, it is best to expose the protrusion by reflecting a flap of the scalp, and, after

returning the contents, if this be possible, and isolating the neck of the sac, to ligature it, closing the membranes in such a way as to prevent leakage of the cerebro-spinal fluid. Sometimes it is necessary to remove the protruded brain matter, to enable the membranes to be closed. On the whole, while the immediate results of operation are satisfactory, the ultimate results are disappointing, as the essential cause of the intra-cranial pressure persists, and the symptoms are reproduced. The method of tapping the sac and injecting iodine has nothing to recommend it.

Traumatic Cephal-hydrocele.—Certain rare cases of simple fracture of the vault, occurring in early childhood, have been followed by the development of a localised fluid swelling in the scalp, which varies in size from time to time, and is partially reducible by pressure. In a majority of cases the swelling pulsates synchronously with the heart, and becomes tense on exertion. A distinct opening in the skull may sometimes be felt. The swelling results from laceration of the membranes, and sometimes of the brain-substance, so that the cerebro-spinal fluid of the subarachnoid space, or even of the lateral ventricle, escapes through the opening in the skull and bulges beneath the scalp. When associated, as it frequently is, with mental deficiency or the occurrence of fits, the cyst may be tapped or its neck ligatured (Hogarth Pringle). Otherwise it should be left alone.

Hydrocephalus.

An excess of cerebro-spinal fluid may collect in the arachnopial space surrounding the brain, or in the interior of the ventricles, constituting in the former case an *external*, and in the latter an *internal hydrocephalus*. Hydrocephalus may be acute or chronic.

Acute hydrocephalus is practically synonymous with tuberculous meningitis, but it may result from other forms of meningeal inflammation. The excess of fluid is found both in the arachnoidal space and in the ventricles. This condition only calls for mention here inasmuch as attempts have been made to treat it by surgical measures, such as Quincke's lumbar puncture, or drainage through the occipital fossa. The results, however, have not been encouraging.

Chronic Hydrocephalus.—*Chronic external hydrocephalus* is rare, and usually results from some definite brain lesion, such as meningitis, tumour, or cerebral atrophy. It is not amenable to surgical treatment.

Chronic internal hydrocephalus, on the other hand, is a comparatively common condition. It may be of congenital origin, or may develop in young rickety children, usually as a result of some chronic inflammatory process in the membranes at the base, the choroid plexuses, or the ependyma of the ventricles. The communication between the ventricles and the subarachnoid space, by way of the foramen of Magendie, becomes obstructed, so that the cerebro-spinal fluid accumulates in the ventricles and gradually distends them. The pressure causes the head to enlarge, the fontanelles to bulge, and the bones to be separated from one another, the intervals between the bones being occupied by a thin translucent membrane.

The cerebral tissue may be greatly thinned out, but the cerebellum and cranial nerves usually remain unaffected.

The appearance of the patient is very characteristic. The enormous dome of the skull surmounts a puny and preternaturally old face; the eyes are pushed downwards and forwards by the pressure on the orbital plates, and the eyebrows are displaced upwards. The head rolls helplessly from side to side, the child moans and cries a great deal, and vomiting is often a prominent symptom. In most cases the intelligence is defective, and epileptic seizures and other functional disturbances of the brain may be present.

In mild cases, especially when associated with rickets or syphilis, recovery sometimes takes place, but in the majority the condition progresses, and death results either from convulsions or from some intercurrent disease. Few hydrocephalic subjects reach adult life.

Treatment.—In all cases occurring in infants and young children antisyphilitic treatment should be tried. The rachitic element must also be treated.

Aseptic puncture of the ventricles is sometimes followed by a remarkable improvement in the symptoms, and may even result in apparent cure. A small trocar and cannula is introduced through the anterior fontanelle, to one or other side of the superior longitudinal sinus, and from a half to one ounce of cerebro-spinal fluid is withdrawn. This is repeated once a week for several weeks. Continuous drainage of the fourth ventricle through an opening made in the occipital region (Parkin); and the establishment of a communication between the ventricular and subarachnoid spaces (Watson-Cheyne), or between the subarachnoid space of the spinal cord and the peritoneal cavity, have been tried, with little more than temporary benefit, however, in the majority of cases.

Microcephalus.—On the erroneous supposition that this condition is due to premature closure of the cranial sutures and fontanelles, the removal of long strips, or of triangular or quadrilateral areas of bone from each side of the skull was suggested and practised by Lannelongue. Portions of the dura mater have also been removed. The operation has been abandoned, as the essential defect has been shown to be in the brain itself and not in the skull.

Cerebral Tumours.

As not more than ten per cent. of tumours of the brain—using the term tumour in its widest sense—are amenable to surgical treatment, it is only necessary here to refer to those aspects of this subject which have a distinctively surgical bearing.

Various forms of tumour occur in the brain, the most common varieties being tuberculous and syphilitic growths, gliomata and sarcomata. Less frequently fibromata, osteomata, and parasitic, hæmorrhagic, and other cysts are met with. The tumour may originate in the brain tissue primarily, or may spread thence from the dura mater or the skull.

Clinical Features.—The growth of a tumour in the brain inevitably results sooner or later in an increase in the intracranial tension, and to this the symptoms are chiefly due.

The earliest and most prominent of the *general symptoms* are severe, paroxysmal headache, optic neuritis, and vomiting which is without relation to the taking of food and is usually unattended by nausea. These symptoms are seldom absent, and are common to all forms of tumour, wherever situated. Vertigo, general convulsions, and signs of mental deterioration are also present in a considerable proportion of cases.

In addition, certain *localising symptoms* may be present. When the tumour is situated in the cortex of the Rolandic area, attacks of Jacksonian epilepsy, preceded by an aura which is usually referable to the centre primarily implicated, are common. The group of muscles first involved, and the order in which other groups become affected, are important localising factors. As the tumour increases in size, these irritative phenomena are replaced by paralyses, which are of even greater diagnostic value. The tactile and muscular sensations are also disturbed, and motor and sensory aphasia may be present. In some cases localised tenderness on percussing the skull may indicate the site of the tumour.

When the tumour is sub-cortical, that is in the centrum ovale, there are no Jacksonian spasms, the paralysis is more general, and sensation is lost. There is no special tenderness on percussion. It is not always possible, however, to distinguish between cortical and sub-cortical tumours, and in many cases both areas are invaded.

Tumours situated in the region of the internal capsule, and in the deeper parts of the brain, are not attended with Jacksonian symptoms, paralysis develops more rapidly than in cortical and sub-cortical tumours, and there is complete loss of sensation on the opposite side of the body. The cranial nerve trunks also are liable to be pressed upon.

As the tumour increases in size, all the symptoms become aggravated, the optic neuritis is followed by optic atrophy and blindness, the patient gradually becomes stuporous, and finally death results from coma. The severity of the symptoms depends to a large extent on the rapidity of growth of the tumour; thus an osteoma growing slowly from the inner table of the skull, and implicating the brain, may reach a considerable size without producing cerebral symptoms, while a comparatively small sarcoma or syphilitic gumma of rapid growth may endanger life. A sudden and serious aggravation of symptoms may result from hæmorrhage into a soft tumour, such as a glioma.

The *diagnosis* of the pathological nature of a cerebral tumour is generally "hardly more than a guess" (Gowers). At the same time it may be borne in mind that syphilitic tumours occur in adults, from forty to sixty years of age, who have suffered from acquired syphilis, and who may present other evidence of the disease. Severe nocturnal pain which interferes with sleep is often a prominent symptom. Syphilitic tumours are generally situated on the surface of the brain, and often originate in the dura mater. They tend to increase somewhat rapidly. Marked improvement in the symptoms usually follows the administration of iodides and mercury, but this is not invariably the case. Tuberculous tumours occur most frequently in children and adolescents, and other signs of tuberculosis are usually present. The cerebellum is a common seat of these tumours, and they are often multiple. Their growth may be rapid at first, and then become arrested for a time. Spasmodic growth of a tumour strongly suggests its tuberculous nature, and superadded signs of basal meningitis confirm the diagnosis.

The *prognosis* is grave in all forms of brain tumour. Even in syphilitic growths, although the more urgent symptoms may be ameliorated by the use of drugs, recurrence is very liable to

occur, and the structural changes induced in the cerebral tissue, and the contraction of the cicatrix which results, may permanently interfere with the functions of the brain, or may induce Jacksonian epilepsy. Tuberculous tumours also may become arrested, and may cease for a time to cause symptoms, but permanent cure is extremely rare. We have known a sarcoma to recur five years after removal. Death sometimes occurs suddenly from hæmorrhage, from acute œdema, or from implication of vital centres.

Treatment.—In all cases the administration of iodides in full doses is indicated, not only with a view to eliminating the possibility of the tumour being syphilitic, but because other forms of tumour, especially gliomata, frequently benefit temporarily by this treatment.

The question of removal by operation arises in cases where there is reason to believe that the tumour is situated near the surface of the brain, that it is of moderate size, and that it may be firm and encapsulated. Unfortunately it is only in a very small proportion (5 to 10 per cent.) of cases that these conditions are present and can be recognised by clinical examination. The skull is opened by reflecting a large osteo-cutaneous flap. If the tumour is in the cortex, it is shelled out. If it is sub-cortical, the cortex is incised and the tumour removed with the aid of a dissector or spoon.

In a certain proportion of cases, where there is no hope of removing the tumour, it is justifiable and even advisable to operate for the relief of tension. By making a large opening in the skull, and incising the dura, so as to allow the brain to bulge under the scalp, the agonising headache, the vomiting, and the optic neuritis and blindness may in many cases be materially alleviated. In some cases puncture of the ventricles may further relieve the tension.

Lumbar puncture frequently repeated has also been practised for the relief of tension in otherwise inoperable cases.

When surgical treatment is contra-indicated, all that can be done is to palliate the symptoms by bromides, opium, phenacetin, caffein, and other drugs.

Surgical Affections of the Cranial Nerves.

Irritation or paralysis of one or more of the cranial nerves may result from lesions implicating their centres or trunks. Paralysis is more common than irritation. The cerebral lesions with which nerve symptoms are most frequently associated are

hæmorrhage—traumatic or pathological—contusion or laceration of the cerebral tissue, meningitis, and new growths, more particularly syphilitic gummata. The nerve trunks may be contused or torn across, especially in basal fractures which cross their foramina of exit; or blood may be effused into their sheaths as a result of trauma apart from fracture. They may also be pressed upon by inflammatory effusions, tumours, gummata, or aneurysms invading the base of the skull.

When the nerve is merely contused or pressed upon by effused blood, the paralysis tends to pass off in the course of a few days. When it is torn across or compressed by new growths, the paralysis is permanent. In some traumatic cases paralysis only comes on a few days after the injury, and is then due either to gradually increasing pressure from blood-clot, or more probably to the onset of septic meningitis or of ascending neuritis.

The paralysis is on the same side as the lesion when the nerve is affected, and on the opposite side when the cortical centre is involved.

(*I.*) The *Olfactory Nerve* is liable to have its fibres ruptured as they pass through the cribriform plate, in fractures implicating the anterior fossa of the skull, in which case there results complete and permanent loss of smell (anosmia). Hæmorrhage into the nerve sheath or contusion of the nerve sometimes causes a transitory loss of smell. Tumours and meningitis in the anterior fossa also may implicate the olfactory nerve. In all cases of anosmia there is also impairment of the sense of taste.

(*II.*) *Optic Nerve.*—Temporary paralysis of one or both optic nerves is a comparatively common result of traumatic effusion of blood into their sheaths. The resulting blindness may pass off in a few days, or it may last for some weeks. When a large effusion takes place, the prolonged pressure on the nerve may result in optic atrophy and permanent blindness. Complete severance of the nerve by a bullet, the point of a sharp instrument, or a fragment of bone, also results in permanent loss of vision. The optic nerves may be paralysed from cellulitis of the orbit, intra-orbital tumours, gummata, and aneurysms in the region of the cavernous sinus.

Lesions implicating the central visual mechanism give rise to hemianopia—that is, loss of sight in the lateral halves of the fields of vision of both eyes—colour-blindness, subjective sensations of light and colour, and other eye symptoms.

Double optic neuritis, followed by optic atrophy, is one of the most constant effects of the growth of tumour within the skull, and is not uncommon in cases of cerebral abscess and meningitis.

(*III.*) *Oculo-motor Nerve.*—One or more of the branches of this nerve are liable to be compressed by extravasated blood, or contused and lacerated in fractures implicating the region of the sphenoidal fissure. Tumours and aneurysms growing in this region also press upon the nerve. Sometimes both nerves are implicated, for example, in fractures involving both sides of the anterior fossa, and in tumours, particularly gummata, growing in the region of the floor of the third ventricle. In lesions of the cerebral hemispheres the third nerve is very frequently paralysed. Its cortical centre lies in close proximity to the centre for the face.

The most prominent symptoms of complete paralysis are ptosis or drooping of the upper eyelid, external strabismus, and slight downward rotation of the eye. There is also dilatation of the pupil from paralysis of the circular fibres of the iris, and loss of accommodation from paralysis of the ciliary muscle.

Paralysis of the muscles supplied by the third nerve is frequently associated with paralysis of other ocular muscles. When all the muscles of the eye are paralysed, the condition is usually due to syphilitic disease in the floor of the third ventricle, and is known as "ophthalmoplegia externa."

(*IV.*) The *Patheticus Nerve*, which supplies the superior oblique muscle, may suffer in the same way as the third nerve. When it is paralysed there is defective movement of the eye downward and outward, and diplopia or double vision may be complained of when the patient looks downward.

(*V.*) *Trigeminal or Trifacial Nerve.*—The most important surgical affection of this nerve is "trigeminal neuralgia," which has already been described (vol. i. p. 334). One or other of the divisions of the nerve may be torn in fractures of the base of the skull, and give rise to anæsthesia in the area supplied by it. In fractures crossing the apex of the petrous portion of the temporal bone, the great and small superficial petrosal nerves may be ruptured, with the result that the soft palate and uvula are paralysed and there is difficulty in swallowing. There are also painful sensations in the ear. When the ophthalmic division is implicated, the conjunctiva is rendered insensitive, and conjunctivitis, which may be followed by ulceration of the cornea, results from exposure to dust and other foreign bodies, which, on account of the anæsthetic condition of the eye, are allowed to remain and cause irritation.

(*VI.*) *Abducens Nerve.*—This nerve, which supplies the external rectus muscle, has the longest course within the skull of any of the cranial nerves. In spite of this fact, it is com-

paratively seldom torn in basal fractures, but is prone to be pressed upon by tumours, gummata, or aneurysms in the region of the base of the skull. When it is paralysed, internal strabismus results.

(*VII.*) *Facial Nerve.*—Paralysis of this nerve, more or less complete, may result from lesions in its cortical centre, in the region of the internal capsule, in its course through the temporal bone, or in its course outside the skull.

Lesions of the *nerve trunk*, between its point of emergence from the brain and the stylo-mastoid foramen, are most frequently the result either of fractures implicating the middle fossa of the skull or of chronic suppuration of the middle ear.

In fractures passing across the petrous temporal, the nerve may be torn across at the time of the injury, or it may become pressed upon by callus later. Considering the frequency of these fractures this nerve is comparatively seldom damaged.

Suppurative disease of the middle ear is a much more common cause of facial paralysis. The nerve, as it traverses the aqueductus Fallopii, may be pressed upon by inflammatory effusions or granulations, or it may be destroyed by the suppurative process. It is particularly liable to be affected in young children, on account of the very thin osseous wall of the aqueduct. It may also be involved in tuberculous and in malignant disease of the middle ear. Not infrequently it has been injured in the course of operations on the mastoid and middle ear.

In complete unilateral *facial paralysis* (Bell's paralysis) the affected side of the face is expressionless and "mask-like." The cheek is flattened and smooth, all its folds and wrinkles being obliterated. When the patient speaks or smiles, the face is drawn to the sound side. The eye on the affected side cannot be closed, and on making the attempt the eyeball rolls upwards and outwards. The patient cannot wink, and the conjunctiva therefore becomes dry, and is irritated by exposure to cold and dust. The tears run over the cheek. There is inability to whistle or to puff out the cheeks, and food collects between the cheek and the gums from paralysis of the buccinator muscle. The orbicularis oris being paralysed also, the patient is unable to show his upper teeth, and the labial consonants are pronounced indistinctly. The sense of taste is often impaired.

Bilateral paralysis is liable to be overlooked owing to the symmetrical appearance of the face.

After it leaves the skull at the stylo-mastoid foramen, the facial nerve may be injured in operations on the parotid gland, in resection of the lower jaw, and in the removal of cervical

glands. Temporary paralysis may result from inflammatory conditions, such as parotitis, or from blows or pressure over the nerve, for example by the forceps in delivery. As the nerve breaks up into numerous branches soon after it leaves the stylo-mastoid foramen, the paralysis may affect one or more of the branches.

In *brain lesions*, such as hæmorrhage, tumour or abscess, the facial paralysis is less complete than when the nerve trunk itself is implicated. The paralysis affects the opposite side of the face, but does not as a rule involve the fibres supplying the orbicularis palpebrarum. The chorda tympani nerve also escapes, and the sense of taste is therefore retained.

Treatment.—In addition to removing the cause when this is possible, the paralysis may be treated by the administration of drugs, such as potassium iodide, strychnin, or iron, by the application of blisters, or by massage and electricity. These measures are most useful in cases due to blows or exposure to cold. When the nerve is accidentally divided in the course of an operation on the face, it should immediately be sutured. When this is impossible or fails, the function of the nerve may be restored by grafting its distal end on to the trunk of the hypoglossal or of the spinal accessory nerve.

Facial Spasm.—Clonic contraction of the facial muscles (histrionic spasm) occasionally results from irritative lesions in the cortex or pons. Sometimes all the muscles are involved, sometimes only one, for example the orbicularis palpebrarum (blepharospasm). This condition may be induced reflexly from irritation of the fifth nerve, notably of the branches which supply the nasal cavities and the teeth.

The *treatment* consists in administering nerve tonics, bromides and other drugs, and in the employment of massage. The facial nerve has been stretched with benefit, sometimes at the stylo-mastoid foramen, sometimes on the face. Any source of peripheral irritation must be removed.

(*VIII.*) *Auditory Nerve.*—The auditory nerve is liable to be damaged along with the facial in fractures which traverse the internal auditory meatus. Both nerves also may be torn across just before they enter the meatus in severe brain injuries apart from fracture. Complete and permanent deafness results. Effusion of blood into the nerve sheath, or into the internal or middle ear, causes transitory deafness, and the patient suffers from noises in the ear, giddiness, and interference with equilibration.

(*IX.*) The *Glosso-pharyngeal Nerve* is comparatively seldom

injured. When it is compressed by a tumour, for example in the region of the medulla, there is interference with speech and deglutition, the tongue becomes ulcerated, and œdema of the glottis may supervene and prove fatal.

(*X.*) The *Pneumogastric or Vagus Nerve* is seldom injured within the cranial cavity.

In the neck it is liable to be divided or ligatured in the course of operations for the removal of malignant or tuberculous glands, for goitre, or for ligation of the common carotid. Division of the nerve on one side is not as a rule followed by any change in the pulse or respiration. If it is irritated, however, for example by being grasped with artery forceps, there is inhibition of the heart, and if it is accidentally ligatured, there is persistent vomiting.

Division of the recurrent laryngeal branch on one side results in paralysis of the corresponding posterior crico-arytenoid muscle —the muscle which opens the glottis. This condition is known as unilateral abductor paralysis, and is accompanied by interference with inspiration and phonation. If both nerves are divided, bilateral abductor paralysis results. The vocal cords flap together, producing a crowing sound on inspiration, and the breathing is greatly embarrassed. Tracheotomy is necessary to prevent asphyxia.

The vagus and recurrent laryngeal nerves have been successfully sutured after having been divided accidentally.

(*XI.*) *Spinal Accessory Nerve.*—This nerve is seldom damaged within the skull. It supplies the sterno-mastoid and trapezius, but as these muscles usually have an additional nerve supply from the cervical plexus, the spinal accessory may be divided, or a considerable portion of it resected, without any serious disablement resulting. This is seen in cases where the nerve has been divided or resected for the cure of spasmodic torticollis. When the spinal accessory is the only source of supply to these muscles, its division is followed by considerable disablement, which appears to depend chiefly on the paralysis of the trapezius. It is liable to be accidentally divided in excising malignant or tuberculous glands from the neck, and the sterno-mastoid or the trapezius, or both, are thus liable to be paralysed. The head is inclined slightly forward, the shoulder is depressed, the arm hangs heavily by the side and is slightly rotated forward, the scapula is drawn away from the spine and rotated on its horizontal axis, and there is slight scoliosis with the concavity towards the affected side. The trapezius is markedly wasted, and is, therefore, less prominent in the neck than normal, and

the movements of the arm and shoulder are impaired, especially in making overhead movements.

When divided accidentally, the nerve should be immediately sutured. Even in cases where the paralysis has lasted for some time, secondary suture should be attempted. Massage, electricity, and the administration of tonics are also indicated.

(*XII.*) *Hypoglossal Nerve.*—This nerve has been ruptured in fractures passing through the anterior condylar foramen. It is also liable to be divided in wounds of the submaxillary region—for example, in cut throat, or during the operation for ligation of the lingual artery, or the removal of glands.

The paralysed half of the tongue undergoes atrophy. When the tongue is protruded, it deviates towards the paralysed side, being pushed over by the active muscles of the opposite side.

The Cervical Sympathetic.—The cervical sympathetic cord and its ganglia may be injured in the neck from stabs or gun-shot wounds, or in the course of deep dissections in the neck. Symptoms referable to the lower part of the cervical cord frequently complicate lesions of the brachial plexus.

Paralysis of the cervical sympathetic is characterised by diminution in the size of the pupil on the affected side. The pupil does not dilate when shaded, nor when the skin of the neck is pinched—"loss of the cilio-spinal reflex." The palpebral fissure is smaller than its fellow, and the eyeball sinks into the orbit. There is anidrosis or loss of sweating on the side of the face, neck, and upper part of the thorax, and on the whole upper extremity of the affected side.

The sympathetic cord in the neck has been resected along with its ganglia for such varied conditions as exophthalmic goitre, epilepsy, trigeminal neuralgia, and glaucoma.

The operation is performed through an incision carried along the posterior border of the sterno-mastoid. This muscle is pulled forward, the carotid sheath inwards, and the sympathetic cord is exposed lying on the front of the transverse processes of the cervical vertebræ. It is only a few years since Jonnesco, Jaboulay, and Gerard-Marchant first carried out these operations, and their real value is as yet undetermined. So far the results have on the whole been satisfactory.

CHAPTER V.

DISEASES OF THE CRANIAL BONES.

Acute periostitis and osteo-myelitis—Tuberculosis—Syphilis—Tumours.

Suppurative Periostitis and Osteo-myelitis.—These conditions are usually secondary to wounds, burns, or ulcers of the scalp, or to fractures which have become infected with pyogenic bacteria. Sometimes they follow suppuration in the middle ear and mastoid process. They are occasionally associated with acute cellulitis of the scalp. In some cases suppuration occurs on both aspects of the bone—a point of importance in treatment.

The disease is usually ushered in by a rigor, which is soon followed by the other signs of suppurative inflammation—high temperature, pain and tenderness, and the formation of a fluctuating swelling in relation to the bone, with œdema of the overlying scalp. This œdema of the scalp—usually spoken of as *Pott's puffy tumour*—is of great value as indicating the extent of the disease in the bone, and of the suppuration between it and the dura. An incision gives exit to a quantity of pus, and exposes an area of bare bone. If the incision be made early, this bone may soon become covered by granulations and recover its vitality; but if the operation be delayed, it usually undergoes necrosis. The sequestrum which forms includes, as a rule, only the outer table, but in some cases the whole thickness of the bone undergoes necrosis. In either case the separation of the sequestrum is an exceedingly slow process, and is not accompanied by the formation of new bone. When the whole thickness of the skull is lost, the deficiency of bone is usually permanent. The gap becomes filled in by a dense fibrous membrane which is adherent to the dura mater.

Serious complications, in the form of septic meningitis, encephalitis, sinus thrombosis, and general pyæmia, are liable to develop at any time during the progress of the disease.

Treatment.—Early, free, and if necessary, multiple incisions

are indicated. Scalp wounds or compound fractures must be thoroughly purified, and efficient drainage established.

Time may be saved by hastening the separation of a sequestrum with the aid of an elevator or sharp spoon, or by chiselling away the dead part till healthy vascular bone is reached. It is sometimes advisable to perform an osteo-plastic operation for the closure of the gap. This may be done by raising from an adjacent part of the skull a flap containing scalp, periosteum, and the outer table, and transplanting this flap into the gap. Bone has also been transplanted from the lower animals. Plates of calcined bone, celluloid, silver, and other materials, have also been employed. When a permanent gap is left in the bone, the patient should wear a leather or metal shield over it to protect the brain from injury. Acute suppurative osteomyelitis, the result of infection through the blood-stream, is described with diseases of bone.

Tuberculosis of the bones of the cranial vault sometimes occurs as a primary disease in children.

Clinically it appears as a soft, circumscribed, tender swelling —a cold abscess—which slowly reaches the surface. When the skin gives way characteristic tuberculous pus escapes through one or more sinuses. On the soft parts being reflected a circular area of necrosed bone, surrounded by granulation tissue, is exposed. This circular portion is separated as a sequestrum which usually includes the whole thickness of the skull, and it is not uncommon to find a sinus leading through the bone to a collection of tuberculous debris between the skull and the dura mater.

The abscess should be laid freely open, all tuberculous granulations scraped away, and the sequestrum removed, with the aid of the chisel if it has not already become loose. After healing is completed a depression or gap in the bone remains for a long time.

Syphilis.—Syphilitic affections usually implicate the frontal and parietal bones, and occur during the tertiary period of the disease.

The process generally begins in the periosteum, either in the form of multiple circumscribed gummata, which are flat, elastic and painless, or as a diffuse gummatous periostitis. The disease always runs a slow course, and is sooner or later complicated by the gumma breaking through the skin. Sinuses form, and septic infection usually takes place and leads to necrosis of the affected portion of bone. The sequestrum is very slowly separated.

If anti-syphilitic treatment be adopted early, the prognosis is

good, but when the condition has become complicated by septic infection, and the carious process has become established over a wide area, it usually progresses in spite of treatment, and large portions of the skull may be destroyed.

When the disease has erupted on the surface, local treatment is carried out on the same lines as for tuberculous disease, and it may be necessary to remove the sequestrum by operation.

Tumours.—The innocent tumours met with in the bones of the skull—chondroma and osteoma—have been described with diseases of bone.

Sarcoma.—All forms of sarcoma are met with in the skull. They may originate in the pericranium, in the diploë, or in the dura mater.

The tumour grows chiefly towards the surface, but it also tends to involve the dura mater and to invade the cranial cavity. The tumour may thus assume the shape of a dumb-bell. Its growth is usually rapid, and the scalp is soon invaded by a diffuse soft swelling, which sometimes pulsates, and which sooner or later fungates through the skin. On account of this rapid growth the tumour is liable to be mistaken for an abscess, and if it be opened, it is found that the finger passes through a softened area in the bone.

When the cranial cavity is encroached upon, signs of compression may ensue. After the tumour has fungated, septic complications within the skull are liable to develop. In all cases the prognosis is extremely unfavourable.

If diagnosed sufficiently early, an attempt may be made to remove the tumour by means of the chisel or the Gigli saw, but very often the operation has to be abandoned.

The bones of the skull may become the seat of secondary tumours, by the direct spread of cancer from the soft parts, or by metastasis of cancer or sarcoma from distant parts of the body.

CHAPTER VI.

THE SPINE AND CORD.

Surgical anatomy—Operation of laminectomy—Injuries of the spinal cord: *Concussion; "Railway spine"; Traumatic hæmatorrachis; Traumatic hæmatomyelia; Total transverse lesions at different levels; Partial lesions*—Injuries of the spinal column: *Sprains; Isolated dislocations of articular processes; Isolated fractures of arches and spinous processes; Compression fracture of bodies*—Traumatic spondylitis — Fracture - dislocations — Penetrating wounds.

Surgical Anatomy.—The spinal column is the central axis of the skeleton, and, in addition to connecting the different parts of the body to one another, it supports the head, furnishes a point of attachment for the ribs, and affords a protecting casement for the spinal cord.

The spine is movable in all directions—flexion, extension, lateral flexion, and rotation around the long axis of the column. Flexion is accompanied by compression of the intervertebral discs, and by a slight forward movement of each vertebra on the one below it. This forward movement is checked by the tension of the ligamenta subflava which pass between the laminæ. In the cervical and lumbar regions the range of movement is greater than in the dorsal region.

In the infant the spine is either straight, or presents one long antero-posterior curve with its convexity backwards. With the assumption of the erect posture the normal S-shaped curve is developed, the cervical and lumbar segments arching forward, while the dorsal and sacral segments arch backward.

It is often difficult to identify with certainty the individual spinous processes through the skin. The spine of the seventh cervical vertebra—vertebra prominens—is that most readily felt. While the arm hangs by the side the seventh dorsal vertebra lies opposite the lower angle of the scapula. The twelfth dorsal vertebra may be recognised by tracing back to it the last rib. The bodies of the upper cervical vertebræ may be felt through the posterior wall of the pharynx. The epiglottis lies on the same level as the body of the fourth cervical vertebra. The cricoid cartilage corresponds in level to that of the lower border of the sixth cervical vertebra, and its transverse process—the carotid tubercle.

It is important for surgical purposes to bear in mind that most of the spinous processes do not lie on the same level as their corresponding bodies. The tips of the spines of the cervical and first two dorsal

vertebræ lie, roughly speaking, opposite the lower edge of their respective bodies; those of the remaining dorsal vertebræ lie opposite the upper edge of the vertebra below; while the spines of the lumbar vertebræ lie opposite the middle of their corresponding bodies. (Gowers and Taylor.)

The *spinal canal* contains the spinal cord so suspended within its membranes that it does not touch the bones, and is not disturbed by the movements of the spinal column.

The *membranes* of the cord are continuous with those of the brain. The arachno-pia invests the cord and furnishes a sheath to each of the spinal nerves as it passes out towards the intervertebral foramen. The arachno-pial space is filled with cerebro-spinal fluid, which forms a water-bed for the cord, continuous with that at the base of the brain. The dura mater constitutes the enveloping sheath of the cord. It hangs from the edge of the foramen magnum as a sac, and is only connected to the bones opposite the intervertebral foramina, where it is prolonged on to each of the spinal nerves as part of its sheath. Between the outer aspect of the dura and the bony wall of the canal is a space filled by loose areolar tissue and traversed by large venous sinuses. The dura extends as far as the upper edge of the sacrum.

The *spinal cord* extends from the foramen magnum to the level of the disc between the first and second lumbar vertebræ.

One pair of spinal nerves leaves each "segment" of the cord. On leaving the cord the nerves incline slightly downwards towards the foramina by which they make their exit from the canal. The obliquity of the nerves gradually increases, till in the lower part of the canal—from the second lumbar vertebra onward—they run parallel with the filum terminale and constitute the cauda equina.

It is to be borne in mind that only the spinous processes of the cervical vertebræ lie even approximately opposite their corresponding segments in the cord. Owing to the obliquity of the spines of the dorsal vertebræ, and the fact that the cord is relatively shorter than the canal, the tips of the dorsal spines lie a considerable distance lower than their corresponding segments.

Functions.—The essential function of the spinal cord is to transmit motor and sensory impulses between the brain and the rest of the body. The general course of the fibres by which these impulses travel has already been described (Fig. 1).

In the grey matter of the cord there are groups of nerve cells—"centres"—which govern certain reflex movements. The most important of these are the centres for the rectal, the vesical, and the patellar reflexes. They are situated in the lumbar enlargement of the cord.

In the great majority of cases of spinal disease or injury coming under the notice of the surgeon the symptoms are bilateral, that is, are of the nature of paraplegia, and the whole of the body below the level of the segment affected is involved in the paralysis. Lesions affecting only one-half of the cord are rare and give rise to symptoms which are exceedingly complicated. When the lesion implicates the nerve-roots only, the symptoms are confined to the area supplied by the affected nerves.

Operation of Laminectomy.—As the operation for opening the spinal canal—laminectomy—will be frequently referred to in the succeeding pages, it is convenient to describe it here. A

longitudinal or semilunar incision is made so as to expose the spinous processes of the vertebræ to be dealt with. The muscles, along with the periosteum, are separated from the spines and laminæ. After the interspinous ligaments have been divided with scissors, the spines are snipped off at their bases with bone pliers. The ligamenta subflava are then divided close to the bone and the laminæ sawn across and levered out. The fatty tissue outside the dura is separated, and any veins which are torn are ligatured. If it is necessary to open the dura, it should be securely sutured again to prevent leakage of cerebro-spinal fluid.

INJURIES OF THE SPINAL CORD.

As the clinical importance of a spinal injury depends almost entirely on the degree of damage done to the cord, we shall consider injuries of the cord before those of the vertebral column. They will be described under the headings: Concussion of the Cord; "Railway Spine"; Traumatic Spinal Hæmorrhage; Total Transverse Lesions; and Partial Lesions of the Cord and Nerve-roots.

Concussion of the Spinal Cord.—It is necessary to restrict this term to such injuries as implicate the cord alone, apart from lesions of the vertebræ, the spinal ligaments or membranes. In this limited sense concussion of the cord is extremely rare.

The term concussion of the cord has only a clinical significance—its pathological equivalent is "contusion of the cord." It can no longer be believed that the symptoms are due to a molecular shaking of the cord or to mere shock. In all cases which have been thoroughly investigated, definite lesions, usually in the form of minute hæmorrhages into the grey matter of the cord, or into the membranes, have been found (Kocher, Byrom Bramwell). These hæmorrhages may be due to squeezing or tearing of the cord or the emerging nerve-roots by a partial and temporary displacement of a vertebra, or to violent distortion of the spine; or they may be produced by a disturbance of the cerebro-spinal fluid, in the same way as the corresponding lesions which accompany concussion of the brain.

The condition is commonly met with in miners as a result of a fall of coal or stones striking them on the back. It is also liable to occur when a rider is thrown from his horse and lands on his back. The most constant symptoms are temporary retention of urine requiring the use of the catheter, and transient

loss of power and numbness in the legs. Simple concussion of the cord is practically never attended with the symptoms characteristic of "railway spine"—a condition with which it is often confused—and it is very rarely, if ever, followed by organic disease of the cord (Byrom Bramwell).

The *treatment* consists in keeping the patient at rest in bed, preferably in the prone position, applying ice-bags to the spine, and administering ergot when bleeding is suspected. The bladder must also be attended to.

"**Railway Spine.**"—This term has been employed to indicate a peculiar disturbance of the nervous system which frequently develops in patients who have been in railway accidents. The condition is seldom, if ever, met with in its characteristic form after injuries sustained in any other way. It is a remarkable fact that it seldom occurs in railway employees, or in passengers who sustain gross injuries, such as fractures or lacerated wounds.

Clinical Features.—The patient usually gives a history of having been forcibly thrown backwards and forwards across the carriage at the time of the accident. He is stunned and dazed for a moment, or, it may be, is little the worse at the time, and is able to continue his journey. On reaching his destination, however, he feels weak and nervous and has pain in his back and limbs. There is no local sign of injury, beyond, perhaps, slight bruising of the back. For a few days he may be able to attend to business, but eventually feels unfit for it and has to give it up.

The symptoms which subsequently develop are for the most part purely subjective, and they vary widely in different cases. They usually include a feeling of general weakness, nervousness, and inability to concentrate attention on work or business matters. The patient is sleepless, or his sleep is disturbed by terrifying dreams. His memory is defective, or rather selective, as he can usually recall the circumstances of the accident with clearness and accuracy. He becomes irritable and emotional. He complains of sensations of weight or fulness in the head, and of temporary giddiness. There is weakness of vision and photophobia, but there are no ophthalmoscopic changes. He is hypersensitive to sounds and sometimes complains of noises in the ears. He has pains in the back on attempting movement, and there is a diffuse tenderness or hyperæsthesia along the spine. There is weakness of the limbs, sometimes attended with numbness, and he is easily fatigued by walking. There may be loss of sexual power and irritability of the bladder; retention is extremely rare. The patient tends to lose weight, and may acquire an anxious careworn expression, and appear

prematurely aged. In examining the patient special attention should be directed to the condition of the deep reflexes and the state of the muscles, as alterations in the reflexes and muscular atrophy indicate some definite organic lesion.

This condition is not to be confused with "concussion of the cord." It will be observed that the symptoms of so-called "railway spine" are almost entirely referable to derangement of the brain rather than of the cord. There is, however, no evidence of organic disease in any part of the central nervous system (Byrom Bramwell, Kocher). The pain in the back is usually the result of muscular sprain and not of lesions of the cord or nerve-roots. As the symptoms are so entirely subjective, it is often extremely difficult to exclude the possibility of malingering.

When the patient's condition is the subject of litigation, it is usually found that the symptoms disappear more or less rapidly after the patient's anxiety and worry have been removed by the settlement of his claim.

Treatment.—So long as litigation is pending the patient derives little benefit from treatment. After his mind is relieved by the settlement of his claim, however—whether favourable to him or not—his health is usually restored by the general tonic treatment employed for neurasthenia.

Traumatic Spinal Hæmorrhage. — Hæmorrhage into the spinal canal is a common accompaniment of all forms of injury to the spine. The lower cervical region is the most common seat of such hæmorrhage. The blood may be effused around the cord (extra-medullary), or into its substance (intra-medullary).

Extra-medullary Hæmorrhage — Hæmatorrachis. — The symptoms associated with extra-medullary hæmorrhage are at first of an irritative kind—muscular cramps and jerkings, radiating pains along the course of the nerves pressed upon, and hyperæsthesia. It is only when the blood accumulates in sufficient quantity to exert definite pressure on the cord that symptoms of paralysis ensue. It is characteristic of extra-medullary hæmorrhage that the paralysis comes on gradually. When the effusion is in the cervical region—the commonest situation—the arms are more affected than the legs, which may only exhibit an exaggeration of the knee-jerks. The blood may trickle down the canal and collect at a lower level and cause paralysis which slowly spreads from below upwards—*gravitation paraplegia* (Thorburn).

The *treatment* consists in rest in bed, preferably in the prone position; applying ice-bags over the spine; administering ergot;

and attending to the bladder and bowels. When there is evidence of progressive pressure on the cord the blood should be removed by spinal puncture if possible, or by laminectomy.

Intra-medullary Hæmorrhage—Hæmatomyelia.—Traumatic hæmorrhage into the substance of the cord occurs almost invariably in the lower cervical region, and results from forcible stretching of the cord by acute flexion of the neck. The blood is usually effused into the anterior cornua of the grey matter and into the central canal.

The severity of the *clinical features* depends upon the extent of the lesion. In contrast with what results in extra-medullary hæmorrhage, paralytic phenomena predominate, and come on immediately after the injury.

When the hæmorrhage is only sufficient to cause *pressure* on the cord the paralysis is of a spastic form, and is usually most marked in the lower extremities because the conducting fibres are pressed upon. This is associated with evanescent anæsthesia for temperature and pain, while tactile sensibility is preserved. There is retention of urine and fæces, and, in young men, priapism. The pupils are contracted. The symptoms soon subside, sensation being restored before motion, and recovery is rapid.

When the lesion is *destructive* there is persistent paralysis with atrophy, and anæsthesia in the area supplied from the segments of the cord directly implicated. As the lesion is usually in the upper part of the cord it is the arms that are most frequently affected. At the same time there may be transitory paralysis of the most distant parts—*e.g.* the feet—from pressure on the conducting fibres.

The *treatment* is the same as for extra-medullary hæmorrhage, except that operative treatment is contra-indicated.

Traumatic Lesions of the Cord.

Gross lesions of the cord are usually the result of severe injuries of the spine, stabs, or gun-shot wounds. Total transverse lesions, that is, those in which the cord is completely crushed or torn across, are much more common than partial lesions.

Total transverse Lesions.—Crushing or tearing of the whole thickness of the cord is an almost invariable accompaniment of complete dislocations and of fracture-dislocations of the spine. Even when the displacement of the bones is only partial and temporary, the cord may be completely torn across.

The *clinical features* vary with the level at which the cord is

injured, and the diagnosis as to the nature and site of the lesion is to be made by a careful analysis of the symptoms. Movement of the patient to admit of a direct examination of the local injury to the spine is attended with considerable risk, and should as far as possible be avoided.

Immediate Symptoms.—At whatever level the cord is damaged, there is immediate and complete paralysis of motion and sensation (paraplegia) below the seat of injury. The paralysed limbs are flaccid. On careful examination a narrow zone of hyperæsthesia may be mapped out above the anæsthetic area, and the patient may complain of radiating pains in the line of the nerves derived from the segments of the cord directly implicated. In complete transverse lesions the paralytic symptoms are symmetrical. Any marked difference on the two sides indicates an incomplete lesion.

Retention of urine, and retention or incontinence of fæces are constant symptoms. In young men priapism is common—the corpora cavernosa are filled with blood without actual erection. There is evidence of vaso-motor paralysis in the form of dilatation of the subcutaneous vessels, and local elevation of temperature in the paralysed parts. The tendon reflexes are abolished.

Later Symptoms.—These are the result of descending degeneration taking place in the antero-lateral columns of the cord. There are often violent and painful jerkings of the muscles of the limbs, and the muscles become rigid and the limbs flexed. After a time the reaction of degeneration is exhibited by the paralysed muscles.

Unless regularly emptied by the catheter the bladder becomes distended, and there is dribbling of urine—the overflow from the full bladder. The constant use of the catheter involves considerable risk of infection of the bladder unless the most rigid antiseptic precautions are adopted. There is always considerable risk of hypostatic pneumonia. Trophic sores are very liable to occur on parts subjected to pressure, such as the sacrum, the scapulæ, the heels and the elbows.

Injuries of the Cord at different Levels.—*Cervical Region.*—Complete lesions of the *first four cervical segments*—that is above the level of the disc between the third and fourth cervical vertebræ—are always rapidly, if not instantaneously, fatal, the nucleus of the phrenic nerve being in the fourth cervical segment.

In lesions between the *fifth cervical and first dorsal segments inclusive*, all four limbs are paralysed. Sensation is lost below the second intercostal space. The parts above this level retain sensation as they are supplied by the supra-clavicular nerves

which are derived from the fourth cervical segments. There is also paralysis of the cervical sympathetic. Respiration is almost exclusively carried on by the diaphragm. Hiccough is often persistent. There is at first retention of urine, followed by dribbling from overflow. Sugar is sometimes found in the urine. Priapism is common. The pulse is slow (40-50) and full; and the temperature often rises very high—a symptom which is always of grave omen.

When the lesion is confined to the *sixth cervical segment* the arms assume a characteristic attitude, as a result of the contraction of the muscles supplied from the higher segments. The upper arm is abducted and rotated out, the elbow is sharply

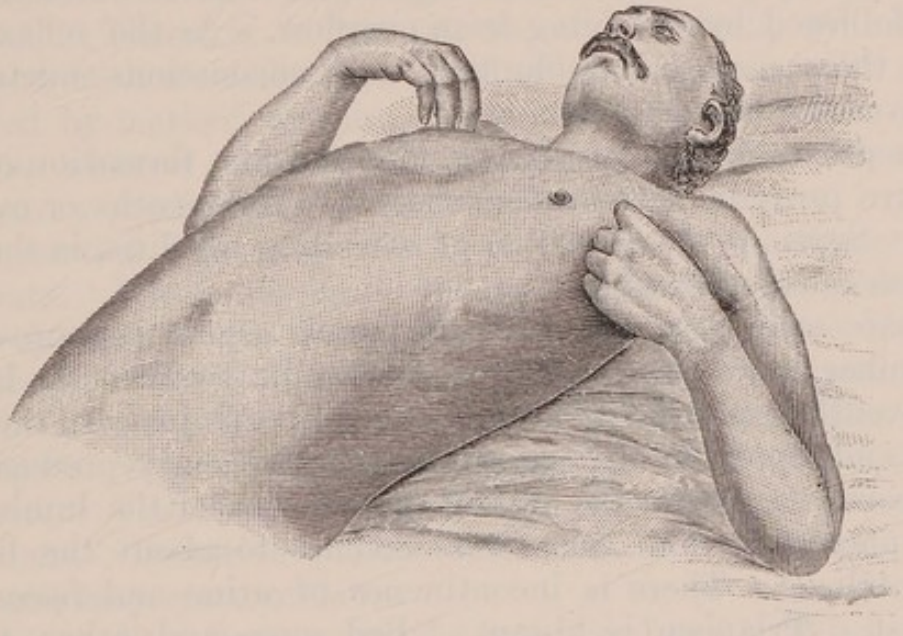

FIG. 11.—Attitude of Upper Extremities in Traumatic Lesions of the Sixth Cervical Segment. The prominence of the abdomen is due to gaseous distension of the bowel.

flexed, and the hand supinated and flexed (Fig. 11). Sensation is retained along the radial side of the limb.

When the lesion is confined to the *first dorsal segment* the attitude of the arm is also characteristic. There is slight abduction at the shoulder and flexion at the elbow, the forearm lies semipronated on the chest or belly, and there is slight flexion of the fingers.

Lesions of the lower cervical segments are usually fatal in from two or three days to as many weeks, from embarrassment of respiration or hypostatic pneumonia.

Dorsal Region.—In injuries of the dorsal region—second to eleventh dorsal segments inclusive—the anæsthesia below the level of the lesion is complete and its upper limit runs horizontally round

the body, and not parallel with the intercostal nerves. Above the anæsthetic area there is a zone of hyperæsthesia, and the patient complains of a sensation as if a band were tightly tied round the body—"girdle-pain."

The motor paralysis and the anæsthesia are co-extensive. The intercostal muscles below the seat of the lesion and the abdominal muscles are paralysed. The respiratory movements are thus impeded, and, as the patient is unable to cough, mucus gathers in the air passages and interferes with respiration. As the patient is unable to aid defecation or to expel flatus by straining, the bowel is liable to become distended with fæces and gas. The meteorism which results adds to the embarrassment of respiration by pressing on the diaphragm. There is retention of urine followed by dribbling from overflow. As the reflex arc is intact there may be involuntary and unconscious micturition whenever the bladder fills.

If septic infection of the bladder and the formation of bed-sores are prevented, the patient may live for months or even for years. Septic pyelo-nephritis, or ascending myelitis, is the most common cause of death.

Lumbo-sacral Region.—All the spinal segments representing the lumbar, sacral, and coccygeal nerves lie between the level of the eleventh dorsal and first lumbar vertebræ. Injuries of the lower dorsal and upper lumbar vertebræ, therefore, may produce complete paralysis within the area of distribution of the lumbar and sacral plexuses. The anæsthesia reaches to about the level of the umbilicus. There is incontinence of urine and fæces from the first. Priapism is absent. Bed-sores and other trophic changes are common, and there is the usual risk of septic complications in relation to the urinary tract.

Cauda Equina.—As the cord terminates opposite the first lumbar vertebra, injuries below this level only implicate the cauda equina. The extent of the motor and sensory paralysis varies with the level of the lesion and with the particular nerves injured. Sometimes it is complete, sometimes selective. As a rule all the muscles of the lower extremity are paralysed, except those supplied by the anterior crural, obturator, and superior gluteal nerves. The perineal and penile muscles are also implicated. There is anæsthesia of the penis, scrotum, perineum, lower half of the buttock, and the entire lower extremity, except the front and outer aspects of the thigh, which are supplied by the external cutaneous nerve, and the cutaneous branches of the anterior crural. There is incontinence of urine and fæces. The prognosis is much more favourable than in lesions affecting the

cord itself, and there is a much greater prospect of life being prolonged for years if septic complications be avoided.

Treatment.—Apart from the injury to the spine, the treatment of patients suffering from total transverse lesions of the cord is chiefly symptomatic, and is largely directed towards the prevention of septic complications from bed-sores and cystitis.

Partial Lesions of the Cord and Nerve-roots.—Partial lesions of the cord, such as bruises, lacerations, or partial ruptures, usually result from distortions or incomplete fractures and dislocations of the spine. They are comparatively rare.

When the *nerve-roots* alone are injured sensory phenomena predominate. Formication, radiating pains, and neuralgia are present in the area of distribution of the nerves implicated. There is motor paresis or paralysis, which may disappear either suddenly or gradually, or may persist and be followed by marked atrophy of the muscles concerned. In contrast to what is observed from pressure by tumours and inflammatory products, twitchings and cramps are rare.

In *partial lesions of the cord* the motor phenomena predominate. Paresis extends to the whole of the motor area below the seat of the lesion, but the weakness is more marked on one side of the body. The distal parts—feet and legs—suffer more than the proximal—arms and hands. The paresis develops slowly, may vary in extent and degree, and may soon improve. Vaso-motor disturbances accompany the motor symptoms. Irritative phenomena, such as twitchings or contractures, may come on later.

Sensory disturbances may be entirely absent. When present they are incomplete, and are chiefly irritative in character. They may not reach the same level as the motor phenomena, and the different sensory functions are unequally disturbed in the areas corresponding to the several nerve-roots. There is sometimes a combination of hyperæsthesia on one side and anæsthesia on the other. The deep reflexes, particularly the knee-jerks, may be absent at first, but they soon return, and are usually exaggerated.

Retention of urine is not always present even when the limbs are completely paralysed, as the fibres of one side of the cord are sufficient to maintain the functions of the bladder. The patient may be aware that the bladder is full, although he is unable to empty it. Similarly sensation in the rectum and anus may be retained although the control of the sphincters is lost. Priapism may be present, but tends to disappear.

The *prognosis* is generally favourable, but must be guarded,

as permanent organic changes in the cord may take place and prevent complete recovery. Septic infection from bed-sores or from the urinary tract is the most common cause of death in cases which terminate fatally.

The *treatment* is carried out on the same lines as for total lesions. Laminectomy, however, is indicated when there is reason to believe that the cause of pressure is capable of being removed.

INJURIES OF THE SPINAL COLUMN.

For purposes of clinical study it is convenient to distinguish between partial and complete lesions of the spinal column. This distinction is important because in partial lesions the continuity of the column is not entirely lost, and the cord may sustain very little damage, or may entirely escape. In complete lesions, on the other hand, the column is broken and the cord is always severely damaged.

Partial lesions include twists or sprains, isolated dislocations of articular processes, isolated fractures of the arches and spinous processes, and isolated fractures of the vertebral bodies. The most important complete lesions are total dislocations and fracture-dislocations.

Twists and dislocations are most common in the cervical region, that is, in the part of the spine where the forward range of movement—flexion—is greatest. Fractures are most common in the lumbar region, where flexion is most restricted. Fracture-dislocations occur where the range of flexion is intermediate, that is, in the dorsal region.

In all lesions of the spine accompanied by displacement the upper segment is displaced forwards.

Twists or sprains are produced by movements which suddenly put the ligamentous and muscular structures of the spine on the stretch; in other words, by lesser degrees of the same forms of violence as produce dislocations. When the interspinous and muscular attachments alone are torn, the effects are confined to the region injured, but when the ligamenta subflava are involved blood may be extravasated and infiltrate the space between the dura and the bone, and give rise to symptoms of compression of the cord. The nerve-roots emerging in relation to the affected vertebræ may be stretched or lacerated, and as a result radiating pains may be felt in the area of their distribution.

In the *cervical* region distortion usually results either from forcible extension of the neck—for example, from a violent blow or fall on the forehead forcing the head backwards—or from forcible flexion of the neck. The patient complains of severe pains in the neck, and inability to move the head, which is often rigidly held in the position of ordinary wry-neck. There is marked tenderness on attempting to carry out passive movements, and on making pressure over the affected vertebræ or on the top of the head. The maximum point of tenderness indicates the vertebra most implicated. In diagnosis, fracture and dislocation are excluded by the absence of any alteration in the relative positions of the bony points, and by the fact that passive movements, although painful, are possible in all directions.

In the *lumbar* region sprains are usually due to over-exertion in lifting heavy weights, or to the patient having been suddenly thrown backwards and forwards in a railway collision. The attachments of the muscles of the loins are probably the parts most affected. The back is kept rigid, and there is pain on movement, particularly on rising from the stooping posture.

Treatment.—Unless carefully treated, the symptoms of spinal sprain are liable to cause prolonged disablement. The patient should be kept at rest in bed, and in the cervical region extension may be applied to the head with the nape of the neck supported on a roller-pillow. Fomentations or ice-bags are employed for a few days to relieve the pain. After a week or ten days, recourse may be had to massage and stimulating liniments. Active movements are forbidden till all symptoms have disappeared. In patients predisposed to tuberculosis, the period of complete rest should be materially prolonged.

When there is persistent disablement, counter-irritation followed by massage, exercises, and cold douching, is the treatment indicated.

Isolated Dislocations of Articular Processes.—This injury, which is most frequently met with in the cervical region, and is nearly always unilateral, is commonly produced by the patient falling from a vehicle which suddenly starts, and landing on the head or shoulders, flexing and twisting the neck. The articular process of the upper vertebra passes forward.

The pain and tenderness are much less marked than in the case of a simple twist, as the ligaments are completely torn and are therefore not in a state of tension. The patient often thinks lightly of the condition at the time of the accident, and may only apply for advice some time after on account of the per-

sistent deformity. The head is flexed and the face turned towards the side opposite the dislocation, the attitude closely resembling that of ordinary wry-neck. The bony displacement is best recognised by palpating the transverse process of the dislocated vertebra. In the case of the upper vertebræ this is done from the pharynx, in the lower between the sterno-mastoid and the trachea. There is pain on attempting movement, and tenderness on pressure, particularly on the side which is not displaced, as the ligaments there are on the stretch. There are often radiating pains along the line of the nerves emerging between the dislocated vertebræ. As the bodies are not separated damage to the cord is exceptional.

Treatment.—Reduction should be attempted at once, before the vertebræ become fixed in their abnormal position. Under anæsthesia, gentle extension is made on the head by an assistant, and the abnormal attitude is first slightly exaggerated to relax the ligaments and to restore mobility to the locked articular processes. The head is then forcibly flexed towards the opposite side, after which it can be rotated into its normal attitude, (Kocher). Haphazard movements to effect reduction are attended with risk of damaging the cord. After reduction has been effected, extension by weight and pulley is applied, and kept on for not less than six weeks.

Isolated Fractures of the Arches and Spinous Processes.—These injuries usually result from direct violence, and are accompanied by bruising of the overlying soft parts, irregularity in the line of the spines, and by the ordinary signs of fracture. They are most common in the lower cervical and in the dorsal regions, where the spines are most prominent and exposed to injury.

In many cases there are no symptoms of damage to the cord or spinal nerves, but when both laminæ give way the posterior part of the arch may be driven in and cause direct pressure on the cord, or blood may be effused between the bone and the dura. In such cases immediate operation is indicated. When there are no cord symptoms, the treatment consists in securing absolute rest, with the aid of extension, if necessary, for several weeks until the bones are reunited.

Isolated Fracture of the Bodies—"Compression Fracture."—The "compression fracture" consists in a crushing from above downwards of the bodies—and the bodies only—of one or more vertebræ. It is due to the patient falling from a height and landing on the head, buttocks, or feet in such a way that the force is transmitted along the bodies of the vertebræ, while the spine at the same time is flexed.

If the patient lands on his head the compression fracture usually involves the lower cervical or upper dorsal vertebræ. When he lands on his buttocks or feet it is usually the lumbar or the lower dorsal vertebræ that are fractured (Fig. 12).

The patient lies helpless and is unable to walk, stand, or sit. As a rule there are no external signs of injury over the spine. The sternum, however, is often fractured, and irregularity and discoloration may be detected on examining the front of the chest. The recognition of a fracture of the sternum should always direct attention to the spine. On careful examination of the back in the region injured a more or less marked projection of the spinous processes may be recognised. In the cervical and lumbar regions this projection may merely obliterate the normal concavity. The spinous process which forms the apex of the projection belongs to the vertebra above the one which is crushed. There are seldom marked signs of pressure on the cord, but the nerves emerging in relation to the damaged vertebræ may be bruised, and give rise to girdle-pain.

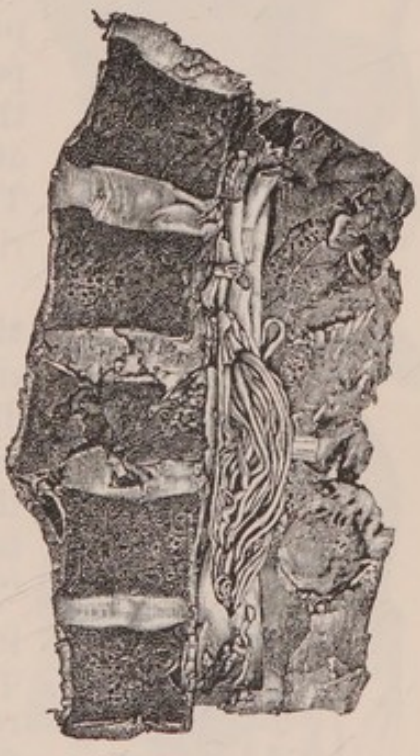

FIG. 12.—Compression Fracture of Bodies of Third and Fourth Lumbar Vertebræ.

Local tenderness is elicited on pressing over the affected vertebræ or on the head and shoulders. As might be expected from the nature of the accident producing this lesion, it is often associated with serious injuries to the head, limbs, or internal organs which gravely affect the prognosis.

The *treatment* consists in taking the pressure off the injured vertebræ in order that the reparative material may be laid down in such a way as to restore the integrity of the column. In the cervical region extension is applied to the head and a roller-pillow placed beneath the neck. In the dorsal and lumbar regions the extension is applied through the lower limbs, and the pillow placed under the loins. The patient is confined to bed for six or eight weeks, and before he gets up a poroplastic or plaster of Paris jacket is applied. This is worn for a month or six weeks.

Traumatic Spondylitis.—After compression fractures a condition known as "traumatic spondylitis" is liable to develop. It is probably due to the callus thrown out for the repair of the

fracture being subjected to strain and pressure too early, or to a progressive softening of the injured vertebra and of the bodies of those adjacent to it. This leads to an alteration in the shape of the affected bones. The usual history is that some considerable time after the patient has resumed work subsequent to the accident he suffers from pain in the back, and radiating pains round the body and down the legs. He becomes more and more unfit for work, and a marked projection appears in the back and may extend over several vertebræ (Fig. 13). While the condition is progressive, the prominent vertebræ are painful and tender. In course of time the softening process is arrested, and the affected bones become fused together. The area of the spine involved becomes rigid and permanent deformity results.

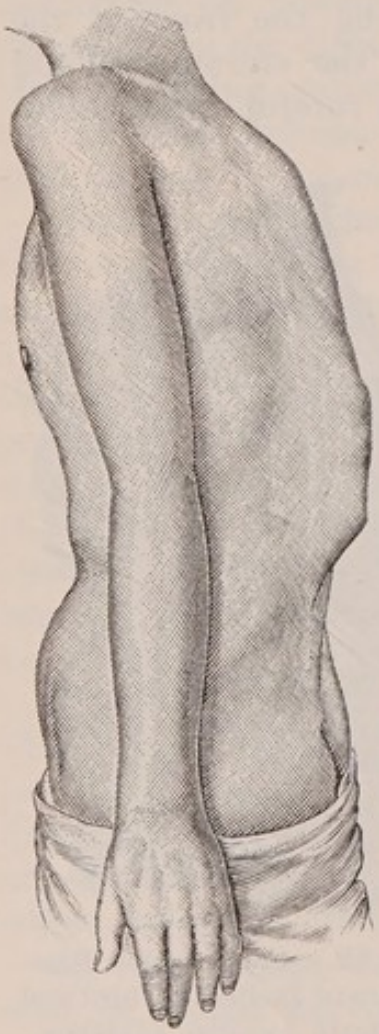

Fig. 13.—Traumatic Spondylitis affecting Lower Dorsal Segment of Spine, following compression fracture.

Dislocations and Fracture-Dislocations.—It is seldom possible at the bedside to distinguish between a complete dislocation of the spine and a fracture-dislocation. *Fracture-dislocation* is by far the more common lesion of the two, and is the injury popularly known as a "broken back." It may occur in any part of the column, but is most frequently met with in the dorso-lumbar region. It usually results from forcible flexion of the spine, as, for example, when a miner at work in the stooping posture is struck on the shoulders by a heavy fall of coal. The spine is acutely bent, and breaks at the angle of flexion and not at the point struck. The lesion consists in a complete bilateral dislocation of the articular processes, together with a fracture through one or more of the bodies. This fracture is usually oblique, running downwards and forwards.

The upper fragment of the body with the segment of the spine above it is displaced downwards and forwards, and the cord is crushed between the posterior edge of the body of the lower vertebra and the arch of the vertebra above it (Fig. 14). In almost every case the cord is damaged beyond possibility of repair.

Total dislocation is exceptional. It is chiefly met with in the lower cervical region. Both articular processes are displaced and the intervertebral disc is separated.

Clinical Features.—The outstanding symptoms of total lesions are referable to the damage inflicted on the cord. The diagnosis should always be made by a consideration of the mechanism of the injury and the condition of the nerve functions below the lesion. On no account should the patient be moved about to enable the back to be examined, as this is attended with considerable risk of increasing the displacement and causing further crushing of the cord. If the fingers be gently passed under the patient's back as he lies recumbent, it is usually found that there is some backward projection of the spinous processes, the most prominent process being that of the vertebra which is broken. The spinous process immediately above it is depressed as the upper segment has slipped forward. Pain, tenderness, swelling and discoloration may be present over the injured vertebræ. There is complete loss of motion and sensation below the seat of the lesion. The symptoms of total transverse lesions of the cord at different levels have already been described.

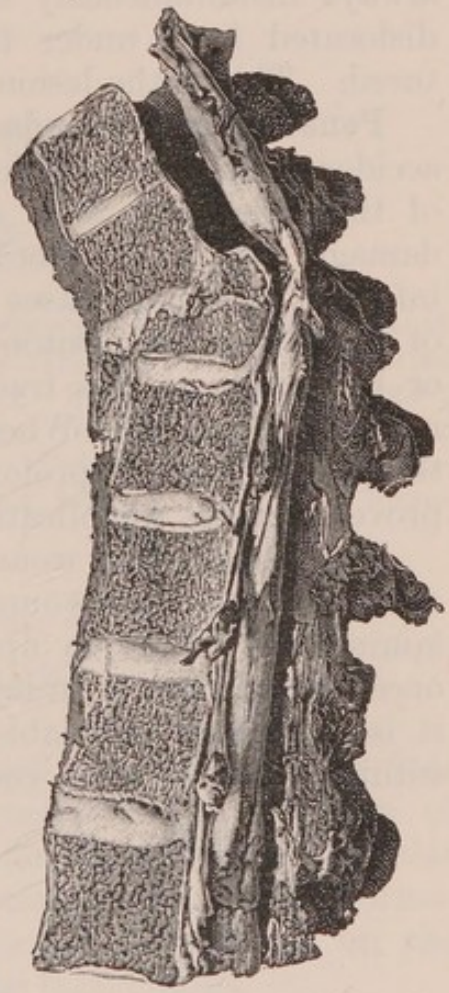

Fig. 14.—Fracture Dislocation of Ninth Dorsal Vertebra, showing downward and forward displacement of upper segment, and compression of cord by upper edge of lower segment.

(Anatomical Museum, University of Edinburgh.)

Treatment.—An attempt may be made to reduce the displacement under anæsthesia. Gentle traction in the long axis of the spine is made by assistants, while the surgeon attempts to mould the bones into position. No special manipulations are necessary as the ligaments are all extensively lacerated, and the bones are, as a rule, readily replaced. A roller-pillow is placed under the seat of the fracture to allow the weight of the body above and below to exert gentle traction, and so to relieve the cord of pressure. Operative treatment is almost never of any avail, as the cord is not only pressed upon, but in most cases is crushed, or even completely torn across.

Even when the cord is only partially injured operative treatment is not likely to yield better results than are obtained by reduction and extension. Great care must be taken to prevent cystitis and bed-sores.

Total fracture-dislocation between the *atlas and axis* is almost always instantaneously fatal. The odontoid process is either dislocated from under the transverse ligament or it is fractured. This is the lesion which occurs in judicial hanging.

Penetrating Wounds.—These result from stabs or gunshot accidents, and are practically equivalent to compound fractures of the spine, and their severity depends on the extent of the damage done to the cord, and on whether or not the wound is infected. In many cases the condition is complicated by injuries of the pleural or peritoneal cavities and their contained viscera, or by injury of the trachea, œsophagus, or large vessels and nerves of the neck. When the membranes of the cord are opened the profuse and the prolonged escape of cerebro-spinal fluid may prove a serious complication.

Treatment.—The wound of the soft parts is treated on the same lines as other wounds. When the spinous processes and laminæ are driven in upon the cord they must be elevated at once by operation. In injuries involving the lumbo-sacral region it is sometimes justifiable to open the spine for the purpose of suturing divided nerve cords.

CHAPTER VII.

DISEASES OF THE SPINE AND CORD.

POTT'S DISEASE: *Pathology; Clinical features*—Pott's disease as it affects different regions of the spine—Disease of the sacro-iliac joint; Syphilitic disease of spine; Tumours of vertebræ; Hysterical spine; Acute osteomyelitis; Rheumatic spondylitis; Spondylitis deformans; Coccygodynia; Tumours of cord and membranes—Congenital deformities: *Spina bifida; Congenital sacro-coccygeal tumours.*

TUBERCULOUS DISEASE OF THE SPINE—POTT'S DISEASE.

PERCIVAL POTT, in 1779, first described a disease of the spinal column which is characterised by erosion and destruction of the bodies of the vertebræ. It is liable to produce an angular deformity of the spine, and to be associated with abscess formation and with nervous symptoms referable to pressure on the cord. This disease is now known to be tuberculous.

It may occur at any period of life, but in at least fifty per cent. of cases it attacks children below the age of ten. In children the spine is the most common seat of tuberculous disease of bone.

Morbid Anatomy.—The tuberculous process may affect any portion of the spine, and as a rule is limited to one region. In some cases foci of disease occur simultaneously at several levels. The disease may begin either as an osteomyelitis of the bodies of the vertebræ, or as a periostitis affecting the anterior surface of the bones.

Vertebral *osteomyelitis* is the form most frequently met with in children. The changes resemble those resulting from tuberculous osteomyelitis in other spongy bones. The bodies of the affected vertebræ become inflamed and softened, particularly in their anterior parts, and, as the disease progresses, caseation and

suppuration ensue, and the destructive process spreads to the adjacent intervertebral discs. In some cases—and particularly in the lumbar region—a distinct sequestrum is formed, either on the surface or in the interior of a vertebra. The pus usually works its way towards the front and sides of the bones, and burrows under the anterior common ligament. Less frequently it spreads towards the spinal canal and accumulates outside the dura, and causes pressure on the cord.

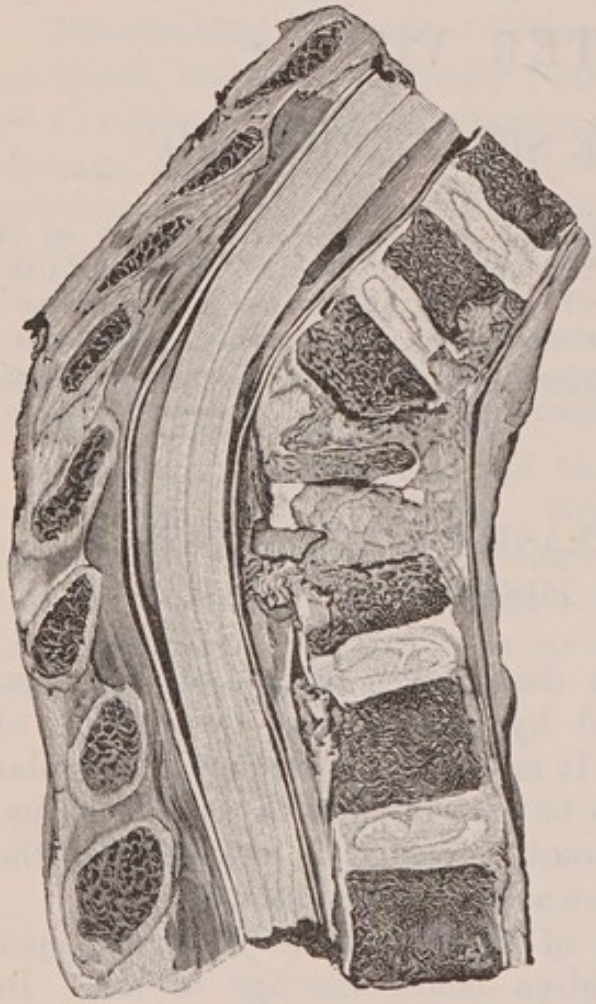

FIG. 15.—Tuberculous Osteomyelitis at Dorso-lumbar Junction.

The compression of the diseased vertebræ by the weight of the body above the seat of the lesion, and by the traction of the muscles passing over it, produces a more or less acute angling of the spinal column. The anterior portions of the bodies being more extensively destroyed, sink in, while the less damaged posterior portions and the intact articular processes prevent complete dislocation. In this way the integrity of the spinal canal is maintained, and the cord is protected from pressure by the bones. The spinous processes of the affected vertebræ project and form a prominence in the middle line of the back. When, as is usually the case, only one or two vertebræ are implicated, this prominence takes the form of a sharp angular projection, whereas if several vertebræ are involved, the deformity is of the nature of a gentle backward curve.

The *periosteal form* of vertebral tuberculosis is that most frequently met with in adults. The disease begins under the periosteum on the front of the vertebræ, and extends along the surface of the bones, causing widespread superficial caries. It may attack the discs at their margins, and spread inwards between the vertebræ. Owing to the comparatively wide area of the spine implicated, this form of the disease is not attended

with angular deformity, but rather with a wide backward curvature, which corresponds in extent to the number of vertebræ affected. Abscess formation is more frequent in periostitis than in osteomyelitis.

Effects on the Spinal Cord and Nerve-roots.—In some cases there is an œdematous swelling of the membranes of the cord resulting from interference with their circulation. In others the tuberculous process attacks the dura mater, and gives rise to the formation of granulation tissue on its outer aspect—*tuberculous pachy-meningitis.*

Less frequently a collection of pus forms between the bone and the dura, and presses the cord back against the laminæ. Occasionally a sequestrum becomes displaced backward and exerts pressure on the cord. The cord is never subjected to pressure as a result of curving of the spine alone, the lumen of the canal never being encroached upon to any extent. It sometimes happens, however, that the cord is nipped by sudden displacement of diseased vertebræ. This is practically equivalent to a fracture-dislocation of the spine.

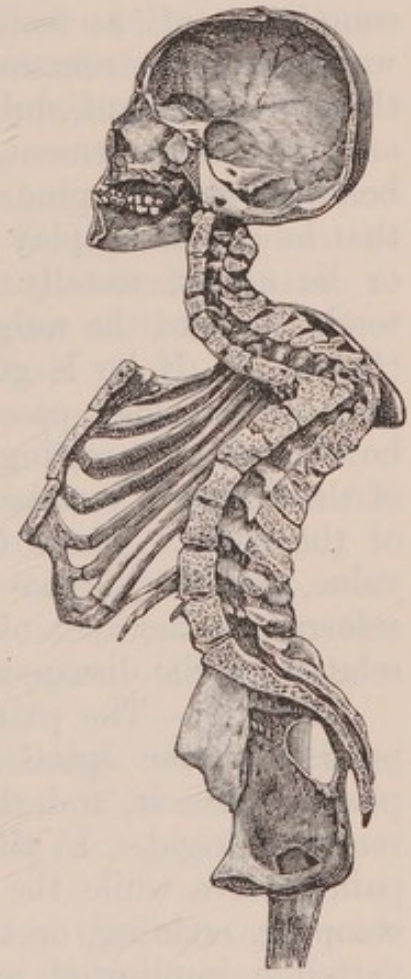

FIG. 16.—Osseous Ankylosis of Bodies of Dorsal Vertebræ following Pott's Disease. There is marked kyphosis at the seat of the disease and compensatory curves above and below.

(Museum of the Royal College of Surgeons, Edinburgh.)

The severity of the symptoms is aggravated by the occurrence of inflammation of the cord—*myelitis*—which is not due to tuberculous disease of the cord, but to interference with its blood-supply from the associated meningitis.

Repair.—When the progress of the disease is arrested, the natural cure of the condition is brought about by the bodies of the affected vertebræ becoming fused by osseous ankylosis (Fig. 16). While this reparative process is progressing, the cicatricial contraction renders the angular deformity more acute, and it may go on increasing until the bones are completely consolidated.

In rare cases the disease affects only the articular or the spinous processes, producing superficial caries and a localised abscess.

Clinical Features.—The clinical features of Pott's disease vary so widely in different regions of the spine that it is necessary to consider each region separately. To avoid repetition, however, certain general features of the disease may be first described.

Pain.—In the earliest stages of the disease the patient complains of a feeling of tiredness, which prevents him walking far or remaining long in a standing position. Later there is a constant, dull, gnawing pain in the back, increased by any form of movement, particularly such as involves jarring or bending of the spine. If the patient is a child it is noticed that he ceases to play with his companions, and inclines to sit or lie about, usually assuming some peculiar attitude which tends to take the weight off the affected segment of the spine (Fig. 17). If he is going about, the pain increases as the day goes on, but may pass off during the night. Tenderness may be elicited on pressing over the spinous or transverse processes of the diseased vertebræ, or on making pressure in the long axis of the spine. These tests, however, are not of great diagnostic value, and they cause the patient unnecessary suffering. Pain referred to the area of distribution of the nerves emerging in relation to the diseased vertebræ is a common symptom.

Rigidity.—The pain produced by movement of the diseased portion of the spine causes reflex contraction of the muscles passing over it, and the affected segment of the column is thus rendered rigid. If the palm of the hand be placed over the painful area while the patient attempts to make movements of stooping, nodding, or turning to the side, it is found that the vertebræ implicated move *en bloc* instead of gliding on one another. This rigidity of the diseased portion of the column and "boarding" of the muscles of the back is one of the earliest and most valuable diagnostic signs of Pott's disease.

Deformity.—The most common and characteristic deformity is an abnormal antero-posterior curvature, with its convexity backwards. The situation, extent, and acuteness of the bend vary with the region of the spine affected, the situation of the disease in the bone, and the number of vertebræ implicated. When the disease is in the interior of the bodies of one or two vertebræ, a short, sharp, angular deformity results; when on the surface of several bones, a long, wide curvature.

Lateral deviation is occasionally met with in the early stages of the disease as a result of unequal muscular contraction, and in the later stages from excessive destruction of one side of a vertebra, or from partial luxation between two diseased vertebræ.

Abscess Formation.—All forms of tuberculous disease of the spine are liable to be complicated with the formation of abscesses, which tend to spread widely, the direction of spread varying with the primary site of the mischief in the bone. The different forms of abscess met with will be described later.

Abscesses occur with greater frequency and at an earlier stage in adults than in children, because in adults the disease usually begins as a periostitis of the surface of the vertebræ.

Pyogenic infection of such abscesses constitutes one of the chief risks to life in Pott's disease.

Nervous Phenomena.—When the spinal cord is pressed upon the motor fibres are first affected, as they lie superficially on the antero-lateral aspects of the cord. There is at first weakness or paresis of the muscles supplied from the part of the cord below the seat of pressure. Later there is paralysis varying in extent, and sometimes amounting to complete paraplegia. This may come on gradually or quite suddenly. The knee-jerks and plantar reflexes are exaggerated, and there is marked ankle clonus. There is wasting of muscles, and later a tendency to contracture and the development of deformities. Trophic sores and septic cystitis may develop, but these complications are less common in diseases than in injuries of the spine. In some cases the patient loses control of the sphincters.

The sensory fibres usually escape, although in some cases there is partial anæsthesia and perversion of sensation. In cases of myelitis loss of sensibility to pain (analgesia) is one of the most characteristic symptoms.

The symptoms referable to pressure on the *nerve-roots* are pain and hyperæsthesia along the course of the nerves which are pressed upon at their points of emergence, and occasionally weakness and wasting of the muscles supplied by them.

General Principles of Treatment.—In every case of Pott's disease absolute rest in the recumbent posture must be maintained until all the symptoms have disappeared. From the nature of the disease this line of treatment must usually be persisted in for from one to two years. While the more acute symptoms last the spine may be immobilised by means of extension and counter-extension with weight and pulley. Later, a double Thomas's splint or a Phelp's box may be used to admit of the patient being moved from one room to another or into the open air. No form of apparatus which is designed to fix the spine is to be relied upon so long as the patient is allowed to assume the erect posture. Such appliances are only useful in giving support to the spine after the disease is cured. The

importance of preventing septic infection of any abscess which may form has already been referred to.

Pott's Disease as it affects Different Regions of the Spine.

Upper Cervical Region, including Atlo-axoid Disease.—In the upper cervical region the disease usually begins in the vicinity of the atlo-axoid articulation, and from the softening of the component bones and ligaments there is a tendency for the atlas to become dislocated forward so that the odontoid process impinges on the medulla and upper part of the cord causing sudden death. If, on the other hand, recovery ensues, the atlas and axis usually become ankylosed.

Fig. 17.—Attitude of Patient suffering from Tuberculous Disease of the Cervical Spine. The swelling on the left side of the neck is due to a retro-pharyngeal abscess.

Clinical Features.—The patient complains of a fixed pain in the back of the neck, and of radiating pains along the course of the sub-occipital and other cervical nerves. The neck is held rigid, and to look to the side the patient turns his whole body round. As the disease advances the head may be bent to one side as in wry-neck, or the head may be retracted and the chin protruded. To take the weight of the head off the diseased vertebræ the patient often supports the chin on the hands (Fig. 17).

An abscess may form between the vertebræ and the wall of the pharynx (retro-pharyngeal abscess). The pus accumulates between the diseased bones and the prevertebral layer of the cervical fascia. The abscess may project towards the pharynx as a soft fluctuating swelling, and may cause difficulty in swallowing and breathing, and snoring during sleep. If it bursts internally it may cause suffocation. The abscess may

bulge towards one or both sides of the neck, and come to the surface behind the posterior border of the sterno-mastoid muscle (Fig. 17). In some cases it comes to the surface in the sub-occipital region.

If the cord is pressed upon by inflammatory products there is muscular weakness, beginning in the arms and passing to the legs, and sometimes followed by complete paralysis. The bladder and rectum are usually implicated.

Sudden death may result when dislocation of the atlo-axoid joint takes place.

Cervical caries has to be diagnosed from sprain of the cervical vertebræ, muscular rheumatism, and suppurating cervical glands. Retro-pharyngeal abscess due to other causes is described with diseases of the pharynx.

Treatment.—Extension is applied to the head, preferably by means of an elastic band fixed to the top of the bed. The head of the bed is raised on blocks so that the weight of the patient's body may furnish the necessary counter-extension. Lateral movements of the head are prevented by means of sand-bags. Counter-irritation may be applied to the sides of the neck. After the acute symptoms have subsided the spine should be fixed by means of some rigid apparatus, such as a double Thomas's splint.

A retro-pharyngeal abscess should be opened from the side of the neck by an incision along the posterior border of the sterno-mastoid, as first recommended by Chiene. The contents are evacuated, and the cavity filled with iodoform emulsion and closed without drainage. An opening made through the mouth is attended with the risks of pus being inhaled into the air passages and of septic infection.

When the patient is allowed to get up, a rigid collar, which supports the head and controls the movement of the cervical and dorsal vertebræ, must be worn until the cure is complete.

Cervico-dorsal Region.—When the lower cervical and upper dorsal vertebræ are affected, in addition to the fixed pain in the diseased bones, the patient complains of pain radiating along the distribution of the superficial cervical nerves and down the arms. There is often a marked angular deformity. If an abscess forms, it may come to the surface in the lower part of the posterior triangle, or may spread into the posterior mediastinum or into the axilla. Sometimes the pus burrows behind the œsophagus and trachea, and it may find its way into the pleural cavity. The cord is less frequently involved than when the disease is in the lower dorsal region. Pupillary symptoms

are sometimes present from irritation or paralysis of the fibres of the cervical sympathetic which supply the dilator pupillæ.

Dorsal Region.—When the disease is confined to the dorsal region, stiffness of the back and boarding of the vertebral muscles are prominent features. On being asked to pick up an object from the floor, the patient reaches it by bending his knees and hips, while he keeps his back straight and rigid. He refuses to make any movement which involves jolting of the spine, such, for example, as jumping from a chair to the ground. Children often attempt to take the weight off the diseased vertebræ by placing the palms of the hands on the edge of a chair so that the weight is borne by the arms.

Angular deformity is often well marked, and may implicate several vertebræ. In order to maintain the head erect, the spine above and below the seat of disease become unduly arched forward—compensatory lordosis. In advanced cases the ribs become approximated, and the lower end of the sternum is projected forward. The antero-posterior diameter of the thorax is thus increased, while its vertical diameter is diminished. These changes, together with the telescoping of the vertebral bodies, lead to the deformity characteristic of the tuberculous hunchback (Fig. 16). The alterations in the shape of the chest may lead to functional disturbances of the heart and lungs.

Dorsal Abscess.—When pus forms it may pass directly backwards along the posterior branches of the intercostal vessels and nerves and come to the surface behind the transverse processes, or it may travel forward between the pleura and the ribs, and, passing along the course of the lateral cutaneous branches of the intercostals, reach the skin opposite the middle of the rib. In the latter case the abscess is liable to be mistaken for one associated with tuberculous disease of the rib, particularly as the rib is usually found to be bare. In rare cases the pus opens into the pleura, constituting one form of empyema. When the disease is on the anterior surface of the bodies of the lower dorsal vertebræ, the pus may spread down through the pillars of the diaphragm and reach the sheath of the psoas muscle.

Treatment.—In the early stages extension should be applied both to the head and to the lower extremities, with or without a double long splint. When the more acute symptoms subside, the patient is placed in a Phelp's box or a double Thomas's splint.

Dorso-lumbar Region.—The symptoms are very similar to those of disease in the dorsal region. Children while standing often assume a characteristic attitude—the hips and knees are slightly flexed, and the hands grasp the thighs just above the

knees. In this way the weight is partly taken off the affected vertebræ and borne by the arms. If the child be laid on its back and lifted by the heels, the spine remains rigid. By this test a projection due to tuberculous disease may be differentiated from one due to rickets, as in the latter case the projection disappears.

The patient often complains of pain in the abdomen—which in children may be mistaken for a simple "belly-ache"—and of pain shooting down the buttocks and into the legs.

Psoas Abscess.—When an abscess forms it usually occupies the sheath of the psoas muscle, in which it spreads down towards the iliac fossa, and into the thigh, passing beneath Poupart's ligament, posterior and external to the femoral vessels (Fig. 18). The communication between the pelvis and the thigh is often very narrow, so that the abscess cavity has somewhat the shape of an hour-glass. The pus may reach the surface in the region of the saphenous opening, or may spread farther down the thigh under cover of the deep fascia. In some cases, as the swelling becomes smaller when the patient lies down, and appears to have an impulse on coughing, it is liable to be mistaken for a femoral hernia.

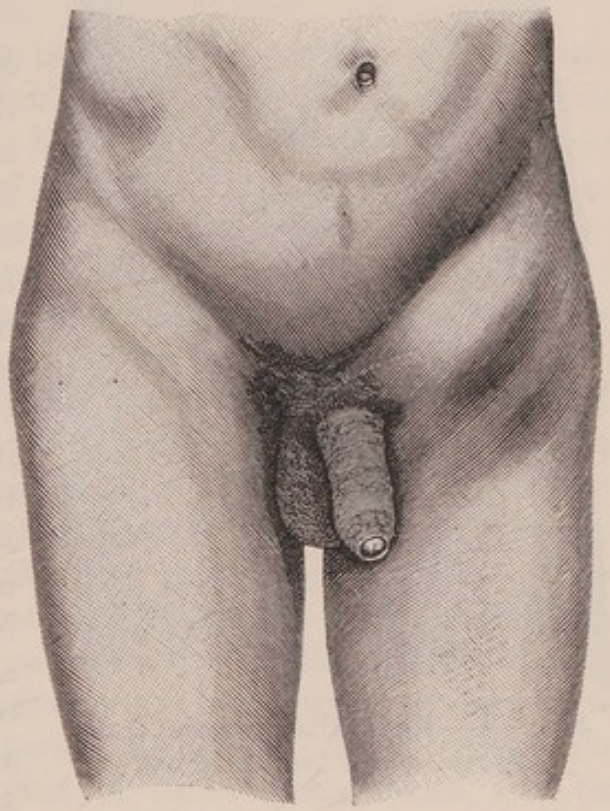

FIG. 18.—Left Psoas Abscess.

Lumbar Abscess.—Sometimes the pus travels along the posterior branches of the lumbar vessels and nerves to the outer border of the erector spinæ, and comes to the surface in the space between the edges of the latissimus dorsi and external oblique muscles—the triangle of Petit. In rare cases it passes through the sacro-sciatic foramen and forms a swelling in the buttock (*sub-gluteal abscess*); or it may pass through the obturator foramen and reach the surface in the adductor region of the thigh or in the perineum.

Lumbo-sacral Region.—Pott's disease in the lumbo-sacral region usually affects adults, and, on account of the breadth of

the vertebral bodies and the limited range of movement in this segment of the spine, is seldom accompanied by marked symptoms or deformity. The diagnosis, therefore, is often very difficult. The disease may be associated with pain in the distribution of the sciatic nerve, which is liable to be mistaken for ordinary sciatica. Single or double *iliac abscess* frequently forms without the patient showing any characteristic signs of spinal disease. When the disease occurs in children it may induce a permanent deformity of the pelvis, the transverse diameter being diminished—kyphotic pelvis.

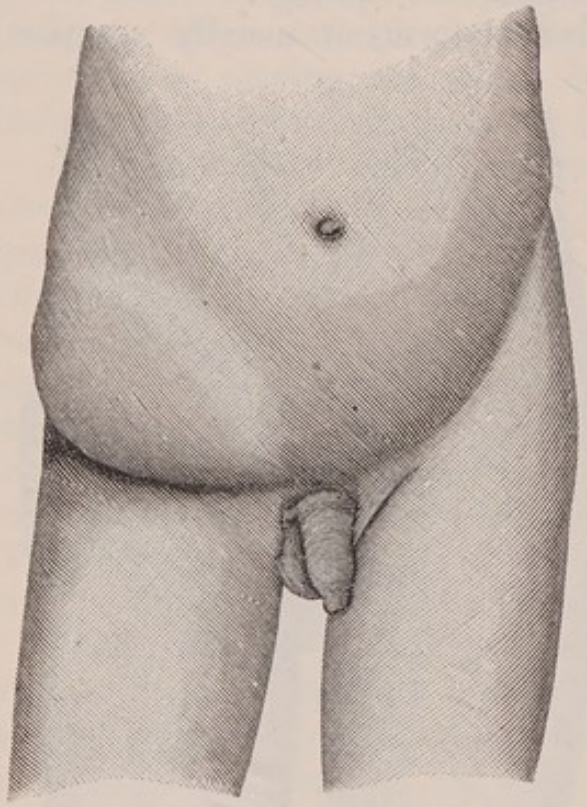

FIG. 19.—Right Iliac Abscess from disease of the lumbar spine.

Tuberculous Disease of the Sacro-iliac Joint.—This condition may occur as a primary affection, but is much more frequently secondary to disease in the ilium, sacrum, or lower lumbar vertebræ, and is most common in adolescents and young adults of the male sex. It is attended with pain in the lumbar region, and sometimes in the buttock and along the course of the sciatic nerve. The pain is aggravated by movements, especially such as involve sudden and violent contractions of the lumbar and abdominal muscles, for example, coughing, sneezing, or straining during defecation. The pain is frequently referred to the loin, the buttock, or the back of the thigh. Tenderness is elicited on making pressure over the joint, on pressing together the iliac bones, or on attempting to abduct the corresponding limb while the pelvis is fixed. As any attempt to bear weight on the limb of the affected side causes pain, the patient walks with a limp, and to save the joint he assumes an attitude which is characteristic. He throws his weight on the sound limb, leans forward using a stick for support, tilts the affected side of the pelvis downwards, and flexes the hip and knee-joints on the affected side. The anterior superior spine is unduly prominent on the affected side, and the limb appears to be lengthened. The muscles of the buttock and thigh are atrophied. Sooner or later, in most cases, an abscess forms, and the pus may reach the

surface directly in the region of the joint. When the pus forms towards the front of the joint it may spread forward as an iliac abscess, or may gravitate downwards in the hollow of the sacrum and emerge on the buttock through the sacro-sciatic foramen. Sometimes it passes into the ischio-rectal fossa or into the perineum. The presence of an intra-pelvic abscess may sometimes be recognised on rectal examination.

Sacro-iliac disease has to be diagnosed from disease in the hip, spine disease, sciatica, and lumbago.

The *prognosis* is on the whole unfavourable, particularly in cases complicated by extensive disease of the ilium with abscess formation and septic infection.

Treatment.—If the patient is able to be out of bed, he should use crutches and wear a patten on the foot of the sound side. The application of a Thomas's hip-splint on the affected side may be useful. In more advanced cases he is confined to bed, and absolute rest to the joint secured by means of extension applied to both legs, or by other suitable apparatus. In children a Phelp's box is a convenient appliance. Counter-irritation by blisters or the actual cautery is sometimes recommended. In dealing with the abscesses which form it is often necessary to remove considerable portions of the ilium to obtain free access to the original seat of the disease.

Syphilitic Disease of the Spine.—All the clinical features of Pott's disease may be simulated by gummatous disease of the vertebræ. This is usually met with in adults who have suffered from acquired syphilis. It rarely occurs in the inherited form of the disease. It is most common in the upper cervical vertebræ, and begins on the anterior surface of the bodies. The onset is more sudden than that of tuberculous caries, and the progress more rapid. The bone is early and extensively destroyed, but abscess formation is rare. Severe nocturnal pains are complained of, and some degree of angular deformity may develop. In almost all cases other evidence of tertiary syphilis is present, and this, together with the history and the rapid improvement which follows anti-syphilitic treatment, renders the diagnosis easy. The local treatment is carried out on the same lines as for tuberculous disease.

Tumours of the Vertebræ.—*Sarcoma* is the most important of the primary tumours met with in the spinal column. It gives rise to symptoms which are liable to be mistaken for those of Pott's disease. The pain, however, is more intense, and the disease progresses more continuously, and is entirely uninfluenced by treatment. In the sacrum—the most common site—the

tumour implicates the sacral nerves, and causes symptoms of intractable sciatica. The presence of the growth is often only detected on making a rectal examination.

Secondary cancer is not uncommon, particularly in cases of advanced scirrhus of the breast. It leads to extensive destruction of the bodies of the vertebræ, so that they are liable to undergo compression similar to that met with in Pott's disease. Clinically it is associated with pain in the region of the vertebræ affected, and along the course of the nerves emerging in the neighbourhood. When paralysis occurs, it is of very rapid development, often becoming complete in a few hours.

Actinomycosis and hydatid cysts also occur in the spine, and are very difficult to diagnose from Pott's disease.

Hysterical Spine.—This term is applied to a functional affection of the spine occasionally met with in neurotic females between the ages of seventeen and thirty, and liable to be mistaken for Pott's disease. The patient complains of pain in some part of the spine—usually the cervico-dorsal or dorso-lumbar region—and there is marked hyperæsthesia on making even very gentle pressure over the spinous processes. As the patients are usually thin, the pressure of the corset is apt to redden the skin over the more prominent vertebræ, and give rise to an appearance which at first sight may be mistaken for a projection. The general condition of the patient, the freedom of movement of the spinal column, and the entire absence of rigidity are sufficient to exclude tuberculosis. The condition is treated on the same lines as other hysterical affections of joints.

Acute suppurative osteomyelitis of the vertebræ is a rare affection. It usually occurs in young subjects, and gives rise to severe localised pain in the region of the vertebræ attacked and to a marked degree of fever. Pus forms rapidly, but is deeply placed, and is not easily recognised unless it points towards the surface. The inflammation is liable to spread to the meninges of the cord and give rise to septic spinal meningitis. The treatment consists in applying extension to the spine, and in opening any abscess which may be detected. The disease usually proves fatal, and, indeed, is often only diagnosed on *post-mortem* examination.

Rheumatic Spondylitis.—In rheumatic subjects the ligaments, muscles, and intervertebral articulations of the vertebræ are liable to undergo changes similar to those met with in other joints. The affected part of the spine becomes stiff and painful, and changes occur in the bones and ligaments which result in permanent rigidity. In the cervical region the spine is twisted

laterally, producing a deformity which simulates wry-neck. In the lumbar region the symptoms simulate those of lumbago. The treatment is the same as for other forms of articular rheumatism.

Arthritis Deformans of Spine.—This term is applied to a condition in which the articular surfaces of the vertebræ undergo

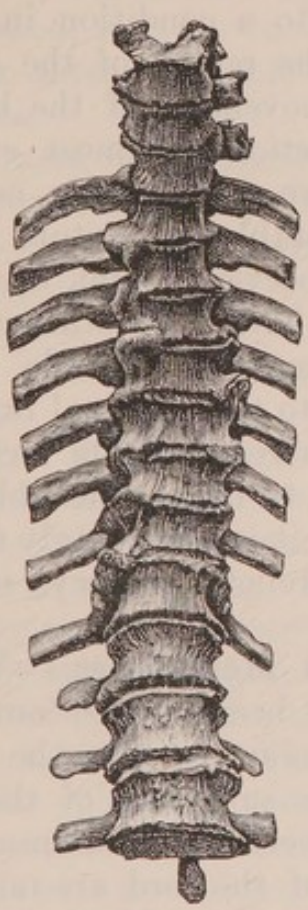

FIG. 20.—Arthritis Deformans of Spine. The vertebræ are fixed to one another by outgrowths of bone which bridge across the inter-vertebral spaces.

(Anatomical Museum, University of Edinburgh.)

FIG. 21.—Advanced Degree of Arthritis Deformans, in which the bodies are fused together by new bone.

(Anatomical Museum, University of Edinburgh.)

changes similar to those of arthritis deformans. The discs disappear, osteophytic outgrowths develop at the margins of the bodies and in connection with the transverse processes, and bridge across the space between neighbouring vertebræ (Fig. 20). The articulations between the ribs and the vertebræ show similar changes, and the ligaments of the several joints tend to undergo ossification, so that the bones are fused together (Fig. 21). The spine becomes rigid and fixed in

the kyphotic attitude, and the deformity leads to embarrassment of respiration. The spinal nerves are liable to be pressed upon as they pass through the intervertebral foramina, and the patient complains of severe pain in the back and shooting pains along the course of the nerves. The treatment is carried out on the same lines as for similar conditions in other joints, but in most cases the relief is but temporary.

Coccygodynia is the name applied to a condition in which the patient experiences severe pain in the region of the coccyx on sitting or walking, and during the movement of the bowels. The pathology is uncertain. The affection is almost entirely confined to females, and the patients are usually of a neurotic type. In some cases the pain is attributable to fracture of the coccyx, or to dislocation of the sacro-coccygeal joint, occurring during labour or from a direct kick or blow. In other cases it appears to be neuralgic in character, and is referable to the fifth sacral and the coccygeal nerves, or to the terminal branches of the sacral plexus distributed in this region. On rectal examination the coccyx is sometimes found to be less movable than normal, and unduly arched forward, and it is exceedingly tender. When medicinal treatment fails to give relief the coccyx may be excised.

Tumours of the Spinal Cord and Membranes.—Within recent years numerous operations have been carried out with varying success for the removal of tumours within the spinal canal. Such growths may occur in the substance of the cord, in the membranes, or in the tissues between the membranes and the bones. Tumours of the substance of the cord are rare, and are seldom amenable to surgical treatment. Meningeal and extra-meningeal tumours are more common, the varieties met with being sarcoma, lipoma and other innocent tumours, tuberculous nodules, syphilitic gummata, and hydatid cysts.

The tumour may press on the nerve-roots, on one half of the cord, or on the whole thickness of the cord, and the symptoms vary accordingly. Pressure on the nerve-roots gives rise to pain, which, according to the seat of the tumour, is of the nature of girdle-pain, or of neuralgic pains shooting along the main nerve trunks of the upper or lower limbs. As the cord becomes pressed upon, there is first motor paresis, followed by complete paralysis, and later by contractures in the paralysed muscles (*spastic paraplegia*). Loss of sensation follows the motor paralysis. When only one lateral half of the cord is pressed upon, the motor paralysis is on the same side as the tumour, and the loss of sensation on the opposite side.

Retention of urine accompanies the onset of paralysis, and later gives place to incontinence. The rectum becomes paralysed, and cystitis and trophic sores develop. Many of these nervous symptoms are due to superadded myelitis.

Anti-syphilitic treatment should be employed in the first instance to exclude the possibility of the lesion being of the nature of a gumma. In deciding where the spinal canal is to be opened, it is to be borne in mind that the lesion is always two or three segments higher than the pain would appear to indicate.

In cases where the tumour cannot be removed by operation the prognosis is hopeless, and the patients usually die in from one to two years from respiratory or septic complications.

Congenital Deformities of Spine.

Spina Bifida.—Spina bifida is a congenital defect in certain of the vertebral arches which permits of a protrusion of the spinal membranes, with or without the nerve structures. It is due to an arrest of development, whereby the closure of the primary medullary groove and the ingrowth of the mesoblast to form the spines and laminæ fail to take place. The cleft may implicate only the spinous processes, but as a rule the laminæ also are deficient. The defect usually extends over several vertebræ (Fig. 22). While the protrusions vary much in size, there is no constant ratio between the dimensions of the swelling and those of the cleft in the spine.

Fig. 22.—Spina Bifida. Note deficiency of arches of several lumbar vertebræ.

(Anatomical Museum, University of Edinburgh.)

The condition is comparatively common, being met with in about one out of every thousand births. It is most frequent in the lumbar and sacral regions, but occurs also in the cervical (Fig. 23) and dorsal regions. It is not uncommon to find spina bifida associated with other congenital deformities such as club-foot or extroversion of the bladder.

Varieties.—Four varieties are usually described according to the character of the protrusion. They are analogous, to a certain extent, to the varieties of cephalocele. (1) *Spinal*

meningocele, in which only the membranes, filled with cerebro-spinal fluid, are protruded. (2) *Meningo-myelocele*, in which the cord and some of the spinal nerves are protruded, and spread out over the inner aspect of the sac (Fig. 24). (3) *Syringo-myelocele*, in which there is a dilatation of the central canal in the protruded part of the cord. Meningo-myelocele is the form most commonly met with clinically. In these three forms the protrusion may be covered by healthy skin, or by a thin, smooth, translucent membrane through which the contents are visible. Frequently this thin covering sloughs or ulcerates, leaving perforations through which cerebro-spinal fluid exudes. (4) The *myelocele*, in which the skin, as well as the vertebral arches and membranes, is absent, and the cord lies exposed on the surface, and there is a copious escape of cerebro-spinal fluid. This form is comparatively common, but as the infants are either dead born or die within a few days of birth, it seldom comes under the notice of the surgeon.

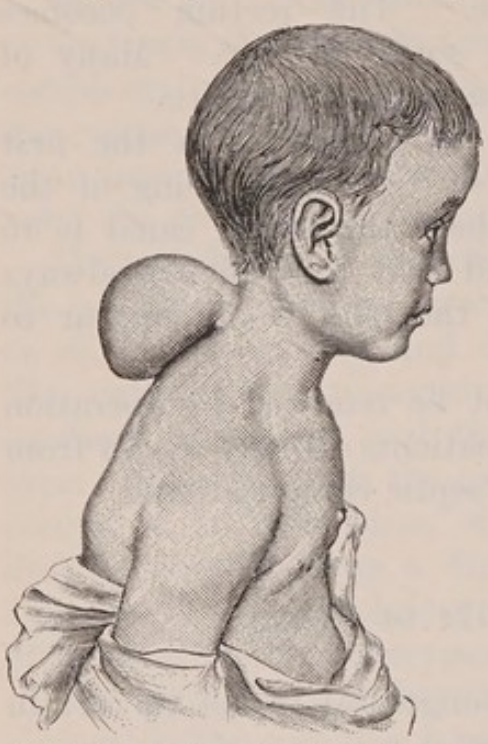

Fig. 23.—Spina Bifida in Cervical Region.

(Mr. Shaw M'Laren's case.)

Clinical Features.—The presence in the middle line of the back of a swelling which has existed since birth, which contains fluid, and which increases in size and tenseness when the child cries or coughs, renders the diagnosis of spina bifida comparatively easy. The swelling is usually sessile but may be pedunculated. A meningocele, as it contains no nerve elements, may be translucent. In a meningo-myelocele the shadows of the cord and nerves stretched out in the sac may be recognised. The presence of the cord is sometimes indicated by a median

Fig. 24.—Meningo-myelocele of Cervical Spine.

furrow over the surface of the swelling. After withdrawal of some of the fluid the cord can sometimes be palpated. It is, however, often very difficult to distinguish between a meningocele and a meningo-myelocele. Gentle pressure applied over the swelling may reduce its size, and in young children may cause a bulging of the fontanelles. This test, however, must be applied with caution as it is liable to induce convulsions. It is usually possible to palpate the edges of the gap in the bones.

Sometimes there are no nervous disturbances, and this is especially the case when the defect is in the lower lumbar and sacral regions beyond the termination of the cord. In most cases, however, there are paralytic symptoms referable to the lower extremities, the bladder and the rectum, and there may also be trophic disturbances in the parts below. Paralytic symptoms, although absent in infancy, may develop during childhood or adolescence.

Prognosis.—Comparatively few children born with spina bifida survive longer than four or five years. The great majority die within a few weeks of birth, death being due to the escape of cerebro-spinal fluid, or to septic infection setting up spinal meningitis. The condition in some cases remains stationary for years, but spontaneous disappearance is rare.

Treatment.—The great majority of cases of spina bifida only call for palliative treatment, which consists in applying an accurately fitting shield and a pad of soft antiseptic wool, and, if the surface is broken, a mild antiseptic dressing.

Operative treatment is indicated only in robust or moderately robust children when the swelling is increasing rapidly and is threatening to burst, and when there is reason to believe that the paralysis is due to pressure. Patients who have survived the early risks and have reached adolescence also may be operated upon.

The operation consists in exposing the neck of the sac by an elliptical incision and isolating the sac. In the case of a meningocele a ligature is applied round the neck of the sac, the sac cut away, and the opening closed in such a way as to prevent escape of cerebro-spinal fluid. In the case of a meningo-myelocele the nerves are separated from the inner aspect of the sac and returned to the spinal canal before the sac is excised. To prevent the cerebro-spinal fluid escaping during the operation, the patient's pelvis should be well raised while the sac is being dealt with.

The gap in the bone may be bridged across by flaps of periosteum or by pieces of bone taken from the adjacent laminæ

or ribs, or engrafted from animals. The soft parts are sutured in successive layers, and the patient is kept in the prone position till the wound heals.

The immediate results of this operation are usually satisfactory, but in a majority of cases the patient subsequently develops hydrocephalus which may prove fatal.

The method of injecting the sac with iodine, as first recommended by Morton of Glasgow, has been almost entirely given up.

The term *spina bifida occulta* is applied to a condition in which there is no protrusion of the spinal contents although the vertebral arches are deficient. The skin over the gap in the bone is often puckered and adherent, and is frequently covered with a growth of coarse hair.

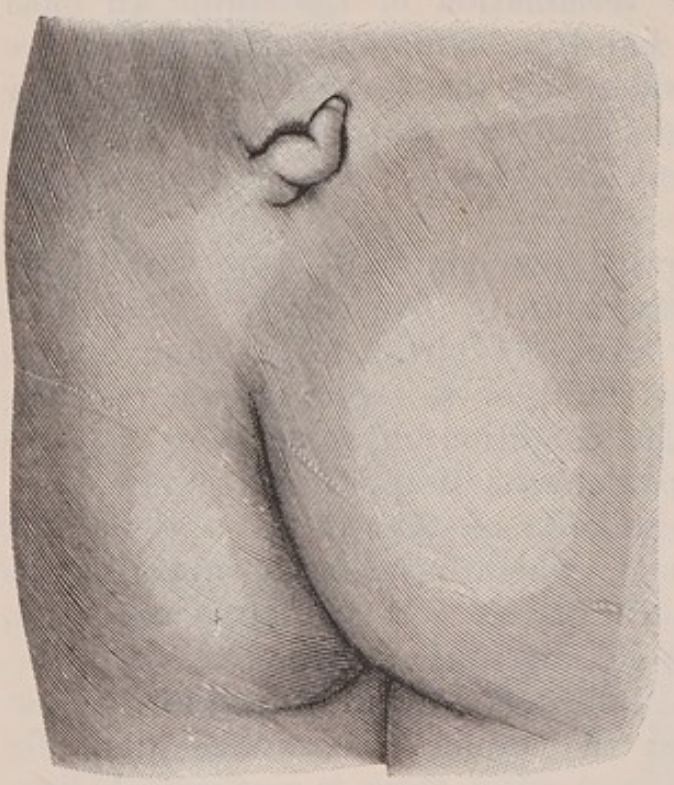

Fig. 25.—Tail-like Appendage over Spina Bifida Occulta.

A mass of fat may project towards the surface, and when situated in the lumbo-sacral region may suggest a caudal appendage or tail (Fig. 25).

The clinical importance of spina bifida occulta lies in the fact that it is sometimes associated with nerve symptoms referable to the lower limbs and the sphincters. Trophic sores may also be present. In some cases these symptoms have been relieved by the removal of a mass of fat from the gap in the vertebral arches.

Congenital Sacro-coccygeal Tumours.—Many varieties of congenital tumours are met with in the region of the sacrum and coccyx. The majority are developed in relation to the communication which exists in the embryo between the neural canal and the alimentary tract—the post-anal gut or neurenteric canal. This canal usually becomes completely obliterated in the course of development, leaving no trace of its existence. It is not uncommon, however, for a shallow depression to be left over the tip of the coccyx—the *post-anal dimple*. Sometimes a dermoid cyst containing a tuft of hair, and less frequently an

adenoma, develops between the coccyx and the rectum. These tumours may project either towards the surface or towards the bowel.

The congenital *lipoma*—a small, rounded, fatty tumour which often suggests a caudal appendage; the *sacral hygroma*, which forms a sessile cystic tumour growing over the back of the sacrum, and which is believed to be a meningocele which has become cut off *in utero* by the continued growth of the spinal arch. Sarcomata, lymphangiomata, and teratomata have also been met with.

The *treatment* consists in removing the tumour if it is causing trouble. From the position of the wound, and the fact that many of these tumours extend into the hollow of the sacrum and therefore necessitate an extensive dissection, there is considerable risk from septic infection, especially in young subjects. The risk is increased when the tumour communicates with the spinal canal.

CHAPTER VIII.

DEVIATIONS OF THE SPINAL COLUMN.

Scoliosis: *Varieties*—Kyphosis: *Varieties*—Lordosis.

Three deviations of the spinal column are here described:—*Scoliosis*, or lateral deviation, in which the spine is arched to one side of the middle line; *Kyphosis*, in which it is unduly arched backwards; and *Lordosis*, in which it is unduly arched forwards.

Scoliosis.—The term scoliosis is applied to a persistent lateral deviation of the spinal column with rotation of the individual vertebræ around a vertical axis. Various forms are met with, that which occurs during adolescence being the most common.

Scoliosis of Adolescents.—*Causes.*—In some cases there is a distinct hereditary tendency to scoliosis, and several members of a family may be affected in succeeding generations. The deformity is most frequently met with in rapidly-growing, anæmic, or chlorotic girls, who are overworked at school and lead a sedentary indoor life. In many cases the development of the scoliosis is coincident with the onset of menstruation. In some it is associated with respiratory obstruction from the presence of adenoids in the naso-pharynx. The free play of the chest is also liable to be interfered with in girls of this age by tight-fitting garments.

In such debilitated subjects the muscular system is weak, and the muscles of the back fail to take their proper share in maintaining the spine erect. The normal ossification of the vertebræ is also interfered with, and the solidity of the vertebral column is therefore defective, with the result that the spine bends under the weight of the body. The patient is easily fatigued, and to rest the muscles and relieve the feeling of tiredness in the back is apt to assume easy and ungainly attitudes.

Scoliosis would therefore appear to be due to the combined influence of weak muscles, imperfectly ossified bones, and the repeated assumption of faulty attitudes.

It would appear that with regard to the production of scoliosis too much stress has hitherto been laid on such factors as the excessive use of one arm in the carrying of weights, the habit of resting on one leg more than the other, the occasional assumption of faulty attitudes in writing, playing the piano or violin, and similar actions.

It is probable that the greater frequency of the primary curvature towards the right is associated in some way with the more general use of the right hand and arm, although primary curvatures towards the left are not confined to left-handed persons.

Morbid Anatomy.—The original deviation or "primary curve" is usually in the dorsal region and has its convexity directed towards the right side. To re-establish the equilibrium of the column, "secondary" or "compensatory" curves, having their convexities to the left, develop in the regions above and below the primary curve. It has been proved experimentally that lateral deviation of the spine is inevitably accompanied by rotation of the vertebræ around a vertical axis, in such a way that their bodies look towards the convexity of the curve, while their spines, laminæ, and articular processes are directed towards the concavity (Fig. 27).

As the deformity increases, the individual vertebræ become distorted, the bodies becoming wedge-shaped from side to side, the base of the wedge looking towards the convexity of the curve while the narrow end looks towards the concavity. As the spines, laminæ, and articular processes also undergo alterations in shape, the tips of the spinous processes do not furnish an accurate index of the degree of lateral deviation of the spine. The ligaments are altered in length in accordance with the changes in the bones. The muscles undergo no structural change except in advanced cases.

In the dorsal region the *ribs* necessarily accompany the transverse processes, so that on the side of the convexity they form an undue prominence behind—the "rib-hump" (Fig. 26), while on the side of the concavity the ribs are flattened and are crowded together so that the intercostal spaces are diminished or even obliterated. The converse—flattening on the side of the convexity and projection on the side of the concavity—is seen on the front of the chest.

The general shape of the thorax is altered, the cavity on the

side of the convexity being longer and narrower than normal and its capacity diminished, while that on the concavity is shorter and broader and its capacity is increased.

The viscera are distorted and displaced in accordance with the altered shape of the thoracic and abdominal cavities. The twisting of the spine causes the patient to lose in stature, and the limbs appear to be disproportionately long. In advanced cases the pelvis becomes obliquely contracted—a deformity known as the scoliotic pelvis.

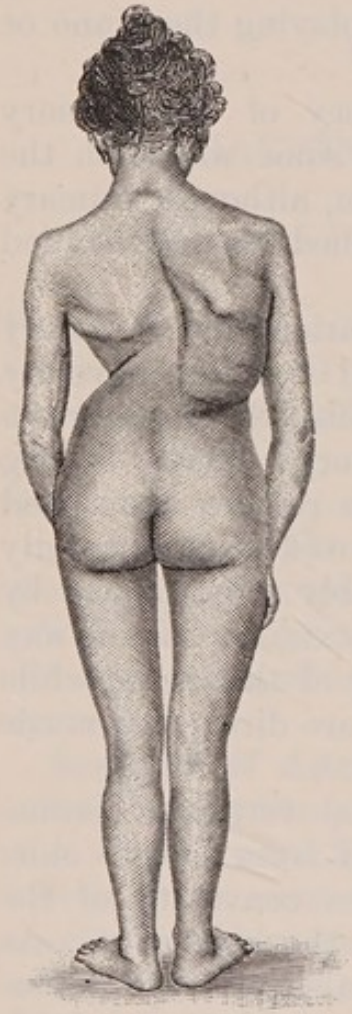

FIG. 26. — Adolescent Scoliosis. Girl, æt. 17. First noticed twelve months before photograph was taken.

In spite of the marked deformity the spinal cord is never compressed.

Clinical Features.—The development of scoliosis is always slow and insidious. As a rule, attention is first attracted to the deformity about the age of puberty, but in most cases it has existed for a considerable time before it is observed. The patient—usually a girl, although it also occurs in boys—is easily fatigued, has difficulty in keeping herself erect, and often complains of pain in the back and shoulders and along the intercostal spaces on the side of the convexity. To relieve the muscles of the back she is inclined to lounge about in easy and ungainly attitudes.

The most common form of scoliosis met with in adolescents is a *primary dorsal curvature* with its convexity to the right (Fig. 26), and with more or less marked compensatory curves towards the left in the lumbar and cervical regions. The dorsal spines lie towards the right of the middle line. On account of the prominence of the ribs the right scapula is projected backwards, and its inferior angle is on a higher level and further from the middle line than that of the left scapula. The right shoulder seems higher than the left, and is popularly said to be "growing out"—a point which is often first observed by the dressmaker. The right side of the back is unduly prominent, while the left side is flattened. A deep sulcus forms in the left flank below the costal margin, and the space between the arm and the chest wall—the "brachio-thoracic triangle"—on

the left side is much more marked than on the right. The left hip is usually projected upwards and backwards. As seen from the front the right side of the chest is flattened, while the left side is abnormally prominent. The right nipple is on a higher level than the left.

In aggravated cases the patient may suffer from shortness of breath on exertion, and the respiratory difficulty may react on the heart, causing dilatation of the right side, palpitation, and precordial pain.

The next most common form is a *primary lumbar* curvature with its convexity to the left (Fig. 27). It is usually met with in males. The deviation of the lumbar vertebræ produces a prominence in the left flank which masks the outline of the hip on that side, while the right flank shows a deep furrow and the hip is unduly prominent. There is a slight compensatory curve to the right in the dorsal region, and the right side of the chest projects backwards. The brachio-thoracic triangle is much more marked on the right than on the left side.

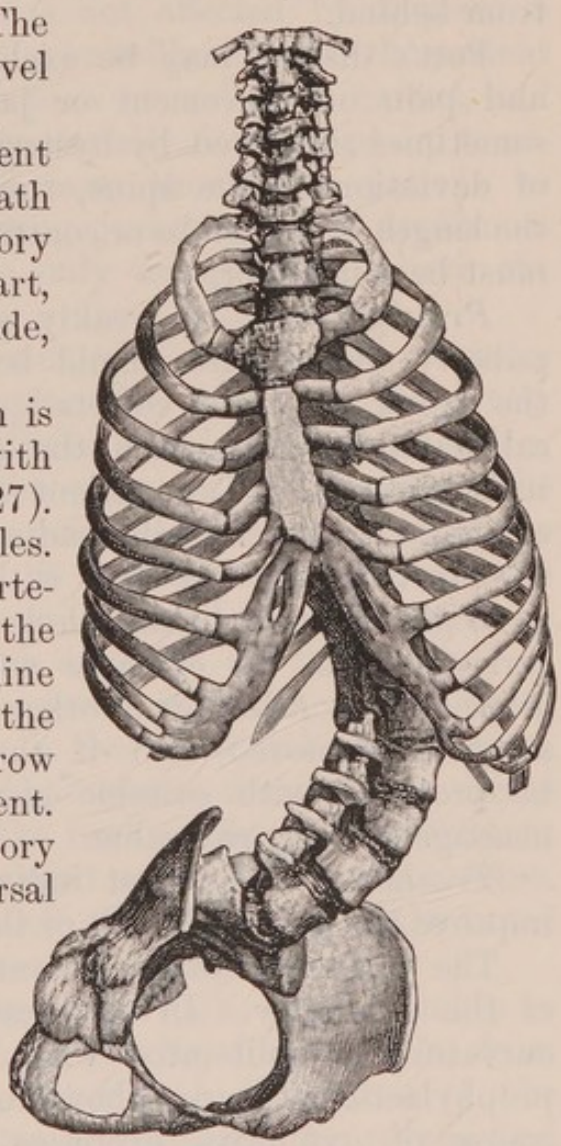

FIG. 27.—Scoliosis in which the primary curvature involves the lumbar region and the convexity is to the left. There is marked rotation of the bodies of the vertebræ.

(Museum of Royal College of Surgeons, Edinburgh.)

Diagnosis.—In many cases the patient is brought to the surgeon on account of pain and weakness in the back before any distinct deviation has developed, and, unless a careful examination is made, the real cause of the symptoms is liable to be overlooked.

The patient should be stripped as far as the buttocks and examined in various attitudes; for example, standing in an easy position, standing as straight as she can, and sitting on a flat stool. In early cases, an inequality in the level of the angles of the scapulæ is often the only physical sign to be detected. It should also be observed whether the line of the spines is altered when the patient hangs from a horizontal bar or trapeze.

Any backward projection of the ribs on one side is rendered more obvious if the patient folds the arms across the chest and bends well forward, while the surgeon looks along the back from behind.

Pott's disease may be excluded by the absence of rigidity and pain on movement or jarring of the spine. Scoliosis is sometimes simulated by hysterical girls. Any mechanical cause of deviation of the spine, such, for example, as inequality in the length of the limbs or contraction of the chest after empyema, must be sought for.

Prophylaxis.—In weakly girls approaching the period of puberty special care should be taken to avoid compression of the trunk by tight corsets; and healthy out-door exercises calculated to strengthen the muscles of the back should be insisted upon. The patient must not be allowed to assume awkward attitudes while reading, writing, or playing the piano; she must sit on a low chair with a sloping back so constructed as to give support to the whole length of the spine. Those who carry weights, for example nurse-maids, should use the arms alternately. Adenoids or other sources of respiratory obstruction must be removed, and if the patient is myopic she should be provided with suitable glasses. Gymnastic exercises and massage are of great value.

Treatment.—The first indication in treating scoliosis is to improve the general health of the patient in every possible way.

The treatment in adolescents depends largely on the extent of the deformity. In mild cases—that is, cases in which the curvature is obliterated when the patient is suspended—the prophylactic measures above mentioned, including a systematic course of gymnastic exercises and massage, must be rigidly enforced. This treatment should not be commenced, however, until all pain and feeling of tiredness in the back have disappeared after a period of rest in bed.

The exercises should be carried out twice or thrice daily, at first in a recumbent position, and later while standing erect. They are to be carried out slowly, the patient breathing naturally while making the movements. They should cease as soon as the patient begins to feel fatigued, and after each séance she should rest, lying on her back on a couch for an hour. As the muscles gain strength, the movements may be made against resistance, for example with a Whiteley's exerciser.

In more severe cases—where, for example, the curvature is diminished but not obliterated by suspending the patient—in addition to the exercises above referred to, the patient should

hang for a few minutes several times a day on an oblique bar, the hand on the side of the convexity grasping the lower end of the bar. In this way the curve is to some extent opened out.

In cases where the curvature is not affected by suspension the deformity is irremediable, but by suitable exercises the patient may be educated to disguise it to a considerable extent, and the pain and disability may be materially diminished by treatment. Only in very aggravated cases should the patient be recommended to wear a supporting jacket. Such appliances have no curative effect, and are only designed to relieve the symptoms.

Other forms of scoliosis are met with, but are less common. In rickety children, for example, the spine is frequently deviated. The curvature is usually in the dorso-lumbar region, and the convexity may be to the right or to the left. The deformity is often extreme and constitutes the hump-back of the rickety dwarf (Fig. 196, vol. i.). It is possible that the position in which the child habitually lies or is carried has some influence in determining the situation and direction of the curve. A rickety child with weak muscles should never be carried sitting on the nurse's arm, but always in the horizontal position in a flat wicker basket. Massage and salt-water douches are useful in strengthening the muscles of the back. The usual treatment for rickets must, of course, be carried out. Late rickets, osteomalacia, and other diseases attended with softening of the bones and general debility, are also causes of scoliosis.

In children who have commenced to walk, any inequality in the length of the limbs — such as results, for example, from infantile paralysis, hip disease, congenital dislocation of the hip or genu-valgum — necessitates a tilting of the pelvis, and may determine the development of a lateral deviation of the spine (*static scoliosis*). In addition to the treatment already described, the length of the limbs must be equalised by wearing a boot with a thick sole.

Scoliosis may develop from purely mechanical causes; for example, in cases of empyema followed by collapse of the lung, in Pott's disease, and in traumatic lesions of the spine. It may also occur in association with sciatica and lumbago. It is frequently met with in those who have suffered from infantile paralysis.

Kyphosis.—Kyphosis, or backward curvature of the spine, may be due to a variety of causes. Those forms which result from Pott's disease and injury have already been mentioned.

In *infants* it is usually a manifestation of rickets or of

general debility. The weak muscles, ligaments and bones are unable to support the weight of the body, and when the child is carried in the sitting posture, or attempts to sit or stand, the spine arches backwards, usually in the dorso-lumbar region at first, and later throughout its whole length. In most cases the deformity disappears as the child grows older and gains strength, but in some it is followed by scoliosis. Treatment is carried out on the same lines as for infantile scoliosis.

In *adolescents* also the development of kyphosis is generally due to an enfeebled condition of the muscles of the back. The curve is usually first observed in the cervico-dorsal region, the patient becoming "round-shouldered." This deformity is often determined in rapidly-growing girls by their assuming a stooping position for prolonged periods; for example, in sewing, writing, or piano-playing. In those who are myopic the necessity of bending over their work increases the tendency to kyphosis. The treatment consists in removing the causes of the condition, and in employing exercises, massage, and tonic treatment on the same lines as for scoliosis.

In *adults* who follow occupations which involve continuous stooping, such as tailors, cobblers, or porters, persistent bending of the back may result. Certain diseases, such as arthritis deformans, osteitis deformans, and acromegaly, are often associated with kyphosis. These are included under the term *spondylitis deformans.*

Lordosis.—An exaggeration of the normal forward curvature of the lumbar spine sometimes occurs in street hawkers and others who habitually carry weights suspended in front of them. In very obese persons, in those who suffer from large abdominal or pelvic tumours, such as uterine fibroids, and in pregnant women, a more or less marked degree of lordosis is often produced.

In another group of cases lordosis is compensatory to the flexion of the hip and tilting of the pelvis which accompany tuberculous disease of the hip-joint, congenital dislocation (Fig. 237, vol. i.), Charcot's disease of the hip (Fig. 229, vol. i.), or ankylosis of the joint in the flexed position

CHAPTER IX.

THE FACE, ORBIT, AND LIPS.

FACE—Congenital malformations: *Hare-lip and cleft palate; Macrostoma; Microstoma; Facial cleft; Mandibular cleft*—Injuries of soft parts: *Wounds; Burns*—Tumours: *Epithelioma.* ORBIT—Injuries: *Contusion; Wounds; Fractures*—Injuries of eyeball—Orbital cellulitis—Tumours. LIPS—*Cracks; Chronic induration; Tuberculous ulcers; Syphilitic lesions*—Tumours: *Nævi; Lymphangioma; Cysts; Epithelioma.*

THE FACE.

CONGENITAL MALFORMATIONS.—The description of the various congenital malformations of the face will be simplified by a brief consideration of the normal development of the parts.

Development.—About the middle of the first month of intra-uterine life the prosencephalon bends acutely forward over the end of the notochord and sends out from its base a series of processes which ultimately blend to form the face (Fig. 28). These processes surround a stellate depression, the primitive buccal cavity or stomodæum, from which the mouth and nasal cavities are developed later. The buccal cavity is bounded above by the fronto-nasal process, which is divided by a fissure—the nasal cleft—into a mesial nasal or globular process and a lateral nasal process.

From the mesial nasal and globular processes the septum of the nose, the inner segment of the premaxillary bone, and the middle portion of the upper lip are developed; while the lateral nasal process forms the roof of the nasal cavity, the ala nasi and adjacent portion of the cheek, and the outer segment of the premaxillary bone. Each segment of the premaxilla or os incisivum carries one of the incisor teeth, and each of the mesial segments may contain in addition an accessory tooth. The nasal cleft ultimately becomes the anterior nares.

The primitive buccal cavity is bounded below by the mandibular arch, which contains Meckel's cartilage, and from which are developed the lower jaw, the lower lip, and the floor of the mouth.

From the outer and back part of the mandibular arch springs the maxillary process, which grows upwards and blends with the lateral nasal process across the naso-orbital cleft—the deeper portion of

which persists as the nasal duct. From the maxillary process are developed the cheeks, certain of the facial bones, the lateral portions of the upper lip, the soft and hard palate (with the exception of the

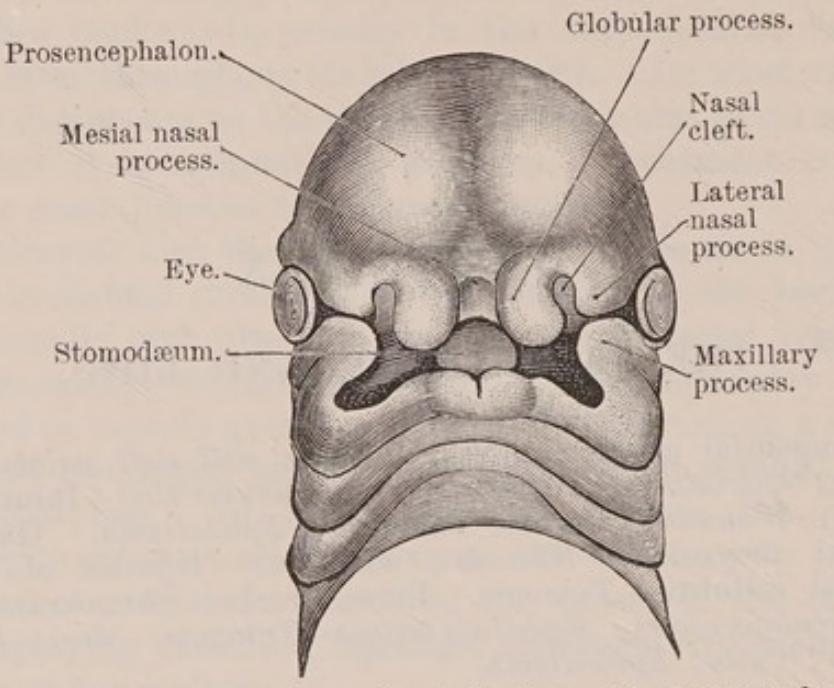

FIG. 28.—Head of human embryo about 29 days old, showing the division of the lower part of the mesial frontal process into the two globular processes, the intervention of the nasal clefts between the mesial and lateral nasal processes, and the approximation of the maxillary and lateral nasal processes, which, however, are separated by the naso-orbital cleft (after His).

intermaxillary bone). The development of the face is completed about the end of the second month of intra-uterine life.

HARE-LIP AND CLEFT PALATE.

Hare-lip is a congenital notch or fissure in the substance of the upper lip, and cleft palate a congenital defect in the roof of the mouth. Either of these conditions may exist alone, but they occur so frequently in combination that it is convenient to consider them together.

In hare-lip the cleft may be median or lateral, and it may or may not be associated with a cleft in the palate. The resemblance to the Y-shaped cleft in the upper lip of the hare, suggested by the name, is in most cases only superficial.

Median hare-lip is extremely rare. It occurs in two forms; one in which there is a simple cleft in the middle of the lip, the result of non-union of the two globular processes of the mesial nasal process; another in which there is a wide gap due to entire absence of the parts developed from the mesial nasal process—the central portion of the lip, the inner segment of the pre-

maxillary bone, and the septum of the nose. The second form is usually associated with cleft palate.

Lateral hare-lip is much more common. It is due to imperfect fusion of the mesial nasal process with the labial plates of the maxillary process. There may be a cleft only on one side of the lip, or the condition may be bilateral. In some cases the cleft merely extends into the soft parts of the lip—*simple hare-lip* (Fig. 29), forming a notch with rounded margins on which the red edge of the lip shows almost to the apex. In other cases the cleft passes into the alveolus of the jaw—*alveolar hare-lip*—partially or completely separating the inner and outer segments of the premaxillary bone. These cases are usually combined with cleft palate (Fig. 30).

FIG. 29.—Simple Hare-lip

FIG. 30.—Unilateral Hare-lip with Cleft Alveolus.

When the hare-lip is *bilateral*, the two clefts may be unequal, one forming a simple notch in the lip, the other passing into the nostril. In most cases, however, both clefts are complete, and the mesial portion of the lip is entirely separated from the lateral portions. The central portion or prolabium is usually smaller than normal, and is closely adherent to the premaxillary bone. This bone may retain its normal position in line with the alveolar processes of the upper jaw

(Fig. 31), or it may be tilted forward so that the incisor teeth, when present, project beyond the level of the prolabium (Fig. 32). In aggravated cases the os incisivum and prolabium are adherent to the end of the nose. In these cases there is a Y-shaped cleft in the palate.

Fig. 31.—Double Hare-lip in a girl æt. 17.

Cleft Palate. — It has already been mentioned that the palate is formed by the blending of the two palatal plates of the maxillary processes with the four segments of the premaxillary bone, derived from the nasal processes. The anterior palatine foramen marks the point at which these elements of the palate unite. The process of fusion begins in front and spreads backwards, the two halves of the uvula being the last part to unite.

Fig. 32.—Double Hare-lip with Projection of Premaxillary Bone.

As development may be arrested at any point, several varieties of cleft palate are met with. The uvula, for example, may be bifid, or the cleft may extend throughout the soft palate. In more severe cases it extends into the hard palate as far forward as the anterior palatine foramen. In these varieties the whole cleft is mesial. In still more aggravated cases the cleft passes farther forward, deviating to one or to both sides in the fissures

between the inner and outer segments of the premaxillary bone, or between the outer segments and the superior maxillæ. These cases are combined with double hare-lip.

The cleft varies considerably in width. It may be so wide that the imperfectly developed nasal septum is seen between its edges, and gives to the cleft the appearance of being double, or the septum is adherent to one edge of the palate—usually the right—and the cleft appears to be to the left of the middle line. In most cases the roof of the mouth is unduly arched, and is narrower than normal.

Clinical Features.—Single hare-lip is about twice as common on the left as on the right side, and it occurs more frequently in boys than in girls. In a considerable proportion of cases there is a well-marked hereditary tendency to these deformities, and they frequently occur in several members of a family.

The nose is characteristically broad and flattened, the ala being bound down to the alveolar margin of the jaw by fibrous tissue. The margins of the cleft in the lip are also attached to the alveolus by firm reflections of the mucous membrane. The orbicularis oris and other muscles of expression about the mouth being defective, the deformity is exaggerated when the child cries or laughs.

In simple hare-lip the child may have difficulty in sucking, but this can usually be overcome by some mechanical contrivance to occlude the cleft. When the hare-lip is double and combined with cleft palate, the child is unable to suck, and food introduced into the mouth tends to regurgitate through the nose. The nutrition can only be maintained by having recourse to spoon-feeding, and in feeding the child it is necessary to throw the head well back and to introduce the food directly into the back of the pharynx. Many of these patients are of such low vitality, however, that in spite of the most careful feeding they emaciate and die of inanition.

In those who survive, the voice has a peculiar nasal twang, as in phonation the air is expelled through the nose instead of through the mouth, and the articulation, especially of certain consonants, is very indistinct. Taste and smell are deficient. The constant exposure of the nasal and pharyngeal mucous membrane renders it liable to attacks of catarrhal inflammation and granular pharyngitis.

Treatment.—The only means of treating these deformities is by operation, and, speaking generally, it may be said that the earlier the operation is performed the better, provided the general condition of the child is equal to the strain. In simple

hare-lip the best time is between the sixth and the twelfth weeks. When cleft palate co-exists with hare-lip, the lip should be operated on first, as the closure of the lip often exerts a beneficial influence on the cleft in the palate, causing it to become narrower.

The operation for cleft palate is usually undertaken towards the end of the second year. It should not be delayed longer, because, even if the cleft in the palate is repaired, the nasal character of the voice persists, as the patient cannot overcome the habit of expelling the air through the nose.

Before the operation is undertaken, the child must be got into the best possible condition of health; and arrangements must be made for its constant supervision by a competent nurse. Success depends largely on the avoidance of septic complications, and on absence of tension between the rawed surfaces which are brought into apposition. These operations should never be undertaken while the child is suffering from any illness which causes coughing or excessive crying.

Operation for Hare-lip.—In operating for hare-lip steps must be taken to free the ala of the nose and the margins of the cleft from their attachment to the maxilla, and to support the ala in such a way that the flattening is corrected. Provision must also be made for the formation of a papilla on the free margin of the lip.

Where there is merely a slight notch in the lip, Nélaton's operation is appropriate. It consists in carrying a $\wedge$-shaped incision through the substance of the lip around the notch, but without dividing the free edge of the lip. The apex of the notch is drawn down and the wound becomes lozenge-shaped. It is then sutured in its vertical axis.

In cases of complete hare-lip Rose's operation may be employed. The edges of the cleft are pared in a crescentic manner, so that, when the raw surfaces are brought into apposition, a projecting papilla is formed on the free margin of the lip.

Where the gap is wide, and it is undesirable to sacrifice tissue by paring the edges, the method of splitting the lip along the junction of skin and mucous membrane, suggested by John Duncan, may be employed. To form a papilla two small flaps are cut from the lower margins of the cleft and turned down. The skin edges are united by one row of sutures, and the edges of the mucous membrane by another.

In cases of *double hare-lip* in which the premaxilla retains its normal position, it is only necessary to separate the prolabium from the bone and to pare its margins so that they fit accurately

between the outer edges of the clefts. The outer margins of the clefts are pared by a crescentic incision, and the margins of the prolabium in a rectangular or Y-shaped fashion according to circumstances.

When the premaxillary bone projects forward, it should be replaced in position. Its replacement may be facilitated by excising a V-shaped segment from the bony septum of the nose. The prolabium is pared and utilised in closing the cleft in the lip, or in forming a columna for the nose. It should never be brought down to the free margin of the lip, as this usually results in depressing the tip of the nose.

In suturing the lip silver wire or silkworm gut should be employed for the deep stitches, and horse-hair for the superficial ones. A light dressing of sterilised gauze is applied, and fixed in position by flexile collodion. The deep stitches are removed on the fourth or fifth day, and the superficial ones on the eighth or tenth day. A dumb-bell shaped piece of adhesive plaster may be worn for some weeks after the removal of the stitches to prevent stretching of the cicatrix.

Operation for Cleft Palate.—The term *uranoplasty* is applied to the operation for complete cleft palate, while the closure of a cleft in the soft palate alone is known as *staphylorraphy*. The operation of Langenbeck is that usually employed. The patient is placed on the table with the chest raised, and the head slightly dependent, in order that blood and mucus may gravitate readily towards the back of the pharynx.

To enable the soft parts covering the hard palate to be brought together in the middle line it is necessary to separate them from the bone in the form of a muco-periosteal flap. This is done by carrying an incision down to the bone from the level of the last molar tooth to the level of the lateral incisor tooth, about a quarter of an inch internal to the alveolar edge. This incision passes internal to the posterior palatine artery and stops short of the anterior palatine. In this way bleeding is avoided, and the vascular supply of the flap is preserved. The flap is then separated from the bone by means of an elevator sufficiently freely to allow of the edges of the cleft being approximated without tension. It is often necessary to carry the lateral incision backwards into the anterior pillar of the fauces, to divide the palatal aponeurosis and the levator palati in the region of the hamular process. To pare the edges the uvula is held with catch forceps, the edge made taut, and a narrow shaving removed by means of a bistoury. The connections with the septum of the nose are divided with a pair of curved scissors.

After paring both edges in this way, interrupted sutures of silver wire, silk, or horse-hair are introduced.

In the after-treatment steps should be taken to prevent vomiting, crying, or coughing. The child must be fed on fluids, carefully administered with a spoon. The mouth must be kept sweet by frequent sponging with a mild antiseptic, such as boro-glyceride, or spraying with peroxide of hydrogen. The sutures may generally be removed in about a fortnight. The raw surface left on each side along the inner margin of the alveolus speedily granulates, the vitality of the palate bone being maintained from its nasal aspect.

An alternative and in many respects a more efficient method of closing the palatal cleft is that introduced by Davies-Colley and modified by Arbuthnot Lane. It consists in raising the soft parts from the palate and adjacent alveolus in the form of flaps, which are folded across the cleft in such a way that their raw surfaces are opposed to one another. The time of operating may also be altered with advantage; according to Lane the best time is the day after birth, or as soon after that as possible.

Voice Training.—The treatment of cleft palate does not cease with a successful operation; the importance of voice training must be explained to the parents.

Mechanical appliances, such as obturators or artificial vela, are only to be recommended in aggravated cases of cleft palate, or in cases in which operative treatment has failed. They should be in the form of plates of vulcanite or gold, fitted to the teeth and kept in position by suction.

Other Congenital Deformities of the Face.—*Macrostoma* is an abnormal enlargement of the mouth in its transverse diameter, due to imperfect fusion of the maxillary and mandibular processes.

Microstoma is due to excessive fusion of the maxillary and mandibular processes. In some cases the mouth is so small as only to admit a probe.

Facial cleft is due to non-closure of the fissure between the nasal and maxillary processes. It passes from the lip through the cheek to the margin of the orbit.

Mandibular cleft is due to non-union of the two lateral halves of the mandibular arch.

Injuries of the Soft Parts of the Face.—Wounds on the face present the same general characters as wounds elsewhere. Punctured wounds may be complicated by perforation of the orbit or cranial cavity. When the maxillary sinus is injured, emphysema may result from escape of air into the cellular

tissue. In incised wounds the bleeding is usually very free at first, but unless one of the larger arteries, such as the facial or temporal, is injured, it soon ceases. The facial, supra-orbital, and infra-orbital nerves are liable to be injured, causing paralysis or loss of sensation. In wounds of the cheek Stenson's duct may be damaged and a salivary fistula result.

Contused and lacerated wounds frequently result from explosions and injuries by firearms, and foreign bodies may lodge in the tissues. Owing to the extreme vascularity of the tissues sloughing seldom occurs, even when the parts are severely damaged. Ligatures are seldom necessary for the arrest of hæmorrhage unless the larger branches are injured, as the bleeding from smaller twigs is arrested by the sutures. Every effort should be made to remove foreign bodies, such as particles of stone or coal, or grains of gunpowder and small shot, as these, if left embedded in the tissues, cause unsightly pigmentation of the skin. The edges of the wound are approximated by a series of interrupted horse-hair stitches. A fine Hagedorn needle is to be preferred, as it leaves less mark than the ordinary bayonet-shaped needle. If the mucous membrane of the mouth is implicated, its edges should be approximated by a separate row of stitches introduced from the inside.

FIG. 33.—Cicatricial Contraction following Burn in Childhood, causing extreme deformity of mouth, neck, and upper extremity.

The *complications* of face wounds, such, for example, as erysipelas, secondary hæmorrhage, cephalic tetanus, are attributable to septic infection.

Cicatricial contraction after severe *burns* of the face may lead to marked deformities of the eyelids, mouth, and nose. When the burn has implicated the neck, the chin may be drawn towards the chest, and the movements of the lower jaw and head seriously impeded (Fig. 33).

Tumours.—The simple tumours met with on the face include

sebaceous and dermoid cysts, nævi, plexiform neuromata and adenomata; the malignant forms include the squamous epithelioma, and rodent, paraffin, and melanotic cancers.

Epithelioma occurs most frequently in men beyond the age of forty. The tumour usually begins near a junction of skin with mucous membrane, as, for example, at the margin of the lip, the edge of the nostril, or the angle of the eye. There is usually a history of prolonged or repeated irritation, or the tumour may develop in connection with a scar, a wart, a cutaneous horn, or an ulcerating sebaceous cyst. It may begin as a hard nodule, or as a papillary growth which soon breaks down on the surface leaving a deep ulcer with a characteristically indurated base. The neighbouring lymphatic glands are infected early, but metastases to other organs are not common. The treatment consists in excising the growth and the associated lymphatic glands as early and as freely as possible.

THE ORBIT.

Injuries.—*Contusion* of the eyelids and circum-orbital region —the ordinary "black eye"—is associated with extravasation of blood into the loose cellular tissue of these parts, and is followed within a few hours of the injury by marked ecchymosis and discoloration. The lids may swell to such an extent that the eye is completely closed. In some cases the impinging object lacerates some of the vessels of the conjunctiva, and produces a sub-conjunctival ecchymosis which may be situated under the palpebral conjunctiva of the lower lid, or close to the corneal margin on the front of the globe. The characteristic play of colours which attends the disappearance of effused blood is observed within a week or ten days of the injury.

This condition is to be distinguished from the effusions which sometimes follow such injuries as fracture of the anterior fossa of the skull, fracture of the orbital ridges, or bruises of the frontal region of the scalp, chiefly by the facts that in black eye the discoloration comes on within a very short time of the injury, that the swelling appears simultaneously in both lids, and that the sub-conjunctival ecchymosis, when present, is coeval with the ecchymosis of the lids. In fractures of the orbital plate and bruises of the forehead, on the other hand, the ecchymosis does not appear in the eyelids for several days, and that under the conjunctiva is usually disposed on the globe as a triangular patch towards the outer canthus of the eye.

Firm pressure applied by means of a pad of cotton wadding and an elastic bandage, if employed early, may limit the effusion of blood; and massage is useful in hastening its absorption.

Wounds of the orbit may result from the introduction of pointed objects, such as knitting-pins, pencils, or fencing-foils, or from chips of stone, or metal, or small shot. They are attended with considerable extravasation of blood, which may be diffused throughout the cellular tissue of the orbit, or may form a defined hæmatoma. In either case the eyeball is protruded, and the cornea is exposed to irritation, and may become inflamed and ulcerated. The optic nerve may be lacerated, and complete and permanent loss of vision result. Sometimes the ocular muscles and nerves are damaged, and deviation of the eye or loss of motion in one or other direction is produced. The globe itself may be injured. Foreign bodies lodged in the orbit, so long as they are aseptic, may give rise to little or no disturbance, and are liable to be overlooked. The Röntgen rays are often useful in determining the presence and position of a foreign body.

All wounds of the orbit require to be carefully purified to prevent septic complications which might endanger the eyeball or the adjacent cranial cavity. In extracting foreign bodies, great care is necessary to avoid injury of the eyeball or of its muscles or nerves.

Fracture of the margin of the orbit may result from a direct blow, and is usually followed by marked circum-orbital and sub-conjunctival ecchymosis. Implication of the frontal sinus may be followed by emphysema of the orbit and lids.

The *roof* of the orbit is implicated in many fractures of the anterior fossa of the skull produced by indirect violence. It is also liable to be fractured by pointed instruments thrust through the orbit, in which case septic intra-cranial complications are liable to ensue, and these in a large proportion of cases prove fatal. When the inner wall is fractured and the nasal fossa opened into, epistaxis and emphysema of the orbit are constant symptoms. Sub-conjunctival ecchymosis, and more or less marked exophthalmos, are almost always present. Treatment is directed towards the complications. When the nasal fossæ or the air sinuses are opened into, the patient should be warned against blowing his nose, as this act is liable to induce or increase emphysema of the orbit or lids.

Injuries of the Eyeball.—These injuries may be divided into two groups—(1) those in which the globe is contused without its outer coat being ruptured, and (2) those in which the outer coat is ruptured.

In cases belonging to the first group, while the sclerotic coat and cornea remain intact, the iris may be partially torn from its ciliary origin, and the blood effused collects in the lower portion of the anterior chamber; or the pupillary margin of the iris may be ruptured at several points, causing apparent dilatation of the pupil. The crystalline lens may be partially or completely dislocated, and in the latter case it may pass forward into the anterior chamber or backward into the vitreous. Among other injuries resulting from contusion of the eye may be mentioned hæmorrhage into the vitreous, rupture of the choroid, and detachment of the retina.

Injuries in which the outer coat of the eyeball is ruptured may be further subdivided into two groups according to whether or not a foreign body is lodged in the globe.

Rupture of the outer coat, especially when it results from a punctured wound, adds greatly to the risk of the injury by opening up a path through which septic material may enter the globe, and this risk is materially increased when a foreign body is retained in the cavity of the eyeball.

When the globe is burst by a blow with a blunt object, the sclerotic usually gives way, and as the rupture takes place from within outwards, there is less risk of septic infection than in cases of punctured wounds. The lens may be extruded through the wound, and the iris prolapsed. If the rupture is large, the conjunctiva torn, and the globe collapsed from loss of vitreous, the eye should be excised without delay. If sight is not entirely lost and no marked collapse of the globe, an attempt should be made to save the eye.

Wounds produced by stabs or punctures are very liable to be followed by septic complications ending in panophthalmitis. When this is threatened, excision of the eye is indicated, not only because the affected eye is destroyed beyond hope of recovery, but to avoid the risk of "sympathetic ophthalmia" affecting the other eye.

Orbital Cellulitis.—The loose cellular tissue of the orbit is frequently the seat of an acute and diffuse inflammation which usually passes on to suppuration. It is met with at any age, but is most common in adults. As a rule it is unilateral, but both orbits may be affected. The pyogenic bacteria which give rise to the condition may gain access to the orbit through punctured wounds or compound fractures, particularly when foreign bodies are lodged in the cavity, or they may spread directly from the conjunctiva or eyeball when these are the seat of suppurative processes. Orbital cellulitis may also be secondary

to erysipelas of the face, or to inflammatory conditions in the nasal fossæ or their accessory air sinuses.

Clinical Features.—The disease is ushered in by general malaise, rigors, high temperature, and severe pain which radiates all over the affected side of the head. There is marked exophthalmos and fixation of the globe, with redness, swelling, and tenderness of the eyelids, and congestion and ecchymosis of the conjunctiva. The pupil is usually dilated, and the cornea becomes opaque and may ulcerate. There is photophobia and sometimes diplopia. Resolution is rare. The pus which forms burrows in every direction, and may ultimately point through the eyelids or conjunctiva. Sometimes the inflammation spreads to the meninges of the brain, or it may set up a thrombo-phlebitis of the ophthalmic vein which spreads to the cavernous sinus. The eyeball may be infected and destructive panophthalmitis result. The prognosis is therefore always grave.

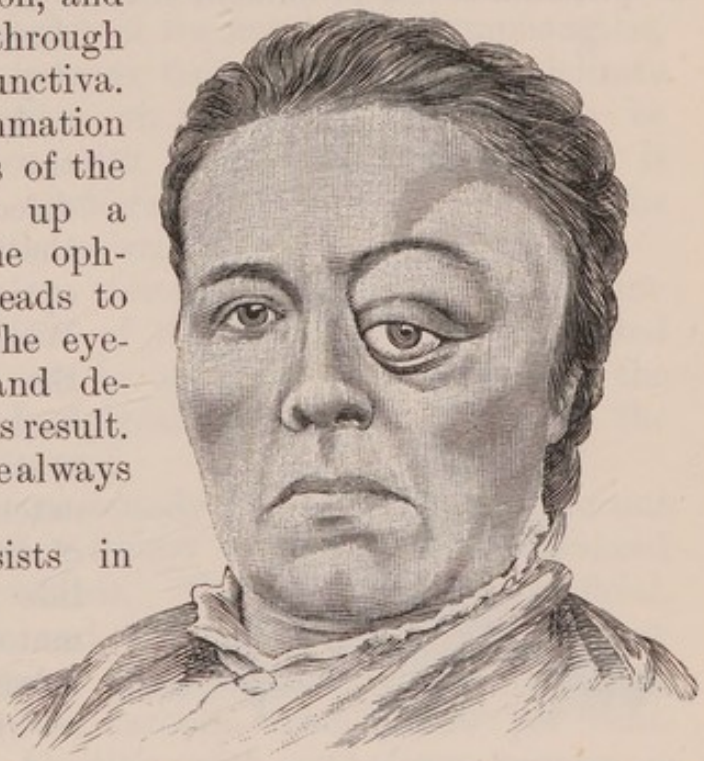

Fig. 34.—Sarcoma of Orbit, causing exophthalmos downward displacement of the eye, and projecting in temporal region.

The *treatment* consists in making one or more incisions into the cellular tissue for the purpose of evacuating the pus and establishing drainage. A narrow bistoury is passed in parallel to the wall of the orbit, care being taken to avoid injuring the globe. When possible, the incision should be made through the conjunctiva, but in some cases efficient drainage can only be established by incising through the lid. When the eye is destroyed by panophthalmitis, the propriety of eviscerating or enucleating it will have to be considered.

Tumours of the Orbit.—Tumours may originate in the orbit or may invade it by spreading from adjacent cavities. Those which originate in the orbit may be solid or cystic. Of the solid tumours the round or spindle-celled sarcoma is the most common. Melanotic tumours also occur, and they probably always originate in the pigmented structures of the globe.

Primary carcinoma begins in the lachrymal gland. Osteoma—usually the ivory variety—may originate in the wall of the orbit, or may spread thence from the adjacent sinuses.

Of the cystic tumours the dermoid is the most common. It usually occurs at the outer angle of the orbital margin (Fig. 35). A less common situation is the anterior part of the orbit, near the nasal wall, and this variety, from its position and from the fact that it is usually met with in children, is liable to be confused with orbital meningocele or encephalocele.

Clinical Features.—In all varieties of intra-orbital tumour exophthalmos is a prominent feature (Fig. 34). The degree and direction of the displacement depend on the position, size, and direction of growth of the tumour. It is seldom directly forward except when the tumour is growing in the optic nerve or its sheath. When the tumour is solid the eye cannot be pressed back into the orbit, but in cystic tumours it may to some extent. When the protrusion of the eyeball is marked, the lids become swollen, œdematous, and dusky. The movements of the eyeball are restricted in a varying degree, and ptosis often results from paralysis of the levator palpebræ superioris. In almost all cases there is also more or less visual disturbance. The cornea being unduly exposed is liable to become inflamed, or even ulcerated. Pain is a variable symptom. When present it usually radiates along the branches of the first and second divisions of the trigeminal nerve. Tenderness on pressure is not always present. It is comparatively uncommon for a tumour of the orbit to invade the globe directly.

Fig. 35.—Dermoid Cyst at outer angle of orbital margin.

Treatment.—In all cases removal of the tumour is the only method of treatment. In malignant tumours it is often necessary to sacrifice the eye to ensure complete removal. When the tumour has invaded the orbit secondarily, its removal may be impossible, but it may be necessary to excise the eye for the relief of pain.

Orbital aneurysms have already been described, vol. i. p. 290.

THE LIPS.

Painful *cracks and fissures* are frequently met with in the middle line of the lip and at the angle of the mouth in young subjects. They usually develop during frosty weather, and as they are constantly being torn open by the movements of the mouth, they are difficult to heal. The application of glycerine or lanoline may be employed. In many cases it is necessary to cocainise the fissure and scrape it with a sharp spoon.

Chronic Induration of the Lips (*Strumous Lip*).—A chronic œdematous infiltration, probably of the nature of a lymphangitis, sometimes affects the sub-mucous tissue of the lips of delicate children. It is most common on the upper lip, and may be associated with a fissure or with chronic coryza. The lip is everted, and its mucous membrane unduly prominent. The cervical glands are frequently enlarged.

The *treatment* consists in removing the cause and in improving the general condition of the patient. In exaggerated cases of long standing it may be necessary to remove from the inner aspect of the lip a horizontal strip of tissue having the shape of a segment of an orange.

Tuberculous ulcers are occasionally met with on the mucous membrane of the lips of patients suffering from advanced pulmonary or laryngeal phthisis. They are usually superficial, may be single or multiple, and are exceedingly painful. They may be treated by scraping with a sharp spoon, and subsequent painting with pure carbolic acid or 20 per cent. solution of lactic acid. Dusting with orthoform powder is useful in relieving pain.

Lupus may spread to the lip from the nose or face.

Syphilitic Lesions.—The upper lip is the most frequent seat of extra-genital chancre. Infection may take place by direct contact with a syphilitic sore or mucous patch—as in the act of kissing, or, in the case of infants, from the nipple of a syphilitic wet nurse. In other cases infection is transmitted through the medium of spoons, drinking glasses, or tobacco pipes.

The chancre begins on the mucous surface as a small crack or blister, which gradually increases till it forms a rounded, indurated swelling, about a quarter of an inch in diameter. The surface is smooth, of a greyish colour, and exudes a small quantity of sero-purulent fluid. The lip is swollen and everted, and there is a considerable area of induration around the

chancre. The sub-mental and sub-maxillary glands on one or on both sides soon become enlarged. They may reach the size of a pigeon's egg, are firm, and somewhat painful. The sore on the lip does not heal for from four to six weeks, and leaves no permanent trace of its existence. In some cases the sore is much less characteristic. It may resemble an ordinary crack or fissure, and its true nature is only revealed when secondary manifestations appear. There is no reason to believe, as is sometimes stated, that syphilis contracted in this way is more severe than genital syphilis.

The patient should be brought under the influence of mercury as rapidly as possible, as it is important to get the sore to heal rapidly to diminish the risk of infecting others. The sore may be dusted with calomel and starch powder, or painted with silver nitrate.

Fig. 36.—Macrocheilia.

(From a photograph lent by Mr. Stiles.)

Mucous patches are frequently met with on the mucous surface of the lips and at the angles of the mouth during the secondary stage of syphilis. In the inherited form of the disease deep cracks and fissures form, and often leave characteristic scars which radiate from the angles of the mouth (Fig. 28, vol. i.).

Various tertiary manifestations in the form of ulcers and gummata occur on the lips, and are liable to be mistaken for epitheliomata.

Tumours.—Nævi are not uncommon on the lips. When confined to the mucous surface they may be dissected out, but when they invade the skin they are best treated by electrolysis.

Lymphangioma.—The term *macrocheilia* is applied to a congenital hypertrophy of the lips (Fig. 36), which is probably of the nature of a lymphangioma (Middeldorpff). One or both lips may be affected. The lip is protruded, the mucous membrane everted, and, when the lower lip is implicated, it becomes pendulous and is liable to ulcerate. The substance of the lip is uniformly firm and rigid, so that it moves in one piece, and sucking, mastication, and phonation are interfered with.

Operative interference is attended with considerable risk of diffuse septic inflammation of the lymphangiomatous tissue. It has therefore been recommended that the lymphatic spaces of the swelling should be occluded as far as possible by electrolysis before any cutting operation is undertaken. The operation consists in removing a wedge-shaped portion of the swelling on the same lines as for "strumous lip."

Mucous cysts occur as small rounded tumours, growing from the inner surface of the lip. They are of a bluish colour, and contain a glairy fluid. They are treated by removal of the cyst wall with the overlying portion of mucous membrane.

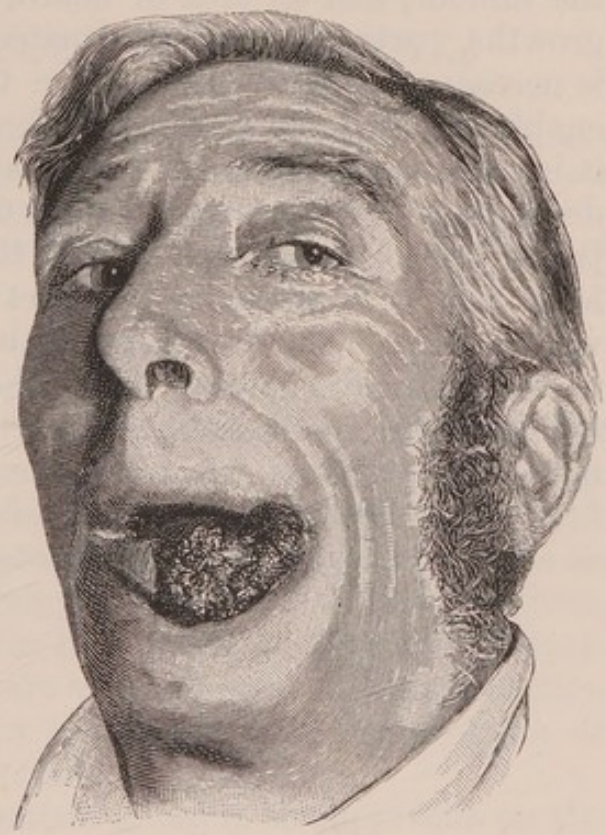

FIG. 37.—Advanced Epithelioma of Lower Lip.

Epithelioma of the Lip is nearly always of the squamous-celled variety, and is met with either as a fungating wart-like projection, or as an indurated ulcer. It almost exclusively occurs on the lower lip of men over forty years of age. The growth begins at the junction of the skin and mucous membrane and usually near the angle of the mouth (Fig. 37). It may originate in a persistent crack or fissure, or in a small papillary hypertrophy. The affection is said to be especially common in those who smoke short clay pipes. It is probable that constant irritation of the lip by the friction of the pipe stem may play some part in determining the excessive growth of epithelium. It is a suggestive fact that, while epithelioma of the lip is rare in women, the majority of those who do suffer are smokers. Other persistent forms of irritation—such, for example, as a rough or carious tooth—are frequently present.

The ulcer gradually spreads into the substance of the lip, which becomes swollen and indurated. The edges are characteristically raised and hard. The raw surface is extremely painful, especially when irritated by hot food or fluids. When the lip is destroyed saliva dribbles from the mouth, the discharge becomes offensive, and the patient may have difficulty in taking

food. The growth is very liable to spread to the lower jaw. Secondary deposits occur early in the sub-mental and sub-maxillary glands, but metastasis to internal organs is rare. Unless removed by operation the disease usually proves fatal in from three to three and a half years.

The *treatment* consists in early and free removal of the tumour and the infected glands. In comparatively small growths which do not involve the angle of the mouth, a V-shaped incision is carried through the entire thickness of the lip so as to include the tumour, and an area of healthy tissue beyond it. In larger growths, particularly when situated at the angle of the mouth, it is necessary to carry an incision transversely into the cheek to enable the lip to be repaired without leaving deformity. When it is necessary to remove the greater part of the lower lip, the defect may be filled up by flaps of skin taken from below the jaw (Syme's operation). When the tumour is adherent to the lower jaw, it is necessary to resect a portion of that bone along with the lip. The frequency with which recurrence takes place in the lymphatic glands below the jaw renders it advisable to remove these in all cases, whether they are palpably enlarged or not.

CHAPTER X.

THE MOUTH, FAUCES, AND PHARYNX.

Stomatitis : *Varieties*—Roof of mouth : *Abscess ; Gumma ; Tuberculous ulceration ; Tumours*—Elongation of Uvula—Inflammation of fauces and tonsils : *Catarrhal ; Suppurative*—Hypertrophy of tonsils—Calculus—Syphilis and Tuberculosis—Tumours—Retro-pharyngeal abscess.

THE MOUTH.

Stomatitis.—The term stomatitis is applied to any inflammation of the buccal mucous membrane. Several varieties are recognised. The simplest is *catarrhal stomatitis*, a condition in which the mucous membrane is hyperæmic and swollen, and exudes an excessive amount of viscid mucous secretion. Vesicles form, and the epithelium desquamates in patches, leaving small superficial erosions or ulcers which are very sensitive. This condition is of septic origin, and is often associated with the presence of carious teeth or an infected wound.

The *aphthous* form of stomatitis is liable to supervene on the catarrhal form in unhealthy underfed children. It is characterised by the occurrence of patches of fibrinous exudation into the superficial layers of the mucous membrane. The epithelium covering these patches is shed, and leaves a series of whitish spots, raised above the surface of the inflamed mucous membrane, and surrounded by a red hyperæmic zone. These spots may become confluent and form small ulcers.

The condition known as *thrush* closely resembles aphthous stomatitis. It is met with in infants during the period of teething, and is due to the *oïdium albicans*, a fungus met with in sour milk. The spots, which are most numerous on the lips, tongue, and throat, have the appearance of curdled milk.

The *treatment* of these forms of stomatitis consists in improving the general condition of the patient, and in employing an antiseptic mouth-wash, such as peroxide of hydrogen, Condy's fluid,

chlorate of potash, or boro-glyceride. The superficial ulcers may be touched with silver nitrate or with a 1 per cent. solution of chromic acid.

Ulcerative stomatitis is frequently met with in debilitated subjects with decayed teeth, who neglect to keep the mouth clean. It is specially liable to occur during the course of acute febrile diseases in which sordes accumulate about the teeth and gums. It is also symptomatic of scurvy and secondary syphilis, and of poisoning by mercury, lead, and phosphorus. Mercurial stomatitis may occur during the therapeutic administration of mercury. Some patients show a special susceptibility to the drug, and one of the first signs of intolerance is some degree of stomatitis, which may ensue after a comparatively small quantity has been administered. It begins on the gums, which become tender, swollen and spongy, and bleed readily. A greenish discoloration appears on the teeth at the edge of the gum, and the teeth may become loose and fall out. In severe cases the alveolar margin of the jaw may undergo necrosis. There is also profuse salivation, and the breath has a characteristically offensive odour.

The *treatment* consists in removing the cause, and in employing antiseptic and astringent mouth-washes. The internal administration of chlorate of potash is also indicated, as this drug is excreted in the saliva.

Gangrenous stomatitis, or cancrum oris, has already been described.

Roof of the Mouth.—*Suppuration* in the soft tissues of the roof of the mouth is usually secondary to suppuration at the root of a carious tooth. It may also arise in excoriations caused by an ill-fitting tooth-plate, or from the impaction of a foreign body, such as a fish or game bone, in the mucous membrane. The inflammation usually begins close to the alveolus, just behind the incisor teeth, and may spread back along the palate. The muco-periosteum becomes swollen, red, and exceedingly tender, and, as pus forms, is lifted up from the bone. A small rounded abscess forms, and on bursting or being incised gives exit to a quantity of foul-smelling pus. The inflammation speedily subsides after the escape of the pus.

The hard palate may be the seat of a *syphilitic gumma*. It begins as a rounded indolent swelling, which is usually situated in the middle line near the posterior edge of the hard palate. The swelling gradually softens and ulcerates, and a sequestrum may separate and leave a perforation in the palate. The treatment consists in employing the usual remedies for tertiary

syphilis. If the perforation persists and causes trouble by allowing food to pass into the nose, or by giving a nasal tone to the voice, it may be closed by an operation on the same principle as that performed for cleft palate, or an obturator may be fitted to occlude the opening.

Tuberculous ulceration of the palate is rare. Lupus may spread from the nose or lips and lead to widespread destruction of the soft tissues, or even to perforation of the bony palate.

Simple tumours, such as lipomata, fibromata, dermoids, and mucous cysts, occasionally occur in the palate. Within recent years there have been recorded a considerable number of cases of *mixed tumours*, similar to those met with in the parotid gland. While they may remain benign for many years, they show a tendency ultimately to become malignant. They occur in young subjects, and grow in the sub-mucous tissue of the soft palate, usually to one side of the middle line. They are of slow growth at first, and give rise to no inconvenience save from their size. In their early stages they are easily removed and show no tendency to recur. Later they grow more rapidly and infiltrate their surroundings, so that complete removal becomes difficult or impossible.

Elongation of the uvula is usually due to a chronic inflammatory engorgement combined with glandular hypertrophy of the mucous membrane. It often occurs in children, and is associated with a constant hacking cough, which is usually worst when the patient is lying down. By tickling the back of the tongue and pharynx it may induce vomiting after food. The treatment consists in snipping off the redundant portion of the uvula with scissors.

THE FAUCES, TONSILS, AND PHARYNX.

Inflammatory Affections.—An acute catarrhal inflammation of the back of the throat, characterised by congestion and hyperæmia of the mucous membrane, is very frequently met with. It may be symptomatic of some general acute febrile disease, such as scarlet fever, measles, influenza, septicæmia, or acute rheumatism. It is comparatively common in those who are much exposed to air contaminated with septic organisms or sewer gas—for example, the resident staff of hospitals (*septic or hospital throat*). After exposure to cold or damp, individuals of a rheumatic tendency are liable to this condition. It may be produced also by the habitual drinking of raw spirit, by excessive smoking,

and in some patients by the taking of certain drugs, such as iodides, belladonna, or mercury. There is slight pain on swallowing, and a peculiar tickling sensation passes along the Eustachian tube to the ear. The throat feels dry, and the patient has a constant desire to clear it. Morning nausea and even vomiting are not infrequent.

It is only when complications ensue that the condition assumes a distinctively surgical aspect. Among these complications may be mentioned extension of the inflammation to the mucous membrane of the larynx, causing œdema of the glottis with obstruction to respiration, or to the Eustachian tube, leading to some degree of deafness. The condition may spread along the Eustachian tube to the mucous membrane of the middle ear, and is often an important factor in the production of chronic suppuration of that cavity. It is an interesting fact that metastasis may take place to the genital organs, giving rise to orchitis or ovaritis.

The *treatment* of the local condition in the throat consists in employing antiseptic and soothing gargles, inhalations of chloride of ammonium, or a spray of menthol or eucalyptol. Lozenges or pastilles containing chloride of ammonium, chlorate of potash, and cubebs may be employed. If the pain is severe, a spray of 5 per cent. solution of cocain may be used. In rheumatic cases salicin and salicylate of soda are indicated.

A *chronic* form of pharyngitis is frequently met with in clergymen and others who require to strain their voices in public speaking. It is usually associated with some gastro-intestinal disturbance, and is aggravated by indiscretions in diet and in the use of alcohol and tobacco. In some cases the mucous membrane is congested, infiltrated, and swollen, the lymph follicles enlarged and prominent, and the surface covered with a viscid muco-purulent secretion (*hypertrophic or granular pharyngitis*). In others the mucous membrane is smooth and glazed, and dry scabs adhere to its surface (*atrophic pharyngitis*). The symptoms are the same in kind as those of acute catarrhal pharyngitis, but less pronounced. The patient is liable to repeated acute exacerbations.

Treatment should first be directed towards improving the condition of the gastro-intestinal tract. Any abnormal condition in the nasal passages should also be corrected. The local treatment is carried out on the same lines as in the more acute form of pharyngitis. In the granular form the hypertrophied follicles may be destroyed by the galvano-cautery. When the tonsils share in the hypertrophy they may be removed.

Acute Suppurative Tonsillitis and Pharyngitis.—Suppurative inflammation of the tonsils and pharynx may ensue on the catarrhal form just described, or may be due to infection of a scratch or abrasion of the mucous membrane produced by a foreign body, such as a fish or game bone. Two forms are recognised—the follicular and the parenchymatous.

In the *follicular* form the inflammation affects chiefly the lymphoid follicles which abound in the tonsils and pharynx. The mucous membrane is red and swollen, and the tonsils are enlarged and project so that they obstruct the isthmus of the fauces, sometimes even meeting in the middle line. A viscid muco-purulent secretion adheres to the surface in patches, and in the openings of the crypts of the tonsils yellowish plugs, consisting of leucocytes and desquamated epithelium, may be visible. There is pain on swallowing, and the respiration is impeded and noisy. The glands behind the angle of the jaw are enlarged and tender. There is usually some degree of fever.

In the *parenchymatous* form—*quinsy*—the inflammation is more diffuse, and affects the whole substance of the tonsils, the pillars of the fauces, the soft palate, and the pharynx. The onset is usually sudden, and the affection is ushered in by a rigor, high fever, and a feeling of malaise. There is persistent thirst and dryness of the throat, and the patient has the sensation of a foreign body being in the pharynx, with a constant tendency to swallow. Swallowing is extremely painful, the pain shooting up into the ears. There are often cracking and noises in the ears. The voice is thick and nasal, and the respiration is impeded and noisy. If the patient can open the mouth sufficiently to afford a view of the back of the throat (which, however, is seldom the case), the inflamed parts are seen to be of a dull reddish violet colour. One tonsil is often more swollen than the other, and the corresponding anterior pillar of the fauces more prominent. The uvula is deviated towards the side on which there is least swelling. Pus forms in from three to seven days, and in adults it is usually in the peritonsillar tissue of the anterior pillar of the fauces. In children the pus sometimes forms in the substance of the tonsil. If left to burst, the abscess discharges itself into the mouth, and the patient experiences instant relief. The pus is always offensive, and if the abscess bursts during sleep, it may enter the air passages and cause septic pneumonia. The lymphatic glands in the neck may become enlarged, and a diffuse septic cellulitis is liable to occur.

Treatment.—As the bowels are usually constipated, calomel or other opening medicine should be given at the outset. In

the early stages soothing antiseptic gargles are indicated. Later the inhalation of steam impregnated with the vapour of carbolic acid or friar's balsam, and the application of hot fomentations to the neck, may afford some relief. If the pain is severe, a 5 per cent. solution of cocain may be sprayed over the back of the throat. When an abscess forms, it should be freely incised, care being taken that the edge of the knife is directed towards the middle line. After an attack of quinsy the patient is very weak and requires a course of tonic treatment. Convalescence is always slow.

Hypertrophy of the Tonsils.—The most common form of hypertrophy of the tonsils is that met with in children between five and ten years of age. It is very often associated with adenoid vegetations in the naso-pharynx and chronic thickening of the pharyngeal mucous membrane. Children of a lymphatic or scrofulous tendency, and children who are backward or mentally deficient, appear to be more predisposed to the condition than others.

The whole tonsil is enlarged, the mucous membrane thickened, and the connective tissue more or less sclerosed. The crypts appear on the surface as deep clefts or fissures, and the lymph follicles are enlarged and prominent. Secretion accumulates in the crypts, and small calculi may form from the deposit of lime salts.

Clinical Features.—The hypertrophy is bilateral but not always symmetrical. Sometimes the tonsils project to such an extent as almost to meet in the middle line; sometimes they scarcely pass beyond the level of the pillars of the fauces. They are usually sessile, but sometimes the base is so narrow as almost to form a pedicle, and the tonsil may hang down into the pharynx. The colour varies from a pale gray to a dull red. During childhood they are usually soft and spongy, but when they persist into adolescence or adult life they become firm and indurated. The repeated attacks of catarrhal or suppurative tonsillitis to which the patients are subject favour this sclerotic change. The lymphatic glands behind the angle of the jaw are frequently enlarged. Swallowing is sometimes interfered with, and the patient is liable to attacks of nausea and vomiting. Respiration is always more or less impeded. The patient breathes through the open mouth, and snores loudly during sleep. The hindrance to respiration interferes with the development of the chest. In some cases alarming suffocative attacks occasionally supervene during the night. The voice is characteristically thick and nasal, especially when adenoids are present in

addition. Hearing is often impaired from obstruction of the Eustachian tube. In many cases the patient has a characteristically vacant and stupid expression.

Treatment.—General tonic treatment is indicated in all cases. In early and mild cases the tonsils should be painted with glycerin of tannic acid, or some other astringent, and an antiseptic mouth-wash should be employed. In more advanced cases *tonsillotomy* is called for. The parts are painted with a 5 per cent. solution of cocain, and the tonsil is seized with vulsella forceps and pulled out from between the pillars of the fauces. The tonsil is then shaved off by means of a curved probe-pointed bistoury, protected with adhesive plaster near the hilt to avoid injuring the lips or tongue. In children as much of the tonsil as possible should be removed, but in adults it is usually sufficient to shave off the projecting portion. The subsequent cicatricial contraction reduces the organ to its normal size. In tonsils which project prominently the guillotine may be preferred to the knife.

Hæmorrhage is seldom excessive and usually ceases spontaneously. When it is persistent, the patient should be made to sit upright and should be given ice to suck. The local application of adrenalin or sponge pressure has been found useful.

Calculi, composed of phosphate or carbonate of lime, are sometimes formed in the crypts of the tonsils. As a rule they are not larger than a pea, but they may be much larger. They cause a sharp stabbing pain on swallowing, and sometimes a persistent hacking cough. The affected tonsil is large and firm and is usually the seat of repeated attacks of inflammation. They are easily removed through a small incision into the tonsil.

Syphilis.—The fauces and tonsils are occasionally the seat of a primary chancre. The parts become red, swollen, and hard, and the condition may closely resemble an epithelioma. The submaxillary glands, however, are early and markedly enlarged, and there is usually considerable constitutional disturbance.

During the secondary period of syphilis, mucous patches are frequently met with on the tonsils and fauces. When these persist or recur with frequency, the tonsils may become permanently hypertrophied, and are then liable to repeated attacks of acute inflammation. Severe phagedænic ulceration sometimes occurs in the later stages of secondary syphilis, especially in alcoholic subjects, and may rapidly eat through the soft palate.

In the tertiary stage a diffuse gummatous infiltration occurs, and is liable to be followed by ulceration which spreads to the

pharyngeal wall and soft palate, and may lead by cicatricial contraction and adhesions to marked stenosis of the pharynx.

Tuberculous lesions of the fauces and tonsils are almost invariably secondary to tubercle of the larynx or lungs, or to lupus of the face or naso-pharynx, and rarely call for surgical treatment.

Tumours.—The *tonsil* is frequently the primary seat of lympho-sarcoma, and of a very malignant form of round-celled sarcoma. The tumour is at first confined to the tonsil, but rapidly infiltrates the surrounding structures, encroaching upon the cavity of the pharynx and causing interference with deglutition and respiration. The mucous membrane soon gives way, and there is often widespread ulceration and sloughing of the tumour substance, leading to septic complications, and sometimes to serious and even fatal hæmorrhage. The patient emaciates very rapidly. The adjacent lymphatic glands are early infected, and metastases to other organs are not uncommon. In the early stages an attempt may be made to remove the growth, either through the mouth, or better perhaps through an incision curving behind the angle of the lower jaw. In this way free access is obtained, hæmorrhage is more easily controlled, and the lymphatic glands can be extirpated as well as the tumour. The operation is facilitated by a preliminary tracheotomy.

Fibromata, lipomata, and other benign tumours have been met with in the tonsils, but are extremely rare.

Epithelioma of the back of the mouth usually implicates the fauces, soft palate, and pharyngeal wall as well as the tonsil. The squamous epithelioma is the most common form, and the disease may begin in the tonsil, the groove between the tonsil and the tongue, or in the soft palate. The naso-pharynx is seldom involved.

Clinical Features.—Males suffer more frequently than females. The disease may exist for some considerable time before giving rise to marked symptoms. Attention may be drawn to it by pain and difficulty in swallowing, or by pain shooting towards the ear. In some cases enlargement of the glands behind the angle of the jaw is the first thing to attract the patient's attention. The other symptoms are very like those of epithelioma of the tongue—pain during eating or drinking, salivation and fœtid breath. Sometimes fluids regurgitate through the nose, and the voice may become nasal and indistinct. As the patient is usually unable to open the mouth widely, it is seldom possible to learn much by inspection. A digital examination may reveal an irregular, hard, and ulcerated growth. The tumour is some-

times palpable from the outside, filling up the hollow behind the angle of the jaw. In this situation also the lymphatic glands may be felt. These are often enlarged out of all proportion to the size of the tumour. The disease tends to spread locally, causing increasing difficulty in swallowing and breathing. The patient gradually loses strength and may die from exhaustion induced by pain and insomnia, from hæmorrhage, or from septic pneumonia.

Treatment.—In early cases an attempt may be made to remove the disease. This can seldom be done through the mouth, and is most satisfactorily accomplished through an incision carried along the anterior border of the sterno-mastoid. Temporary resection of the lower jaw, preliminary tracheotomy, and ligation of the external carotid artery, are measures which greatly facilitate the operation.

In advanced cases it is only possible to relieve the patient's suffering by palliative measures. Antiseptic mouth-washes are used to diminish the fœtor of the breath and the risk of septic pneumonia, and morphin to relieve pain. The nasal tube, or even a gastrostomy, may be necessary to enable the patient to take sufficient food, and tracheotomy may be called for to relieve dyspnœa.

Retro-pharyngeal Abscess.—The chronic retro-pharyngeal abscess associated with tuberculous disease of the cervical vertebræ, in which the pus accumulates behind the prevertebral fascia, has already been described.

The acute form of abscess occurs in the space between the prevertebral fascia and the wall of the pharynx. The inflammation usually begins in one of the lymphatic glands which occupy this space, and rapidly ends in suppuration, which spreads to the surrounding cellular tissue. It is most common in children during the first and second years. The patient may be convalescent after one of the eruptive fevers attended with inflammation of the bucco-pharyngeal mucous membrane—such as scarlet fever, measles, or chicken-pox—or may suffer from nasal excoriations or coryza. In some cases the irritation of dentition is the only discoverable cause.

In infants the condition is usually very acute, and is attended with fever, rigors, vomiting, and often with convulsions. The head is held fixed, and usually twisted to one side, and there is pain on attempting to move it. The child has great pain on swallowing, and refuses all food. The saliva dribbles from the mouth. There is marked dyspnœa and a short, dry cough. The back of the throat is red and swollen, and a localised

projection, which is soft and fluctuating, and is usually asymmetrical, may be recognised by digital examination. Sometimes the voice is lost, and the patient has severe attacks of choking —symptoms which have led to the disease being mistaken for membranous laryngitis. In some cases a soft swelling is palpable on one or on both sides of the neck. Unless promptly treated the condition usually proves fatal. The treatment consists in incising the abscess. The mouth is opened by means of a gag, the head allowed to hang over the end of the table, and the abscess incised, with a guarded bistoury, through the wall of the pharynx. The dangers associated with opening the abscess from the mouth appear to have been exaggerated.

A less acute form of retro-pharyngeal abscess sometimes develops in the course of chronic middle-ear disease, the inflammatory process spreading along the Eustachian tube, in the wall of which an abscess forms and burrows into the retro-pharyngeal space. The symptoms are the same as in the other varieties.

CHAPTER XI.

THE JAWS, INCLUDING THE TEETH AND GUMS.

TEETH: Dental caries. GUMS: Gingivitis; Pyorrhœa alveolaris; Hypertrophy; Epithelioma. JAWS: Inflammatory affections: *Periostitis and ostitis; Acute osteomyelitis; Phosphorus necrosis; Tuberculosis; Syphilis; Actinomycosis*—Tumours: *Of alveolar process; Of superior maxilla; Of inferior maxilla*—Fracture of upper jaw—Fracture of lower jaw—Affections of the temporo-maxillary articulation: *Dislocation of lower jaw; Acute arthritis; Tuberculous arthritis; Arthritis deformans; Closure of the jaw.*

Dental caries is a process of disintegration which begins on the surface of the enamel of a tooth—usually in the region of its neck—and gradually extends through the dentine till the pulp cavity is reached. It is essentially due to the decalcifying action of acid substances produced in the mouth by bacteria. The part of the tooth first affected becomes blackish or greenish, and the substance crumbles away. While the enamel is being eroded, the tooth is sensitive to contact with hot or cold or irritating substances. When the superficial layers of the dentine are exposed, there is a dull aching pain, but this passes off as the deeper dentinal fibres and tubules are reached. When the pulp cavity is opened into, the pain returns and is more severe.

Results of Dental Caries—Pulpitis.—Infection of the exposed pulp cavity by septic organisms may set up an acute purulent pulpitis. This is associated with severe pain, which is not confined to the diseased tooth, but may spread to the adjacent teeth, and sometimes to all the branches of the fifth nerve on the corresponding side of the face. Careful search must be made for the offending tooth, lest sound teeth, to which the pain is referred, be sacrificed.

Periodontitis.—The inflammatory process may spread from the tooth to the alveolo-dental periosteum, and set up a peri-odontitis. In the affected tooth there is at first a feeling of

uneasiness, which is relieved by the patient biting against it. Later there is severe lancinating or throbbing pain. The affected tooth usually projects beyond its neighbours, and is excessively tender when the opposing tooth comes in contact with it in mastication. The gum becomes red and swollen, and the cheek is œdematous.

Alveolar Abscess.—Periodontitis is usually followed by the formation of an alveolar abscess. The pus which forms at the root of the tooth in most cases works its way through the bone and into the gum, constituting a "gum-boil." The pus may then burst through the gum, or may spread underneath the external periosteum of the jaw and lead to necrosis of that bone.

In some cases the cheek becomes adherent to the gum and to the jaw before the abscess bursts, and the pus escapes through the skin, leaving a sinus which leads down to the defaulting tooth, and which is very slow to heal. The opening of the sinus is most commonly situated at the under margin of the lower jaw. An alveolar abscess deeply seated in the upper jaw may open into the antrum of Highmore and cause suppuration in that cavity. The abscess should always be opened from the mouth to avoid a scar on the face. In all cases the extraction of the carious tooth is necessary before the abscess will cease discharging and the sinus heal. Among the other effects of dental caries may be mentioned localised necrosis of the alveolar margin, septic cellulitis of the neck, and enlargement of the cervical lymphatic glands.

Cystic growths are frequently found attached to the roots of decayed teeth. They are lined by epithelium, and are probably derived from a belated portion of the enamel organ which has been stimulated to active growth by septic processes in the pulp cavity. They are seldom larger than a pea, and they contain a pultaceous mass like inspissated pus. They give rise to no symptoms, and are only recognised after extraction of the root.

Odontomata have already been described (vol. i. p. 184).

Affections of the Gums.—Inflammation of the gums—*gingivitis*—is usually only a part of a general stomatitis. The gums are swollen and spongy, and may show superficial ulceration, associated with bleeding and extreme fœtor of the breath. The teeth become loose, project from the alveoli, and sometimes fall out. These symptoms are prominent in cases of scurvy, chronic mercurial poisoning, and sometimes in syphilis. In chronic lead-poisoning a characteristic narrow blue line is seen on the gums near the dental margin. The *treatment* consists in removing the cause, improving the hygienic and dietetic

conditions of the patient, and administering appropriate drugs, such as lime-juice, iodide of potash, quinine, or cod-liver oil, according to the cause. Antiseptic mouth-washes and dentifrices are also indicated. Chlorate of potash, being excreted in the saliva, is particularly useful. When the gums fungate they may be cauterised.

Pyorrhœa alveolaris is an extremely chronic form of gingivitis, which begins in relation to the necks of the teeth and the alveolo-dental periosteum. It is due to septic infection, and is associated with an accumulation of tartar between the gums and the teeth. A muco-purulent discharge escapes from within the free edge of the gum and alveolus. The alveolar borders and the gum subsequently undergo atrophy, so that the roots are exposed, and the teeth are liable to fall out. The condition may only affect a few teeth, or it may spread to the whole set, in which case the patient may in the course of some years become edentulous. It is essentially a disease of middle and advanced life. The treatment consists in removing the tartar from the teeth, applying strong antiseptics—pure carbolic, or 1 in 1000 corrosive sublimate—to the groove between the teeth and the gums, and employing antiseptic mouth-washes and dentifrices.

Hypertrophy of the gums is occasionally met with in children and young adults. The patients are usually mentally defective, and the teeth develop very early and are abnormally large. The gums almost bury the teeth, and form large polypoid masses which tend to fungate. The treatment consists in removing not only the hypertrophied gums, but also the affected alveolus (Heath).

A localised hypertrophy—*polypus of the gum*—sometimes results from the irritation of carious teeth, and may simulate an epulis. The swelling is usually pedunculated, and if cut away close up to the alveolar margin does not tend to recur.

Epithelioma sometimes originates on the gum in relation to a carious tooth or to an artificial tooth plate. The growth tends to invade the bone and to spread to the cheek or buccal mucous membrane. Early and complete removal of the tumour and adjacent segment of the bone is the only treatment.

Other tumours of the gums, such as angiomata and papillomata, are extremely rare.

Epulis is described with tumours of the jaws.

The Jaws.

Inflammatory Affections.—*Pyogenic Inflammations.*—The

great majority of pyogenic inflammations of the jaws originate in relation to carious teeth, beginning as a periodontitis which is followed by the formation of an alveolar abscess. It has already been mentioned that these conditions may cause diffuse periostitis which leads to necrosis of considerable portions of bone. It is probable that the different forms of periostitis and ostitis of the jaws previously attributed to the special poisons of scarlet, typhoid, and other exanthematous fevers, and those associated with mercurial and phosphorus poisoning, are also due to ordinary septic infection, and that the general disease merely reduces the patient's power of resistance, and so acts as a condition favouring the growth of pyogenic bacteria.

Acute osteomyelitis occasionally attacks the jaws. It is more common in the lower than in the upper jaw, and it usually begins near the angle. Pus rapidly forms under the periosteum, and a considerable area of bone may undergo necrosis.

In *cancrum oris* also the maxillæ are frequently attacked and undergo necrosis.

Phosphorus Necrosis.—A diffuse form of suppurative periostitis, ending in necrosis, is occasionally met with in the jaws—usually the lower—of those who work in match factories and other places where yellow phosphorus is used. It was for long believed that the disease was essentially due to the action of the phosphorus fumes on the bone. The affection always begins in relation to carious roots or empty sockets. It is now generally recognised that this condition, like the other inflammatory diseases of the jaws, is due to the action of micro-organisms, and that the effect of the phosphorus is merely to lower the vitality of the bone and so render it a more suitable soil for the bacteria. Having isolated the tubercle bacillus from all the cases he has examined, Stockman is of opinion that the disease is tuberculous in nature. Other observers believe that it is due to ordinary pyogenic bacteria.

In the early stages the *clinical features* resemble those of periodontitis and alveolar abscess. As the disease progresses, there is profuse suppuration under the periosteum, the bone undergoes necrosis, and a peculiarly porous sequestrum of a gray or greenish colour forms. The sequestrum, which may include almost the whole of the bone, is exceedingly slow to separate, and the process is accompanied by an excessive development of periosteal new bone. The face becomes œdematous and swollen, and one or more sinuses may form.

The substitution of red for yellow phosphorus, and the systematic examination of the teeth of match-makers imposed

by the Factories Acts, have materially diminished the frequency and severity of this disease. The local treatment is carried out on the same lines as for other forms of periostitis and necrosis of the jaws.

Tuberculous disease of the jaws is comparatively rare. It is occasionally met with on the orbital margin of the superior maxilla and in the region of the malar bone. In the lower jaw it usually occurs near the angle. When a cold abscess bursts on the surface it leads to the formation of sinuses.

Syphilitic affections of the jaws are also rare. A localised gumma may develop in the neighbourhood of the angle of the lower jaw, or the whole of the body of that bone may be the seat of a diffuse gummatous infiltration. In either case the clinical importance of the condition lies in the fact that it is liable to be mistaken for a new growth, such as an osteo-sarcoma.

Treatment.—In all inflammatory conditions which have gone on to suppuration the first indication is to evacuate the pus, and, wherever possible, this should be done from the mouth to avoid a cicatrix on the face. In certain situations, however—for example, the angle or ascending ramus of the lower jaw, or the facial portion of the upper jaw—it is seldom possible to avoid making an external opening. Efficient drainage must be secured, and the mouth kept sweet by the frequent use of antiseptic washes. When the condition is due to a carious stump or to an unerupted tooth, this should be extracted at the same time as the abscess is opened. The popular belief that the tooth should not be removed until the inflammation subsides is without foundation.

The sequestrum should be allowed to become completely separated before being removed. The process of separation is usually slow, taking from two to four months according to the acuteness of the inflammation and the extent of the necrosis. In the lower jaw the sequestrum becomes surrounded by a sheath of new periosteal bone, so that, even if the greater part of the jaw undergoes necrosis, the arch is reproduced, and after removal of the sequestrum little or no deformity results. The sequestrum can usually be removed from the mouth by dividing the mucous membrane and gouging away a portion of the outer aspect of the new sheath. The cavity is swabbed out with pure carbolic acid and stuffed with iodoform gauze. When the ascending ramus is involved, precautions must be taken to prevent closure of the jaw during the healing process. In the upper jaw no new bone is formed.

Actinomycosis. — Actinomycosis is met with in the jaws

more frequently than in any other part of the body. The lower jaw is attacked oftener than the upper. The actinomyces probably gains access to the bone through a carious tooth or through the gum.

At the outset the patient complains of pain and tenderness referred to one or more carious teeth. Within a few weeks a swelling forms—in the lower jaw near the angle as a rule, and in the upper jaw in some part of the cheek. The tumour, which varies in consistence, is firmly fixed to the jaw. The skin over it becomes inflamed, suppuration occurs, and sinuses form and give exit to a sero-purulent fluid in which the characteristic yellow "sulphur grains" may be detected. The surrounding soft tissues become infiltrated, and the part becomes riddled with sinuses, which lead down to bare bone. The disease usually runs a chronic course, lasting for one or two years, and is not attended with fever, unless pyogenic infection be superadded.

In the absence of the characteristic yellow granules actinomycosis may readily be mistaken for tuberculous or syphilitic disease of the jaw, or for sarcoma.

The *treatment* consists in removing the diseased tissue by the knife or sharp spoon, and in the administration of large doses of potassium iodide.

Tumours of the Alveolar Process. — The tumours which grow from the alveolar processes of the jaws are essentially of the nature of fibro-sarcomata. In some the fibrous element predominates, and they closely resemble fibromata, but the frequency with which they recur after removal, unless the segment of bone from which they spring is also excised, indicates their malignant tendency. In some cases the tumour is of the myeloid type—myeloma—in others it contains masses of bone in its substance—osteo-sarcoma. As these tumours originate in the periosteum, the periodontal membrane or the bone of the alveolus, and not in the gum, the term "epulis," which was previously applied to them, is inaccurate.

They are most frequently met with in females, between the ages of fifteen and twenty-five, and are more common in the lower than in the upper jaw. The tumour may begin between two teeth or in the socket of a tooth which has been lost. It grows slowly, either towards the cavity of the mouth, or more frequently towards the lip or cheek, where it appears as a smooth, firm, rounded swelling which is adherent to the jaw, and may be sessile or pedunculated. It causes little pain, but is liable to interfere with mastication. As it increases in size

it becomes softer, assumes a dark violet colour, and if subjected to pressure or irritation may ulcerate and bleed.

The true alveolar tumour is to be diagnosed from a mass of redundant granulations such as may form in relation to a carious stump, from an epithelioma of the gum, a tumour of the body of the jaw, or an angioma.

The *treatment* consists in removing the tumour together with a wedge-shaped or quadrilateral portion of the alveolar process from which it grows. The area of bone to be removed is outlined by an incision through the mucous membrane and gum, and the bone is divided with a chisel or saw. After being freely removed these tumours show little tendency to recur and metastasis is very rare.

Tumours of the Superior Maxilla.—*Sarcomata* are the most common primary tumours of the upper jaw. All varieties are met with, the round or spindle-celled being the most common. Their malignancy is evidenced by the rapidity of their growth, the manner in which they infiltrate adjacent parts, and the frequency with which they recur after removal. They occur at all ages, and have even been met with in children.

The *clinical features* vary according to whether the tumour originates on the outer aspect of the bone, in the maxillary antrum, or behind the bone in the spheno-maxillary or pterygo-maxillary fossa.

When the tumour begins in the periosteum covering the front of the bone, it forms a swelling under the cheek, usually in the vicinity of the malar bone. The tumour grows towards the mouth as well as towards the surface. The substance of the cheek is invaded, and in some cases the growth extends into the antrum. In the early stages there is no obstruction of the nasal passage or of the tear duct. There is no displacement of the eye or bulging of the palate.

When the tumour originates in the interior of the antrum, it first fills the cavity and then bulges its walls in every direction, so that, on pressure being made over the swelling, the osseous shell of the antrum dimples and crackles under the finger. The antrum is dark on transillumination. The tumour may cause obstruction of the nostril on the corresponding side, and epiphora by pressing on the tear duct. The tumour may be seen through the anterior nares, and may be attended with a sanious discharge. The eyeball is liable to be displaced upward, and if the ethmoid cells are invaded, it is also pushed outward; the palate may be depressed and the cheek projected (Fig. 38).

When the tumour begins in one or other of the fossæ behind

the jaw, the eyeball is usually protruded by the invasion of the orbit from behind, and in time a swelling appears in the temporal region. If the antrum is invaded, the tumour may spread in the various directions already indicated. Sometimes a tumour which appears to have its seat in the upper jaw is really a downward prolongation of a growth originating in the base of the skull.

In all cases the tumour tends to infiltrate the surrounding tissues indiscriminately. There is severe pain referred to the distribution of the second division of the fifth nerve. Hæmorrhage is liable to occur when exposed portions of the tumour ulcerate—for example, in the nasal fossæ. Sarcomata are to be distinguished from dentigerous cysts which also may distend the bone, bulging the hard palate and projecting on the face (Fig. 39).

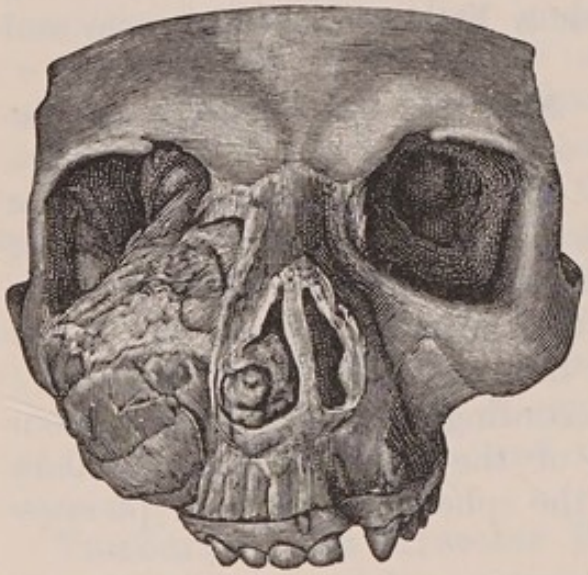

FIG. 38.—Sarcoma of the Upper Jaw involving sphenoid, ethmoid and right superior maxilla, and projecting into the right orbit and nose, forming a prominent tumour in the situation of the antrum on the right side.

(Anatomical Museum, University of Edinburgh.)

Treatment.—The only method of treatment is complete removal, and in most cases this involves excision of the whole of the upper jaw. In cases where the growth has trespassed the limits of the superior maxillary bone the operation is contra-indicated. In general terms it may be said that the cases favourable for operation are those in which the tumour is of slow growth, hard, well defined, limited to the upper jaw, and with the skin still movable over it (Jacobson).

The operation consists in reflecting the cheek outward by an incision carried through the middle of the upper lip, round the ala, along the side of the nose to the inner angle of the eye, and along the lower border of the orbit on to the malar bone. The cartilage of the nose is separated from the nasal process of the maxilla, and the periosteum of the floor of the orbit freed. The jaw is then divided at its junction with the malar bone, at its articulation with the nasal process of the frontal, and in the middle line between its palatal processes. The soft palate is conserved by an incision being carried between it and the hard

palate on the affected side. Finally, a broad chisel is pushed in behind the posterior wall of the antrum, and the body of the bone is seized with lion forceps and forcibly wrenched out. After hæmorrhage has been arrested, the cheek flap is replaced and stitched in position. Care is taken to prevent the accumulation of discharges in the mouth, and the cavity is kept sweet by frequent spraying with peroxide of hydrogen, Condy's fluid, or some other antiseptic. The chief risks are shock, septic

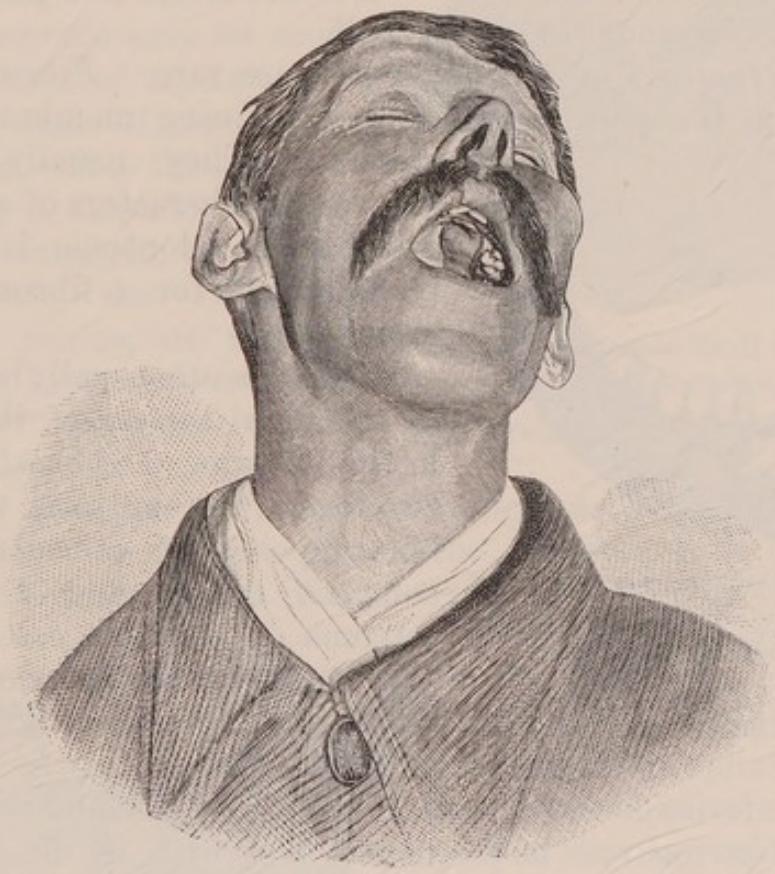

FIG. 39.—Dentigerous Cyst of the Upper Jaw in a man, æt. 36, bulging the hard palate and projecting on the face.

(Mr. C. W. Cathcart's case.)

pneumonia, and secondary hæmorrhage. From the difficulty of completely eradicating the growth recurrence is very liable to occur, and in a majority of cases the disease sooner or later reappears.

Carcinoma.—The variety of carcinoma most frequently met with in the upper jaw is the squamous epithelioma. In a majority of cases the tumour originates in the mucous membrane of the alveolus or palate, and it is often associated with irritation produced by a carious tooth or by an ill-fitting tooth plate. Less frequently the growth begins in the nasal cavity or in the cavity of the antrum. As it grows the tumour

tends to spread backward along the palate towards the tonsil. In some cases the jaw is secondarily affected by cancer spreading from the lip or face.

The cervical glands are more liable to be implicated in carcinoma than in sarcoma.

The *treatment* is carried out on the same lines as for sarcoma, but in many cases it is not necessary to remove the whole of the maxilla. Where it can be done with safety, an attempt should be made to conserve the orbital plate and so prevent displacement of the eyeball.

Simple tumours of the upper jaw are rare. *Fibromata* may originate in the periosteum or in the lining membrane of the antrum. They usually tend to assume the characters of sarcomata. The fibrous odontoma is liable to be mistaken for a fibroma of the upper jaw.

FIG. 40.—Dentigerous Cyst of Lower Jaw of child, æt. 4, containing rudimentary teeth.

(Anatomical Museum, University of Edinburgh.)

Chondromata usually begin either on the nasal surface of the bone or in the antrum. *Osteomata* occur in two forms: the exostosis, which may be composed of cancellated or of compact tissue, and the diffuse osteoma or leontiasis ossea.

Tumours of the Inferior Maxilla.—The same varieties are met with as in the upper jaw. The non-malignant forms—osteoma, chondroma and fibroma—are rare.

A *dentigerous cyst* is frequently met with in the lower jaw It appears as a smooth, rounded, and painless swelling, usually in the region of the molar teeth. The bone gradually becomes expanded and crackles on pressure. The cyst is filled with a glairy mucoid fluid, and may contain one or more unerupted teeth (Fig. 40). The treatment consists in removing the anterior wall of the cyst, scraping the interior, and packing the cavity with iodoform gauze.

The myeloid tumour or *myeloma* is comparatively common. It develops in the interior of the bone and causes the affected segment to become expanded. It grows slowly, is more or less encapsulated, and therefore does not infiltrate the surrounding tissues. There is no glandular involvement, and the tumour shows little evidence of malignancy (Fig. 41).

The *periosteal sarcoma* is the most malignant form (Fig. 42). It grows rapidly, and infiltrates the surrounding tissues. The

submaxillary salivary gland and the cervical lymphatic glands are usually implicated, and the disease tends to spread by metastasis to distant parts.

Epithelioma is the commonest tumour affecting the lower jaw. It is usually secondary to cancer of the lip, tongue or floor of the mouth, of which it constitutes a serious complication.

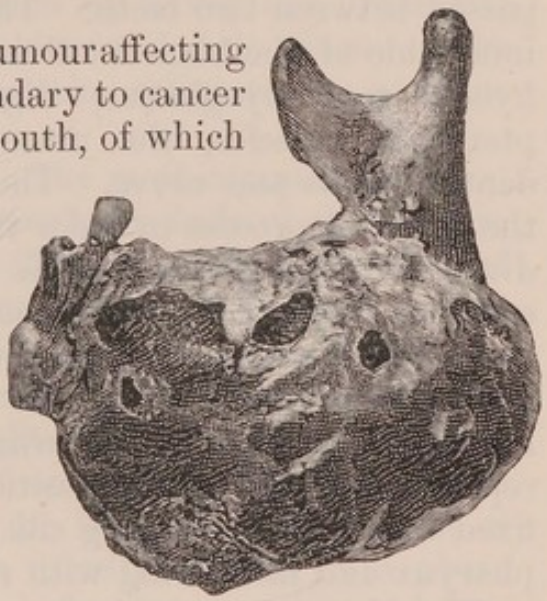

FIG. 41.—Osseous Shell of Myeloma of Lower Jaw.

(From Professor Annandale's collection.)

Treatment.—Partial removal of the lower jaw may be undertaken in cases of myeloma, and in certain cases of sarcoma and epithelioma when the tumour is limited to a small area of the bone—for example, to the alveolar process, the angle, the horizontal ramus, or the symphysis. In very small tumours it is possible to perform the operation through the mouth, but in most cases an external incision is indispensable. When practicable, the arch of the jaw should be left intact by conserving the lower border of the bone. If this cannot be done with safety, the integrity of the arch should be maintained temporarily by means of a simple wire splint or other suitable apparatus. Later a plate bearing artificial teeth is fitted by the dentist.

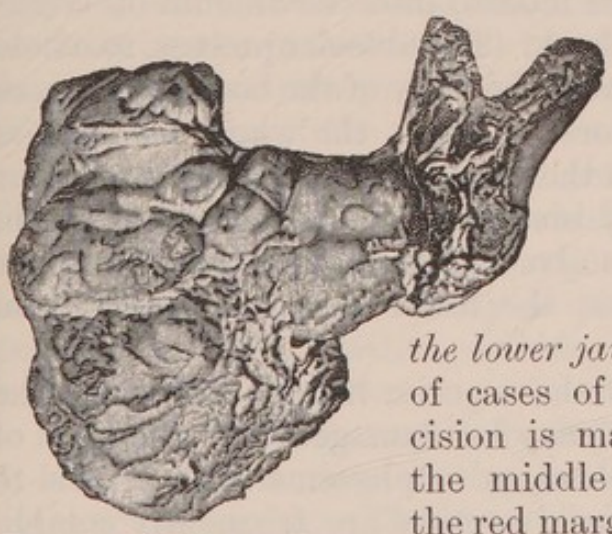

FIG. 42.—Sarcoma of Lower Jaw removed by Syme.

(Anatomical Museum, University of Edinburgh.)

Removal of one-half of the lower jaw is called for in the majority of cases of malignant tumour. An incision is made through the lower lip, in the middle line, beginning just below the red margin, and is carried down to the chin, then along the lower border of the bone as far as the angle, and up behind the ascending ramus to a little below the lobule of the ear, stopping short of the facial nerve. The facial artery as it crosses the jaw in front of the masseter is caught with forceps before being cut. The masseter and buccinator muscles having been separated from the bone, the flap is thrown up, the reflection of the mucous

membrane on to the gum divided, and the jaw thus exposed. The body of the jaw is divided by means of a Gigli wire-saw passed between two teeth. The knife is then carried along the inner side of the bone to divide the attachments of the genio-hyoid, genio-hyoglossus, digastric, mylo-hyoid and internal pterygoid muscles, the mucous membrane, and the inferior dental vessels and nerve. The jaw is then depressed to expose the coronoid process in order that the temporal insertion may be divided. Finally the condyle is disarticulated by dividing the external pterygoid tendon and the ligaments of the joint, care being taken to avoid injuring the internal maxillary artery as it lies between the neck of the condyle and the internal lateral ligament. After all hæmorrhage has been arrested, the flap is replaced and stitched in position. The tongue should be transfixed with a loop of strong silk to prevent it falling back into the pharynx and interfering with respiration.

The after-treatment is the same as for excision of the upper jaw.

Injuries of the Jaws.

Fracture of the Upper Jaw.—Fractures of the upper jaw are nearly always due to direct violence, such as a blow on the face, a stab, or a gunshot wound. They are usually rendered compound by opening into the mouth, into the antrum of Highmore, or on to the skin of the cheek. The alveolar process, in whole or in part, may be separated from the body of the bone by a severe blow, such as the kick of a horse. When the whole alveolus is detached, it may carry with it the hard palate. Limited portions of the alveolus are frequently broken in the extraction of teeth. The main trouble after severe alveolar fractures is that the upper teeth do not accurately oppose the lower ones, and mastication is thereby interfered with.

When the nasal portion of the superior maxilla is broken, the lachrymal sac and nasal duct may be damaged and the flow of the tears obstructed. In such cases emphysema is also liable to develop. Fractures of the facial portion are frequently complicated by hæmorrhage from the infraorbital vessels and anæsthesia of the area supplied by the infraorbital nerve. Suppuration may occur in the antrum later. In some cases the upper jaw is driven in as a whole, and in others the fracture radiates to the base of the skull and cerebral symptoms develop.

The *treatment* consists in reducing any deformity which may be present, ensuring efficient drainage, and keeping the mouth as aseptic as possible. Union takes place very rapidly, and

owing to the vascularity of the parts necrosis is rare, even when suppuration ensues. When the alveolar portion is comminuted, the fragments may be kept in position by fixing the lower jaw against the upper by means of a four-tailed bandage, or by adjusting a moulded lead or gutta-percha splint to the alveolus and palate.

Fractures of the Lower Jaw.—The most common situation for fracture of the lower jaw is through the *body* of the bone in the vicinity of the canine tooth. The depth of the socket of this tooth, and the comparative narrowness of the jaw at this level, render it the weakest part of the arch. The fracture is usually due to direct violence, such as a blow in fighting, the kick of a horse, or a fall from a height. It is sometimes bilateral, the bone giving way at the canine fossa on one side and just in front of the masseter on the other; or both fractures may be at the canine fossæ. The fracture is usually oblique from above downwards and outwards, and is nearly always compound into the mouth.

When only one side is broken, the smaller fragment is usually displaced outwards and forwards by the masseter and temporal muscles, so that it overlaps the larger fragment. In bilateral fractures the central loose segment is drawn downwards and backwards towards the hyoid bone by the muscles attached to the chin, while both lateral fragments are tilted outwards and forwards by the masseters and temporals. The amount of displacement is best recognised by observing the degree of irregularity in the line of the teeth. Abnormal mobility and crepitus are readily elicited, and there is severe pain, particularly when the inferior dental nerve is stretched or crushed. The patient's attitude is characteristic; he supports the broken jaw with his hands, and keeps it as steady as possible when he attempts to speak or swallow. Saliva dribbles from the open mouth and the speech is indistinct.

In adults the bone may be broken at the *symphysis* as a result of lateral compression of the jaw—for example, by pressing together the angles. The general characters of the fracture are the same as those of fracture of the body, but the displacement is inconsiderable.

Fractures at the *angle* and through the *ascending ramus* are less common, and are not attended with deformity, as the fragments are retained in position by the masseter and internal pterygoid muscles. Fracture of the *coronoid process* is extremely rare.

The *condyles* are frequently fractured just below the insertion

of the external pterygoid muscles by a fall on the chin or by a severe blow on the side of the face. When the fracture is unilateral the broken condyle is tilted inward and forward by the external pterygoid, and can be palpated from the mouth, while the rest of the jaw is displaced *towards* the affected side, and not away from it, as happens in unilateral dislocation. When the fracture is bilateral, the lower jaw falls backwards so that the lower teeth lie behind those of the upper jaw.

In a few rare cases the condyle has been driven through the glenoid cavity, causing fracture of the base of the skull.

Complications.—As the majority of fractures of the jaw are compound, suppuration is comparatively common during the process of repair. If antiseptic precautions be taken, however, it can usually be kept in check, and seldom leads to necrosis. The teeth adjacent to the fracture are liable to be loosened or displaced. If merely loosened they should be left in place, as they usually become firmly fixed in the course of a few days. Care must be taken that a displaced tooth does not pass between the fragments, as this has been the cause of difficulty in reducing a fracture and of its failure to unite. Irregular union by destroying the alignment of the teeth leads to interference with mastication. Want of union is a rare event. The bone usually unites in from four to six weeks.

FIG. 43.—Four-tailed Bandage applied for Fracture of Lower Jaw.

Treatment.—In the majority of cases, after the fracture has been reduced, the fragments can be kept in apposition by closing the mouth and keeping the lower jaw fixed against the upper by means of a four-tailed bandage (Fig. 43). Care must be taken that the posterior tails of the bandage do not pull the lower jaw backward. Additional security may be given by a light poroplastic or gutta-percha splint fitted to the chin, the vertical portion passing well up the ramus of the jaw. The apparatus is worn for four or five weeks, during which time the patient is fed on fluid or semi-fluid food. The mouth must be regularly purified by an antiseptic mouth-wash.

In a certain number of fractures implicating the body of the jaw, and particularly in bilateral fractures, there is some difficulty in maintaining the fragments in apposition by the four-tailed bandage and external splint. It may then be necessary to employ some form of dental splint, of which, perhaps, Hammond's

is the best. It consists of a stout nickelled-iron or silver-wire frame, which is accurately moulded so as to surround several teeth on each side of the fracture. Loops of wire are then passed between the individual teeth and round the frame so that the splint is divided into a series of compartments, each of which contains a tooth. To obtain the most satisfactory results with this appliance the aid of an expert dentist is necessary. The method of applying loops of wire round the teeth on each side of the fracture is open to the objections that it fails to secure complete and absolute apposition, and that the teeth are liable to be loosened or displaced. In rare cases it is necessary to wire the bone.

Even in badly united fractures the original contour of the bone is eventually restored by the movements of the tongue moulding it into shape.

Affections of the Temporo-maxillary Articulation.

Dislocation of the Lower Jaw.—Dislocation of the lower jaw may be unilateral or bilateral. The bilateral form is the more common, and is met with most frequently in middle life and in females. The liability to dislocation is greatest when the mouth is widely open—for example, in yawning, laughing, or vomiting—as under these conditions the condyle, accompanied by the meniscus, passes forwards out of the glenoid cavity and rests on the summit of the articular eminence. If, while the bone is in this position, the external pterygoid muscle is thrown into contraction, it pulls the condyle forward over the eminence into the hollow beneath the root of the zygoma, and the contraction of the masseter and temporal muscles retains it there. The majority of bilateral dislocations are in this way due to muscular contraction.

Dislocation may also be produced by a downward blow on the chin, by the unskilful introduction of a mouth gag, particularly if the patient is anæsthetised, or even in the attempt to take a big bite—say, of an apple. From such causes the dislocation is usually unilateral.

In some patients the ligaments of the joint are unnaturally lax, and dislocation is liable to occur repeatedly from comparatively slight causes—*recurrent dislocation*.

Clinical Features.—The appearance of a patient suffering from *bilateral* dislocation is very characteristic. The mouth is open, the jaw fixed, and the chin protruded so that the lower teeth project beyond those of the upper jaw. The patient has diffi-

culty in swallowing, and the saliva dribbles from the mouth. As the lips cannot be approximated, the speech is indistinct and guttural. Just in front of the auditory meatus a deep hollow can be felt, and in front of this the condyle forms an undue projection. The coronoid process is displaced below and behind the malar bone, and may be felt through the mouth. Above the zygoma the contracted belly of the temporal muscle forms a more or less marked prominence.

In *unilateral* dislocation (Fig. 44) the deformity is the same in character but is less marked, and in mild cases its cause is liable to be overlooked. In most cases the chin deviates towards the sound side.

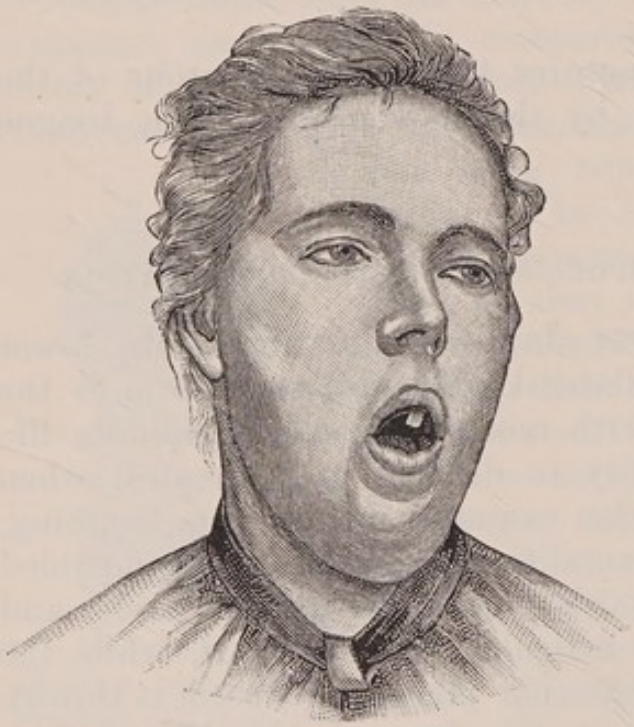

FIG. 44.—Unilateral Dislocation of Lower Jaw, caused by yawning, showing prominence of right condyle on cheek.

Treatment.— In recent cases reduction is usually easily effected. The patient should be seated on a low chair or stool, an assistant supporting the head from behind. The surgeon, standing in front, places his thumbs, well protected by a roll of lint, far back on the molar teeth, and with his other fingers grasps the body of the jaw. Pressure is now made downwards and backwards to free the condyles from the articular eminence, and as this is effected the tip of the chin is carried upward, while the whole jaw is pushed directly backward. The condyle slips into position, sometimes with a distinct snap. When difficulty is experienced in levering the condyle from its abnormal position a cork may be placed between the molar teeth on each side to act as a fulcrum. After reduction the jaw is fixed by means of a four-tailed bandage for a week or ten days. The patient is warned to avoid all wide movements of the jaw for some weeks.

Old-standing Dislocation.—It sometimes happens that, from having been overlooked or neglected, the dislocation remains unreduced. In such cases the movement of the jaw is in time partly restored, and the patient acquires sufficient control of the lips to be able to articulate intelligibly and to prevent dribbling

of saliva. The power of masticating the food, however, remains impaired. The hollow behind the condyle and the projection of the chin persist. Reduction is seldom possible after the dislocation has existed for more than three months, but it has been effected as long as ten months after the accident. Attempts at reduction should be repeated at intervals of two or three days. In the event of failure it may be necessary to expose the joint by operation before reduction can be effected. In some cases it is even necessary to excise the condyle to restore movement.

Sub-luxation of the Temporo-maxillary Joint.—In a few rare cases the inter-articular cartilage becomes loose, and is liable to be displaced and to interfere with the movements of the jaw. Annandale has successfully treated this condition by suturing the cartilage in position.

Acute arthritis of the temporo-maxillary joint occurs in two forms, non-suppurative and suppurative.

The *non-suppurative* form is usually due to rheumatism or to gonorrhœal infection, and as a rule is bilateral. The patient complains of neuralgic pains shooting towards the ears and temples, and of pain in the joint on movement. The jaw is therefore kept fixed, usually with the mouth slightly open and the chin protruded. He is unable to masticate and the speech is indistinct. There is effusion into the cavity of the joint and a swelling may be detected in front of the ear. The inflammation may subside and movement be restored, or fibrous ankylosis may result.

The *suppurative* form either may be due to direct spread of inflammation from adjacent parts, as, for example, in middle ear disease, suppurative parotitis, or pyogenic affections of the lower jaw, or it may be part of a general pyæmic infection, as sometimes occurs after exanthematous fevers and in gonorrhœa. The clinical features are similar to those of the non-suppurative forms, but the signs referable to the joint are often masked by those of the adjacent inflammation. When the pus originates in the joint, it may point either towards the skin or into the external auditory meatus through the Glaserian fissure. The joint is usually completely disorganised and ankylosis results. The treatment is carried out on the same lines as in other joints.

Tuberculous arthritis is very rare. It may occur as a primary infection, but is usually secondary to tuberculous disease of the jaw, the temporal bone, or the middle ear. It leads to destruction of the joint and ankylosis. It is treated by incision and scraping, or by excision of the condyle.

Arthritis deformans is a comparatively common affection,

and is generally bilateral. The condyle is usually hypertrophied and distorted in the earlier stages of the disease. In the later stages it may be worn away and almost completely disappear. The glenoid cavity is correspondingly broadened and flattened, and in time may be filled up by new bone. Osteophytic outgrowths form around the joint and lead to fixation or locking. The meniscus almost always disappears. The enlarged condyle may be felt in front of the ear, and there is pain and creaking on movement. The pain is worst at night and in wet weather. The jaw is usually depressed and the chin protruded. The disease runs a very chronic course, with occasional acute exacerbations. Excision of the condyle may be advisable when non-operative measures have failed to give relief.

Closure or Fixation of the Jaw.—It is necessary to distinguish between temporary and permanent fixation of the jaw.

Temporary fixation is due to spasmodic contraction of the muscles of mastication, particularly the masseter. This may be symptomatic of some inflammatory condition in the vicinity, such as a pyogenic affection of the lower jaw—for example, that associated with a carious root, or an unerupted wisdom tooth, parotitis, or tonsillitis. In such cases the spasm passes off on the removal of the cause. It is occasionally hysterical.

Temporary fixation may be due to rheumatic or syphilitic myositis, and this is sometimes followed by fibroid degeneration of the muscle, rendering the fixation permanent.

Permanent fixation may be due to a variety of causes. Fibroid degeneration of muscles following myositis has already been mentioned. Much more frequently it results from cicatricial contraction of the soft parts of the face or mouth following such conditions as cancrum oris, ulceration, or burns. Ankylosis of the joint, as a result of fracture or dislocation, or of any of the forms of arthritis, is also a common cause. The ankylosis may be fibrous or osseous, and may be intra- or extra-articular.

The *clinical features* vary with the degree of separation of the jaws. There is always some deformity, and more or less interference with mastication and speech. Owing to the patient's inability to cleanse the mouth, particles of food lodge and decompose there, causing irritation of the mucous membrane and fœtor of the saliva and breath. When osseous ankylosis occurs in children, it leads to an arrest of development of the lower jaw.

Treatment.—When the cause of the fixation is in the joint itself, the best treatment is to resect one or both condyles. An incision is made along the lower border of the zygoma. The parotid gland is retracted along with the branches of the facial

nerve. The joint is exposed by clearing away the posterior fibres of the masseter, and the condyle divided by a Gigli's wire-saw or an osteotome. The attachment of the external pterygoid is then separated and the condyle removed. The meniscus is retained. In some cases these measures are insufficient, and it is necessary to resect the condyle, the coronoid process, and a portion of the ascending ramus.

When the fixation is due to cicatricial contraction of the soft parts, mobility is best restored by forming an artificial joint well in front of the cicatricial tissue, as suggested by Esmarch. This is effected by excising a wedge of bone from the lower jaw. The base of the wedge measures about an inch and is towards the lower border of the jaw. To prevent relapse the muscles should be stitched across the gap in the bone, and active and passive movements carried out from the first.

CHAPTER XII.

THE TONGUE.

Wounds—Inflammatory Affections: *Acute parenchymatous glossitis and hemi-glossitis; Mercurial glossitis; Gangrene; Chronic superficial glossitis: Leucoplakia; Smoker's patch*—*Tuberculous disease; Syphilitic affections: Primary sore; Secondary lesions; Tertiary lesions: Sclerosing glossitis; Gummata; Ulcers and fissures*—Tumours: *Carcinoma; Sarcoma; Innocent tumours; Cysts*—Thyro-glossal cysts and tumours—Malformations: *Absence; Bifid tongue; Tongue tie; Excessive length of frenum; Macroglossia*—Nervous Affections.

Wounds of the tongue are most commonly produced by the teeth, as, for instance, when a child falls on the chin with the tongue protruded, or when a patient bites his tongue during an epileptic fit. Less frequently a foreign body, such as a pipe-stem, a bullet or a displaced tooth, is driven into the tongue. The immediate risk of such injuries is hæmorrhage, particularly when the posterior part of the tongue is implicated and the wound penetrates deeply. In superficial wounds of the anterior part the bleeding is seldom serious, except in hæmophilics. Of the later complications sepsis and secondary hæmorrhage are the most serious, and the risk is greatest when a foreign body is embedded in the tongue.

Treatment.—The hæmorrhage should be arrested, a general or local anæsthetic being employed if necessary. In superficial wounds near the tip the oozing is efficiently arrested by sutures. In deeper wounds, and especially if they implicate the posterior part of the tongue, a ligature must be applied to the bleeding vessel. Ligature of the lingual artery in the neck is seldom called for. Secondary hæmorrhage is much more difficult to arrest on account of the friable state of the tissues, and it may be necessary to ligature the lingual, or even the external carotid in the neck.

To prevent septic complications, any foreign body must be removed and an antiseptic mouth-wash regularly employed.

Cases have been recorded in which such a foreign body as a bullet, a needle or a piece of a pipe-stem has remained embedded in the substance of the tongue for long periods, and caused a firm, indolent swelling liable to be mistaken for a new growth. The removal of such bodies may be attended with considerable hæmorrhage.

Inflammatory Affections. *Acute Parenchymatous Glossitis.*—Acute inflammation implicating the whole of the substance of the tongue is comparatively rare. It usually occurs in young men, and is said to be most frequent during the winter months. The condition may follow on an attack of erysipelas or of scarlet fever. The numerous forms of bacteria which exist in the mouth play an important part in its production, and different types of the disease are recognised according to the nature of the more active organisms present.

In the streptococcal variety the whole tongue becomes markedly œdematous and the inflammatory process tends to spread to the tissues of the neck as a diffuse cellulitis—one variety of angina Ludovici. In the staphylococcal variety, on the other hand, the inflammation tends to be more limited, and results in the formation of a circumscribed abscess.

The onset is usually sudden, and is marked by severe pain and stiffness of the tongue, particularly when the patient attempts to masticate or to speak. The tongue rapidly swells, and in the course of twenty-four or forty-eight hours may fill the mouth and protrude beyond the teeth. It is fixed and covered with a thick white fur. There is profuse salivation, and in addition to difficulty in swallowing and speaking there may be considerable interference with respiration. The salivary and lymphatic glands in the submaxillary space are enlarged and tender. In the majority of cases the symptoms begin to subside in three or four days if suppuration does not occur.

The *treatment* consists in administering a sharp purge and employing an antiseptic mouth-wash. Leeches may be applied to the submaxillary region with benefit. When dysphagia and dyspnœa are prominent symptoms, it may be necessary to make longitudinal incisions into the substance of the tongue to relieve the congestion. If an abscess forms it must of course be opened.

Acute Parenchymatous Hemi-glossitis.—Occasionally the inflammation is confined to one-half of the tongue—usually the left. The swelling is usually confined to the anterior part of the tongue, and this variety rarely ends in suppuration.

Mercurial Glossitis.—An acute form of glossitis was formerly common among workers in mercury and in patients taking this drug medicinally. It is now seldom met with. There is profuse salivation and extreme fœtor of the breath. The swelling of the tongue is associated with a spongy condition of the gums, looseness of the teeth, and other signs of mercurial stomatitis. The treatment is the same as that for mercurial stomatitis.

Gangrene or sloughing of portions of the tongue may occur as a result of mercurial glossitis, sepsis, or syphilis, or from the spread of cancrum oris. A sloughing wound may result from the rough use of unsuitable tongue forceps during anæsthesia.

Chronic Superficial Glossitis.—Several forms of chronic superficial glossitis are met with. The most important, as it is frequently followed by the development of epithelioma, is that known as *leucoplakia* or *leuco-keratosis.*

The tongue is covered with white patches which result from overgrowth and cornification of the surface epithelium, whereby it becomes thickened and raised above the surface, and at the same time there is small-celled infiltration of the submucous tissue. The patches are irregularly lozenge-shaped, and when crowded together they present the appearance of a mosaic. Similar patches are also met with on the mucous membrane lining the cheek.

The disease is met with almost invariably in men between the ages of forty and fifty. Syphilis appears to be a predisposing factor, while any form of irritation—for example, the chewing or smoking of tobacco, the drinking of raw spirits, friction by a rough tooth or tooth-plate—tends to induce or aggravate the condition.

The milder forms give rise to no discomfort, but when the condition is advanced the patient complains of dryness and hardness of the tongue, with impairment of the sense of taste and persistent thirst. When cracks, fissures or warts develop, there may be pain on taking hot or irritating food. The glands below the jaw may be enlarged.

The disease is most intractable and persistent, and even after disappearing for a time is liable to recur. After a variable number of years epithelioma is liable to develop, usually in one or other of the fissures which accompany the condition.

The *treatment* consists in removing all sources of irritation and employing mouth-washes. Butlin recommends antiseptic ointments applied before going to bed. In some cases painting the patches with chromic or lactic acid is useful in removing

the excess of epithelium, but stronger caustics are to be avoided. Constitutional treatment is of little use even when the patient has suffered from syphilis.

The "*smoker's patch*" consists of a small oval area on the front of the tongue from which the papillæ have disappeared. It is slightly raised, smooth and red, and may be covered with a yellowish-brown or yellowish-white crust. It causes no discomfort unless the crust is removed and a raw sensitive surface exposed. The condition is liable to spread over the tongue if the patient persists in smoking. It may eventually assume the characters of leucoplakia. The *treatment* consists in stopping smoking, painting the patches with chromic acid, tannic acid, or alum, and using a chlorate of potash mouth-wash.

Tuberculous Disease.—The tongue is very rarely the primary seat of tuberculosis. In the majority of cases the patient suffers from advanced pulmonary or laryngeal phthisis, and the tongue is infected by bacilli from the sputum. In other cases the infection is secondary to lupus of the face or nose. When associated with pulmonary disease it is most frequently met with in adult males. When secondary to lupus it is usually females who suffer. The condition has been observed in children.

The condition is met with clinically either as a tubercle nodule in the substance of the tongue or as an ulcer.

In the *nodular form* a lump, seldom larger than a hazel-nut, appears on one side or near the tip of the tongue. At first the swelling is covered by epithelium, and is firm and painless. In time caseation takes place, the epithelium gives way, tuberculous debris escapes, and an open sore is formed.

The *tuberculous ulcer* is the form most frequently met with. The surface of the ulcer is uneven, pale and flabby, and is covered with a yellowish-grey discharge, with here and there feeble granulations showing through. The edges are shreddy, sinuous in outline, and there is little or no induration. The surrounding parts are slightly swollen, and may be the seat of several small tubercle nodules. The ulcer may be quite superficial, or it may extend into the muscular substance. The tip of the tongue may be completely eaten away so that it looks as if it had been cut off with a knife (Fig. 45). As the disease advances there is severe pain and usually profuse salivation. The submaxillary glands may be, but are not always, enlarged. Healing of the ulcer may take place, but is usually only temporary.

Primary ulcers should be removed along with the affected portion of the tongue. Even when secondary to pulmonary

disease, it may be advisable to excise the ulcer in order to relieve pain and to permit of the patient taking food. Care must be taken to avoid reinfecting the raw surface of the wound. When excision is impracticable, it is only possible to palliate the symptoms by local anæsthetics and by attending to the hygiene of the mouth and removing all sources of irritation.

Syphilitic Affections.—The *primary sore* of syphilis presents the same characters on the tongue as on other parts of the body. There is always marked enlargement of the submaxillary lymphatic glands on one or both sides. It is more common in men than in women, infection usually taking place through the medium of tobacco pipes, or implements such as the blow-pipes of glass-blowers.

FIG. 45. — Tuberculous Ulceration which has destroyed the tip of the tongue, occurring in a man who suffered from advanced pulmonary phthisis.

During the *secondary stage* of syphilis—particularly in the later periods—mucous patches are very common. They may appear on any part of the tongue, but are most frequently seen on its edges. They appear as smooth, irregularly rounded or oval areas with a greyish-white covering, the removal of which exposes a smooth, red, elevated surface. When situated on the under aspect of the tongue they often assume a condylomatous or warty appearance. As the secretion from these patches is highly contagious, it is necessary to warn the patient of the risk of infecting others by using dishes, cutlery, or pipes in common.

If not treated, the surface of a mucous patch may break down, leaving a tortuous or stellate fissure or ulcer, which tends slowly to increase in width and depth. The edges are punched out or undermined, the base raw, sloughy, and devoid of granulations, and the sore is exceedingly tender. After healing, these sores leave puckered scars of a silvery or leaden hue.

The treatment consists in employing the usual anti-syphilitic remedies, and in painting the patches with a solution of chromic acid (10 grains to the ounce).

The *tertiary* manifestations of syphilis in the tongue are sclerosing glossitis, gummata, and gummatous ulcers.

Sclerosing glossitis is the term applied by Fournier to a condition in which tuberous masses appear on the dorsal aspect of the tongue during the tertiary stage of syphilis. They tend to be oval in outline, are elevated above the level of the mucous membrane, and present a dull red mammillated or lobulated surface, comparable to the surface of a cirrhotic liver. They are firm, elastic and insensitive. There is no enlargement of the neighbouring lymphatic glands.

Gummata are usually situated on the dorsum of the tongue, and more often towards the centre than at the edges. They seldom implicate the floor of the mouth or the base of the tongue, so that the tongue can usually be protruded freely. They form indolent swellings which tend slowly to break down and ulcerate. So long as they remain unbroken they do not cause pain, and there is no enlargement of the adjacent lymphatic glands. Two forms are met with—the superficial, and the deep or parenchymatous.

Superficial gummata are almost always multiple, and appear as small hard nodules under the mucous membrane of the tongue, varying in size from a pin's head to a pea. The mucous membrane over them is redder than normal, and in the early stages retains its papillæ, but later becomes smooth. They tend to break down early, forming extensive superficial ulcers.

The *deep* or parenchymatous form may be single or multiple. It varies in size from a hazel-nut to a walnut, and feels like a hard body in the substance of the tongue. The mucous membrane over the swelling is of normal colour, but is usually devoid of papillæ. The gumma may remain for months unchanged, or may approach the surface, soften, and break down, leaving a deep ragged ulcer.

Syphilitic ulcers and fissures are nearly always preceded by gummata which have softened and broken down. The ulcers have seldom the typically rounded or serpiginous outline of gummatous ulcers on other parts of the body. The base is ragged and unhealthy, and on it a yellowish-grey slough resembling a piece of wash-leather may be seen. The edges are steep, ragged, and often undermined, and the surrounding parts thickened and indurated. The neighbouring glands are not usually enlarged. The ulcer is extremely painful when irritated by food, hot fluids, or spirits. If untreated, the sore may remain indolent and for months show no sign either of spreading or

healing. It may at any time take on the characters of a malignant ulcer.

Syphilitic fissures are met with as long, narrow, deep clefts, or as stellate or sinuous cracks in the substance of the tongue. After the healing of these ulcers and fissures permanent clefts and furrows remain.

Treatment.—The tertiary manifestations of syphilis in the tongue are treated on the same general lines as other tertiary lesions. Locally, the use of antiseptic mouth-washes, such as chlorate of potash or black wash diluted with lime-water, the insufflation of powdered iodoform and borax with a small quantity of morphin, or the application of mercurial ointment is useful. The sore must be thoroughly cleansed before these remedies are applied.

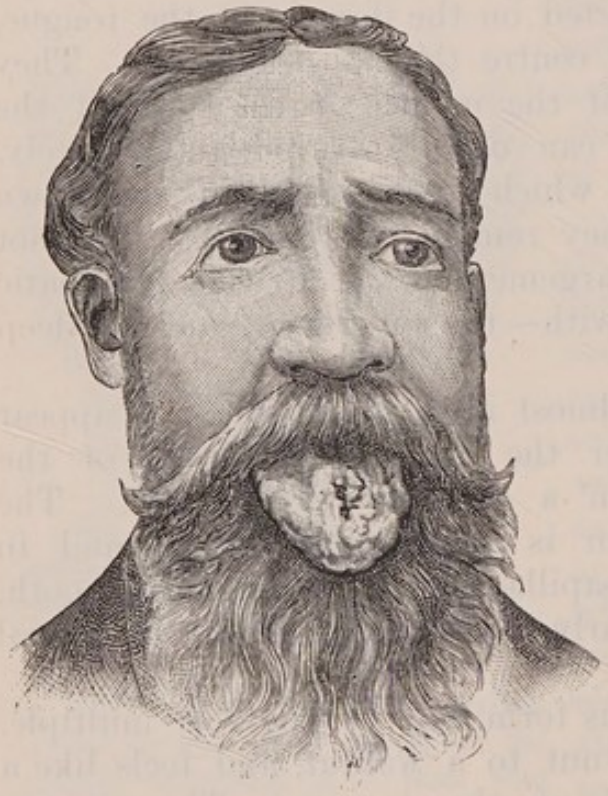

FIG. 46.—Epithelioma of Tongue which supervened on chronic superficial glossitis of many years' standing.

TUMOURS.

Carcinoma is by far the most common form of new growth met with in the tongue, and it is almost invariably a squamous-celled epithelioma.

Epithelioma generally occurs between the ages of forty and sixty, and attacks males oftener than females, in the proportion of about six to one. Its development is favoured by any long-continued irritation, such as the rubbing of the tongue against a carious tooth, an ill-fitting tooth-plate, or the rough end of a clay pipe. Chronic superficial glossitis, syphilitic fissures or scars, and chronic ulcers also act as predisposing factors. The repeated application of strong caustics to chronic inflammatory conditions of the tongue is, according to Butlin, an important determining cause of cancer.

The disease is usually situated on the anterior half of the tongue, and more commonly on the edge than on the dorsum. The disease may begin as an indolent excoriation, ulcer or fissure, as a warty growth, particularly in association with a patch of

leucoplakia, or, less frequently, as a hard nodule beneath the mucous membrane. In all cases ulceration begins early, and the base of the ulcer and the surrounding parts become indurated. The lymphatic glands are, as a rule, very early infected.

Clinical Features.—The clinical appearances vary widely. Sometimes the surface presents a warty growth, sometimes it is excavated, forming a deep ulcer with raised nodular edges. In other cases the ulcer is smooth, and its edges even and rounded. Extreme hardness of the edges and of the base of the ulcer is always a characteristic feature. The tongue becomes unduly fixed and cannot be protruded. This is most marked when the disease spreads towards the floor of the mouth. The patient complains of a constant gnawing pain in the tongue, and of severe pain shooting along the branches of the fifth nerve, and especially towards the ear. In the advanced stages there is profuse salivation and extreme fœtor of the breath. Owing to the immobility of the tongue there is interference with speech and mastication.

When the disease is situated on the edge of the tongue, it tends to spread to the floor of the mouth and to invade the lower jaw. If situated far back on the dorsum, it spreads towards the epiglottis, the pillars of the fauces, and the tonsil.

The neighbouring lymphatic glands—particularly those under the jaw and along the line of the carotid vessels—soon become enlarged and hard. The submaxillary and sublingual salivary glands are also liable to be affected. The enlarged cervical glands are liable to undergo softening, or to suppurate and burst on the skin surface, forming fungating ulcers. Metastasis to the liver, lungs, and other viscera is exceptional. The patient usually dies in from twelve to eighteen months from repeated small hæmorrhages, septic absorption, or septic pneumonia.

Differential Diagnosis.—Cancer of the tongue has to be diagnosed from syphilitic and tuberculous affections, papillomata, and simple ulcers and fissures. It is to be borne in mind that any of these conditions may take on malignant characters and develop into epithelioma. When there is any doubt as to the nature of the growth, it should be treated as if it were cancerous. The microscopic examination of a portion of the growth removed under cocain anæsthesia is often useful.

An unbroken gumma is liable to be confused only with the uncommon form of epithelioma which begins as a nodule under the mucous membrane. Gummata, however, are often

multiple, and the tongue shows old scars or other evidence of syphilis.

Gummatous ulcers are usually on the dorsum of the tongue, are frequently multiple, and have sloughy, undermined edges. The surrounding parts, although indurated, are not so densely hard as in cancer. There is not necessarily any involvement of lymphatic glands. The cancerous ulcer is usually single and situated on the edge of the tongue. Its edges are hard, raised, and nodular. The glands are usually enlarged and hard. It must not be forgotten that cancer may become engrafted on syphilitic lesions.

Tuberculous ulcers usually occur in association with other and unmistakable evidences of tuberculosis. It is not so essential to establish the diagnosis with certainty as the treatment is the same as for cancer, namely removal. This remark applies also to papillomata which show a marked tendency to become malignant. Simple ulcers and fissures are usually recognised by the history of the condition, the absence of induration and of glandular involvement, and by the fact that they heal quickly on removal of the cause.

Treatment.—The only treatment which offers any hope of cure is early and free removal of the disease.

The method of operating depends on the site and extent of the disease, and upon whether or not the glands are palpably enlarged. Some surgeons advocate the performance of a preliminary laryngotomy on the ground that it facilitates the administration of the anæsthetic, and enables the back of the mouth to be packed so as to diminish the risk of blood passing into the air-passages. Preliminary ligation of the lingual artery or temporary occlusion of the external carotid is also recommended. Jacobson is of opinion that the cervical, submaxillary, and submental glands should be systematically removed at a separate operation carried out three or four weeks after the removal of the tongue.

The choice of operation lies between Whitehead's and Syme's methods.

Whitehead's operation is specially adapted to cases of cancer limited to one side of the anterior portion of the tongue, but it may be performed even when the whole tongue is implicated. The mouth is opened widely with a gag, and each half of the tongue is transfixed with a loop of stout silk passed through its substance beyond the disease, to enable it to be pulled well out of the mouth. The tongue is then split along the middle line to well beyond the level of the growth. The mucous membrane

along the line of its reflection on to the alveolar process is next divided with scissors, and the anterior pillar of the fauces cut through. Next the muscles between the tongue and the floor of the mouth are snipped through with the scissors, the vessels being caught with forceps as they are divided. Finally the tongue is cut across well behind the tumour. The lingual vessels can usually be seized with forceps before being cut. If necessary the other half of the tongue is then removed in the same way.

Syme's operation is suitable to cases in which the whole tongue has to be removed along with the structures in the floor of the mouth. It consists in carrying an incision in the middle line through the lower lip, over the chin, and down to the hyoid bone. The symphysis of the lower jaw is then divided by means of a Gigli's saw passed between the incisor teeth, and the tongue separated from the alveolar process on each side. The anterior pillars of the fauces having been divided, the muscles inserted into the genioid tubercles are separated from the bone and the diseased tissue dissected up from the floor of the mouth. The tongue is then divided transversely well beyond the disease, the lingual arteries being secured if possible before being cut. Infected lymphatic glands are removed at the same time. The two halves of the jaw are then wired and the soft parts sutured.

In all these operations, before putting the patient back to bed a loop of silk should be passed through the stump of the tongue to prevent it falling back and obstructing the respiration.

The *after-treatment* consists in keeping the mouth sweet by spraying it frequently with peroxide of hydrogen and washing it out with Condy's fluid or other antiseptic lotion. The patient is fed with nourishing fluid food through a tube attached to a feeding cup. It is of great importance to allow him to sit up, and to get him out of bed, as early as possible.

The great risk after operation is septic pneumonia from inhaling blood and septic products. Hence the importance of keeping the mouth as dry and as sweet as possible. The patient is usually able to be out of bed on the fourth or fifth day, and is well in a fortnight or three weeks. Permanent recovery follows operation in from 10 to 20 per cent. of cases. The operation, even when followed by recurrence, usually prolongs life by six or eight months, and renders the patient more comfortable by removing the foul ulcer from the mouth. When recurrence takes place, it is usually in the glands, and may be attended with great suffering.

Treatment of Inoperable Cases.—When the disease is so widespread that removal by operation is impracticable, palliative treatment alone is available. The mouth must be kept as sweet as possible. The pain may be relieved to some extent by cocain or orthoform, but as a rule the free administration of morphin is called for. If hæmorrhage takes place from the ulcerated surface and cannot be controlled by adrenalin, turpentine, or other local styptics, it may be necessary to ligature the lingual, or even the external carotid artery. Interference with respiration may necessitate tracheotomy. When the taking of food causes much pain, recourse should be had to rectal feeding. Pain shooting up to the ear may be relieved by resection of the lingual nerve.

Sarcoma.—Sarcoma of the tongue is rare. The small-celled, the round-celled, and the lympho-sarcoma are the varieties usually met with. Some show little tendency to recur after removal, while others are extremely malignant. The diagnosis is always difficult, and is seldom made unless a portion of the growth has been removed and examined microscopically.

Innocent tumours of the tongue are rare. Lipomata, fibromata, and various forms of angiomata are occasionally met with. They are all of slow growth, and only give rise to inconvenience by their bulk.

Papillomata may occur on any part of the tongue, and at any age. When associated with leucoplakia they are liable to assume malignant characters.

Cysts.—*Dermoid* cysts occasionally occur beneath the tongue. They lie in the middle line, between the genio-hyoglossi, and on the upper surface of the mylo-hyoid. They may be noticed soon after birth, or may only attract attention during adult life. The cyst usually projects under the chin, forming a soft fluctuating swelling, which varies in size from a pigeon's to a turkey's egg. When they bulge towards the mouth, they are recognised by their yellow colour and by their mesial position from retention cysts of the salivary glands, which are purplish and lie to one side of the middle line. They are treated by excision.

Hydatid and cysticercus cysts have also been met with.

Thyro-glossal Cysts and Tumours.—Cysts and solid tumours may develop in the embryonic tract which passes from the isthmus of the thyroid gland to the foramen cæcum at the base of the tongue—the so-called thyro-glossal duct. The solid tumours have the same structure as the thyroid gland, and in some cases they attain considerable size and appear to be

physiologically active, as their removal has been followed by myxœdema. The cysts are lined with ciliated epithelium and have thyroid gland tissue in their walls. These growths occupy the dorsum of the tongue, and extend from the foramen cæcum backwards towards the epiglottis. They are of a bluish-brown or dark red colour. As the walls of the cysts are very vascular, they are liable to repeated attacks of hæmorrhage. The blood may fill the cyst, causing it to become suddenly enlarged, or the cyst may burst and the blood escape into the mouth. These variations in size and repeated attacks of bleeding help to distinguish thyro-glossal cysts from other swellings of the tongue. Treatment is only called for when the swelling causes interference with speech or swallowing. The tumours are then removed by dissection.

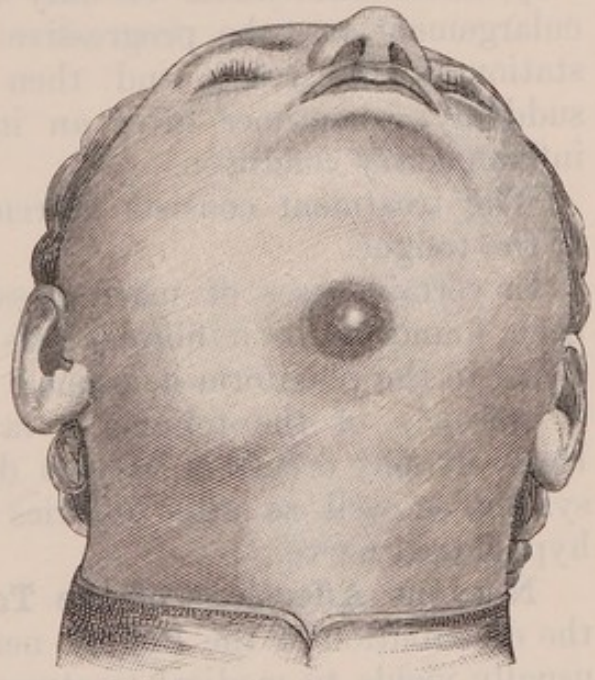

FIG. 47.—Thyro-glossal Cyst in girl, æt. 10.

Malformations. — Complete or partial *absence* of the tongue is exceedingly rare.

Occasionally the fore part of the tongue is *bifid*. The function of the organ is not interfered with, and the operation of paring and suturing the two halves is only called for to remove the disfigurement.

Congenital tongue-tie is a condition in which the tip of the tongue is bound down to the floor of the mouth by an abnormally short and narrow frenum, or by folds of mucous membrane on each side of the frenum. The patient is unable to protrude the tongue. This deformity is rare. It is very common, however, for parents to blame an imaginary tongue-tie when a child is slow to begin to speak, or when he speaks indistinctly or stammers, and surgeons are frequently requested to divide the frenum under such circumstances. In the vast majority of cases nothing is found to be wrong with the frenum. This fact is emphasised because hæmorrhage, septic complications, deforming cicatricial contraction, and other untoward effects have followed the needless division of the frenum. In the rare cases of true tongue-tie the shortened bands should be divided close behind the incisor teeth, and the cut surfaces prevented

from reuniting by frequent packing with gauze or gentle stretching with the tip of the finger.

Excessive length of the frenum is occasionally met with, and in young children may allow of the tongue falling back into the throat and causing sudden suffocative attacks which may prove fatal. In some cases the patient is able voluntarily to fold the tongue back behind the soft palate.

Macroglossia is the term applied to a variety of conditions in which the tongue becomes unduly large. The typical form—lymphangiomatous macroglossia—is due to a dilatation of the lymphatic spaces of the tongue. It is often congenital, and may affect the whole or only a part of the tongue. The enlargement may be progressive from the first, or may remain stationary for years, and then begin to develop somewhat suddenly, sometimes after an injury or as a result of some inflammatory condition.

The treatment consists in removing a wedge-shaped portion of the tongue.

In certain cases of macroglossia in children the lesion has been found to be a fibromatosis of the nerves of the tongue allied to the plexiform neuroma.

Atrophy of the tongue is rare as a congenital condition. Hemi-atrophy occurs in various diseases of the central nervous system, as well as after injuries and diseases implicating the hypoglossal nerve.

Nervous Affections of the Tongue.—*Neuralgia* confined to the distribution of the lingual nerve is comparatively rare. It usually yields to medical treatment, but in inveterate cases it is sometimes necessary to resect the nerve.

It is more common to meet with a condition in which the patient complains of severe burning or aching pain in the region of the foliate papilla, which is situated on the edge of the tongue just in front of the anterior pillar of the fauces. The patient is usually a middle-aged woman, decidedly neurotic, and often with a gouty or rheumatic tendency. The pain, for which it is seldom possible to discover any cause, is usually worst at night, and may last for months, or even years. The practical importance of the condition is that, as the foliate papilla is prominent and red, it is very liable to be mistaken on superficial examination for commencing epithelioma. An inspection of the opposite side of the tongue, however, will reveal an exactly similar condition which is not painful. The first and most important step in treatment is to assure the patient that the condition is not cancerous. Potassium bromide and anti-gouty

and anti-rheumatic drugs may be prescribed, and if the pain is severe, cocain may be applied locally. Caustics and other irritating applications are to be avoided.

Spasm of the tongue sometimes occurs after injuries of the head implicating the centre or trunk of the hypoglossal nerve. It may also appear as a reflex condition in inflammatory affections of the teeth and gums, or as a manifestation of some general disease of the central nervous system.

Paralysis of the tongue—unilateral or bilateral—may be due to injury or disease of the nerve centres of the hypoglossal nerve, less frequently to injury or pressure on the nerve trunk. The nerve may be bruised or divided in operations for the removal of tuberculous glands in the neck.

CHAPTER XIII.

THE SALIVARY GLANDS.

Surgical anatomy—Injuries—Salivary fistulæ—Salivary calculi—Inflammatory affections: *Parotitis; Inflammation of submaxillary gland; Angina Ludovici; Inflammation of sublingual gland; Tuberculous disease*—Tumours: *Ranula; Mixed tumours of parotid; Sarcoma; Carcinoma; Tumours of submaxillary and sublingual glands.*

Surgical Anatomy.—The *parotid gland* lies between two layers of fascia on the outer surface of the masseter muscle. It reaches up to the posterior part of the zygoma, and down to the level of the angle of the jaw. A prolongation of the gland usually passes deeply between the glenoid cavity and the mastoid process, and there is often a detached portion on the surface of the masseter—the *socia parotidis.* The deep surface of the gland lies in close relation with the internal carotid artery, the internal jugular vein, and the vagus, glosso-pharyngeal, spinal accessory, and hypoglossal nerves. The external carotid artery passes through the substance of the parotid, and bifurcates opposite the neck of the condyle into the temporal and internal maxillary arteries. It is accompanied by the venous trunk formed by the junction of the temporal and internal maxillary veins. The facial nerve and its branches also traverse the lower third of the gland from behind forwards. The excretory duct—*Stenson's duct*—emerges from the anterior border of the gland, and after crossing the masseter pierces the buccinator muscle and the mucous membrane obliquely, and opens into the mouth opposite the second upper molar tooth. The course of the duct is indicated by a line passing from the upper part of the lobule of the ear to the ala of the nose—that is, at a higher level than the facial nerve. Several lymphatic glands lie inside the capsule of the parotid just in front of the ear.

The *submaxillary gland* lies under the integument and fascia in the triangle formed by the lower jaw and the two bellies of the digastric muscle. Its anterior part is crossed by the facial vessels, and several lymphatic glands lie inside its capsule. The duct—*Wharton's duct*—opens into the mouth by the side of the frenum of the tongue.

The *sublingual gland* lies in the floor of the mouth just beneath the mucous membrane. It has numerous ducts, some of which open directly into the mouth, others into Wharton's duct.

Injuries.—The *parotid* is frequently injured by accidental wounds and in the course of operations. If the blood-vessels

traversing the gland are divided, such wounds are liable to bleed freely, and if the facial and auriculo-temporal nerves are damaged, corresponding motor and sensory paralyses ensue. Wounds of the parotid heal rapidly and without complications so long as septic infection is prevented, but if suppuration takes place, they are liable to be followed by the escape of saliva, which may go on for weeks or months before ceasing. In some cases a persistent salivary fistula is thus established.

Stenson's duct may be divided and a salivary fistula result. If the external wound heals rapidly a salivary cyst may develop in the substance of the cheek. This forms a swelling, which fills up each time the patient takes food, and which may be emptied by external pressure, the saliva escaping into the mouth.

In a wound implicating the whole thickness of the cheek the cutaneous surface should be accurately sutured, care being taken that the stitches do not include the duct, but the mucous surface should be left open in order that the saliva may readily reach the mouth.

Salivary Fistulæ.—A salivary fistula may occur in relation to the glandular substance of the parotid or in relation to Stenson's duct. Fistulæ in connection with the glandular substance—*parotid fistulæ*—may result from wounds, made, for example, in the removal of tumours or in operations on the ramus of the jaw, or as a sequel of suppuration in the gland, and particularly of abscesses which develop around concretions. The fistulous opening is usually small, and may occur at any point over the gland. The fistula may be dry between meals, or the saliva may escape in small transparent drops, but the quantity is always greatly increased when the patient takes food. Parotid fistulæ, although they may continue to discharge for weeks, or even for months, usually close spontaneously.

In persistent cases the edges of the fistula may be pared and brought together with sutures, or the actual cautery may be applied.

Fistula of Stenson's duct is much more important. It is usually due to a wound, less frequently to abscess or impacted calculus. The opening, which is most frequently situated over the buccinator muscle, is usually very minute and is surrounded by a mass of pouting granulations. There is an almost continuous flow of clear limpid saliva, which is greatly increased in quantity while the patient is eating. These fistulæ show little tendency to close spontaneously. Attempts to close the opening by the external application of collodion, by cauterising the edges, or even by paring the edges and introducing sutures, usually

fail. It is necessary to establish an opening into the mouth, either by opening up the original duct or by making an internal fistula in place of the external one. If possible, a fine probe or bougie should be passed from the normal opening in the mouth along the whole length of the duct, and fixed in position sufficiently long to allow the external opening to close. While the probe is in position, the occlusion of the external opening by collodion helps to direct the saliva along the duct. When the oral end of the duct is impermeable, a silk thread should be passed through the fistula into the mouth so as to include and strangulate a portion of tissue, the sloughing of which establishes a permanent channel into the mouth along its track.

Salivary Calculi.—Salivary calculi are most commonly met with *in the submaxillary gland.* They consist of phosphate and carbonate of lime with a small proportion of organic matter, and result from the chemical action of bacteria on the saliva. In rare cases a foreign body, such as a piece of straw, a fruit-seed or a fish-bone, forms the nucleus of the concretion. They vary in size from a pea to a walnut. Those which form in the gland itself are usually irregular, while those met with in the duct are rounded or spindle-shaped. They are hard, of a whitish or grey colour, and rough on the surface.

A calculus in the duct gives rise to a sharp lancinating pain, which is aggravated when the patient takes food. The duct is seldom completely obstructed, but the flow of saliva is usually so much impeded that the gland becomes greatly swollen during meals. The swelling gradually subsides between times, or can be made to disappear by external pressure. The calculus can usually be felt through the mucous membrane as a hard lump in the floor of the mouth, or by means of a probe passed along the duct. When the obstruction is complete, a retention cyst forms in which suppuration is liable to occur. In some cases the wall of the duct and the surrounding tissues become thickened and indurated, forming a swelling which is liable to be mistaken for a malignant growth. The treatment consists in making an incision through the mucous membrane over the calculus and extracting it with forceps or a scoop.

Inflammatory Affections—**Parotitis.**—Inflammation of the parotid gland may be non-suppurative or suppurative.

Of the *non-suppurative* varieties the most common is the epidemic form known as *mumps.* This is an acute infective condition which usually attacks young children, and implicates both glands, either simultaneously or consecutively. It runs a

definite course which lasts for from one to two weeks, and almost invariably ends in resolution. The parotid gland is swollen and tender, and there is pain on attempting to open the mouth. Owing to the difficulty in swallowing there is dribbling of saliva. The surgical interest of this disease lies in the fact that it is frequently complicated by pain and swelling of the testis and œdema of the scrotum, and occasionally by a urethral discharge. Atrophy of the testis has been observed after such an attack. In females there is sometimes pain in the region of the ovary, tenderness and swelling of the breasts, and a discharge from the vagina.

The parotid on one or on both sides may suddenly become swollen and tender in patients who are taking large doses of mercury, in gouty subjects, or in patients suffering from inflammatory conditions of the genito-urinary organs, such as orchitis, ovaritis, urethritis, or cystitis. The condition is usually transient and leads to no complications.

The treatment of these non-suppurative forms of parotitis is entirely symptomatic.

Suppurative parotitis may occur in the course of any disease in which there is a general infection of the blood with pyogenic bacteria. It has been met with in diphtheria, typhoid fever, scarlet fever, measles, and other eruptive fevers, and it is comparatively common after certain abdominal operations, such as those for suppurative appendicitis, perforated gastric ulcer, ovarian cyst, and pyosalpinx.

In exceptional cases it is due to the direct spread of local conditions, such as arthritis of the temporo-maxillary joint, periostitis of the jaw, or suppuration in a lymphatic gland, or to infection from the mouth along Stenson's duct.

The early symptoms are apt to be overshadowed by those of the general disease from which the patient suffers. At first the gland is swollen, hard and tender; later the part becomes red, œdematous and fluctuating. The movements of the jaw are restricted and painful, the patient is unable to open the mouth, and has difficulty in swallowing. The inflammation reaches its height on the third or fourth day, and ends in suppuration. The pus is scattered in numerous foci throughout the gland, and sometimes large sloughs form. The dense capsule of the gland prevents the pus reaching the surface and causes it to burrow among the tissues of the neck. It may find its way downwards towards the mediastinum, inwards towards the pharynx—where it constitutes one form of retro-pharyngeal abscess,—or upwards towards the base of the skull. Not infrequently it burrows

into the temporo-maxillary joint, or escapes by bursting into the external auditory meatus. Serious hæmorrhage may result from erosion of the vessels traversing the gland or of the internal jugular vein, or venous thrombosis may ensue. Persistent paralysis may follow destruction of the facial nerve.

Treatment.—During the first two or three days hot fomentations are applied, and the mouth is frequently washed out with an antiseptic. As soon as pus has formed, it must be evacuated. An incision is made behind the angle of the jaw, parallel to the branches of the facial nerve, the abscess opened by Hilton's method, and a large drainage tube inserted.

Acute inflammation of the **submaxillary gland** is met with under the same conditions as that of the parotid. Both glands are occasionally attacked at the same time.

An acute phlegmonous periadenitis sometimes occurs in the loose cellular tissue around the submaxillary gland, and spreads with great rapidity through the cellular planes of the neck. The condition—which goes by the name of *angina Ludovici*—is usually met with in adults, and appears to originate in some septic focus in the mouth. The onset is sudden and acute, and is marked by a rigor, with high temperature and a rapid, intermittent, and compressible pulse. The submaxillary region becomes densely infiltrated and brawny, and the swelling extends upwards towards the root of the tongue and downwards in the neck towards the mediastinum. The mouth is closed, the tongue fixed, and swallowing is impossible. The inflammatory swelling may spread to the air-passages and induce œdema of the glottis. Diffuse suppuration and sloughing of the cellular tissue usually occur, and may lead to general pyæmia by causing venous thrombosis. Unless incisions are made early the condition may prove fatal.

The *treatment* consists in making incisions through the deep fascia in order to relieve the tension, or to evacuate pus if it has formed. The general toxæmia must be treated, and free stimulation is urgently called for.

Acute suppurative inflammation of the **sublingual gland** is associated with the formation of an exceedingly painful and tender swelling under the tongue. The tongue is gradually pushed against the roof of the mouth, so that swallowing is difficult and respiration may be seriously impeded. There is marked constitutional disturbance. An incision into the swelling is immediately followed by relief of the symptoms.

Tuberculous disease of the salivary glands is rare. It usually begins in the lymphatic glands within the capsule of the parotid

or submaxillary, and spreads thence to the salivary gland tissue.

Tumours.—**Cystic Tumours—Ranula.**—The term ranula is applied to any cystic tumour formed in connection with the salivary glands in the floor of the mouth. Formerly these tumours were believed to be retention cysts due to blocking of the salivary ducts. They are now known to be the result of a cystic degeneration of one or other of the secreting glands in the floor of the mouth. They contain a thick glairy fluid which differs from saliva in containing a considerable quantity of mucin and albumin, while it is free from any amylolytic ferment or sulphocyanide of potassium. Numerous degenerated epithelial cells are found in the fluid.

The *sublingual ranula* is the most common variety. It appears as a painless, smooth, tense, globular swelling of a bluish colour. It usually lies on one side of the frenum, and over it the mucous membrane moves freely. A probe can usually be passed along Wharton's duct. As it increases in size it gradually pushes the tongue towards the roof of the mouth, and so causes interference with speech, mastication, and swallowing.

The *treatment* consists in making an incision through the mucous membrane over the swelling, dissecting away as much of the cyst wall as possible, and swabbing the remainder with a solution of chloride of zinc (40 grains to the ounce). The cavity is then stuffed with iodoform gauze and allowed to close by granulation. It is sometimes found more satisfactory to dissect out the cyst through an incision below the jaw.

Cystic tumours form in the other glands in the floor of the mouth, for example, the incisive gland, which lies just behind the symphysis menti, as well as in Blandin's gland on the under aspect of the tip of the tongue. They differ from the sublingual ranula only in their position. In rare cases children are born with a cystic swelling in the floor of the mouth—the so-called *congenital ranula*. It is usually due to an imperfect development of the duct of the submaxillary or sublingual gland.

Solid Tumours—Mixed Tumours of the Parotid.—The most important of the solid tumours met with in the salivary glands is the so-called "mixed tumour of the parotid," which is now believed to be an endothelioma derived from a proliferation of the endothelial cells lining the lymph spaces and blood-vessels of the gland. In some places the structure is that of an adenoma, in others it resembles cartilage, or it may be myxomatous, sarcomatous, or angiomatous, the proportion of these different elements varying in individual specimens. A gelatinous sub-

stance forms in the intercellular spaces of the tumour, and may accumulate in sufficient quantity to give rise to cysts of various sizes. There is reason to believe that the tumours of the parotid previously described as adenoma, chondroma, angioma, myxoma, and many of the cases of sarcoma, were really mixed tumours in which one or other of these tissues predominated.

The tumour develops in the substance of the parotid, and in doing so becomes encapsulated, and presses on the salivary tissue, thinning it out and causing it to undergo atrophy. In the early stages the growth can be shelled out of the gland.

Clinical Features.—The mixed tumour is usually first observed between the ages of twenty and thirty. It is of slow growth and painless, and forms a rounded, nodular swelling, the consistence of which varies with its structure. The skin over the swelling is normal in appearance and is not attached to the tumour (Fig. 48). Only in rare cases does paralysis result from pressure on the facial nerve.

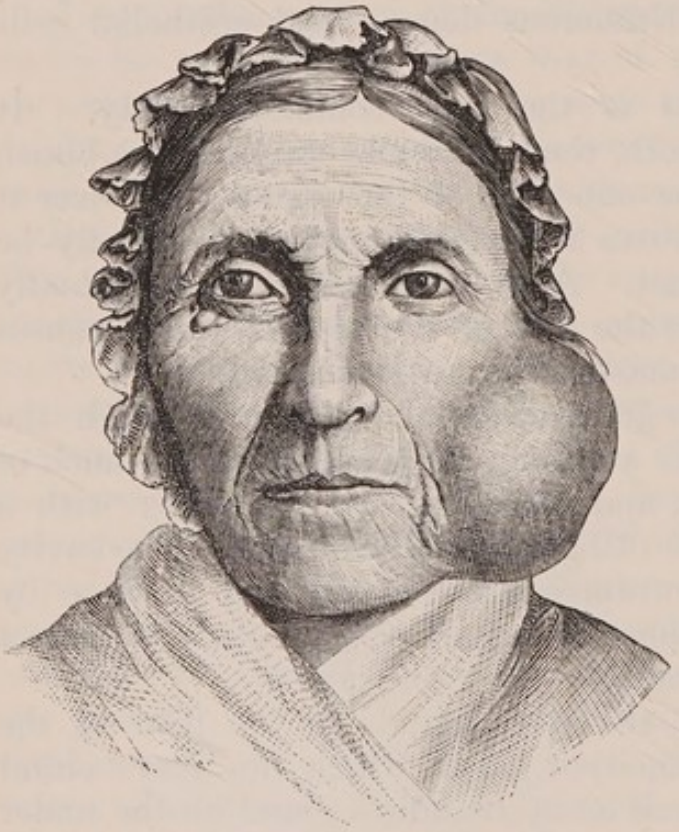

FIG. 48.—Mixed Tumour of the Parotid of over twenty years' duration.

Although usually benign, these tumours may, after lasting for years, take on malignant characters, growing rapidly, implicating adjacent lymphatic glands, and showing a marked tendency to recur after removal.

The *treatment* consists in making a free incision over the tumour and shelling it out of the gland, care being taken to avoid injuring the facial nerve or Stenson's duct. If it is removed early and completely recurrence is rare.

Sarcomata and carcinomata of the parotid are rare. They are very malignant, grow rapidly, infiltrate surrounding parts, including the skin, and infect the adjacent lymphatic glands. There is severe neuralgic pain, and paralysis from involvement of the facial nerve is an early symptom. Recurrence is

very liable to occur after removal. The *treatment* consists in excising the whole of the parotid gland with the tumour, no attempt being made to conserve the facial nerve or other structures traversing the gland.

The *submaxillary and sublingual glands* may be the seat of the same varieties of tumour as the parotid. These glands are particularly liable to become invaded along with the adjacent lymphatic glands in cancer of the tongue.

CHAPTER XIV.

THE EAR.

Surgical anatomy. CARDINAL SYMPTOMS OF EAR DISEASE: *Impairment of hearing; Tinnitus aurium; Earache; Giddiness; Discharge* —Hearing tests — Inspection of ear — Inflation of middle ear. AFFECTIONS OF EXTERNAL EAR: *Deformities; Hæmatoma auris;* Epithelioma and rodent cancer; *Impaction of wax; Eczema; Boils; Foreign bodies.* AFFECTIONS OF TYMPANIC MEMBRANE AND MIDDLE EAR: *Rupture of membrane; Acute inflammation of middle ear; Chronic suppuration; Suppuration in the mastoid antrum and cells.*

Surgical Anatomy.—The anatomical subdivision of the ear into three parts—the external, middle, and internal ear—forms a satisfactory basis for the study of ear lesions. The outer ear consists of the auricle and external auditory meatus, the latter being made up of an outer cartilaginous portion half an inch in length, and a deeper osseous portion three-quarters of an inch long. The canal forms a curved tube, which can be straightened to a considerable extent for purposes of examination by pulling the auricle upwards and backwards. It is closed internally by the tympanic membrane, which separates it from the tympanic cavity or middle ear. The middle ear includes the tympanum proper, which is crossed by the chain of ossicles—malleus, incus, and stapes—the Eustachian tube, which communicates with the naso-pharynx, and the mastoid antrum and cells. As these cavities lie in close relation to the floor of the middle cranial fossa, inflammatory conditions in the tympanum and mastoid cells are liable to spread to the interior of the skull. The internal ear or labyrinth lies in the petrous part of the temporal bone, its outer boundary being the inner wall of the middle ear.

Physiologically the different parts of the auditory mechanism may be divided into (1) the *sound-conducting apparatus*, which includes the outer and middle ears; and (2) the *sound-perceiving apparatus*—the internal ear and central nerve tracts. Impairment of hearing may be due to causes existing in one or other or both of these subdivisions. The condition of the sound-conducting apparatus can be investigated by direct inspection through the speculum, and by inflation of the Eustachian tube and tympanum, while that of the sound-perceiving apparatus is ascertained partly by testing the hearing, and partly by excluding affections of the outer and middle ear. When the sound-conducting apparatus is at fault, the resulting deafness is spoken of as "obstructive"; when the sound-perceiving apparatus is affected, the term "nerve deafness" is used.

Cardinal Symptoms of Ear Disease.—The most important symptom of ear disease is *impairment of hearing*, which varies in degree, and may be due to lesions either in the sound-conducting or in the sound-perceiving apparatus. The sudden onset of deafness may be due to impaction of wax in the external meatus or to hæmorrhage or effusion into the labyrinth. A gradual onset is more common. In children there is a great tendency for acute inflammatory conditions of the middle ear to arise in connection with the exanthemata and in association with adenoids. In adult life chronic catarrhal processes are more common causes of gradually increasing deafness, while in advanced age there is a tendency to auditory nerve impairment. Certain anomalous conditions of hearing are occasionally met with, such as the "paracusis of Willis"—a condition in which the patient hears better in a noise; "diplacusis," or double hearing; and "hyperæsthesia acustica," or painful impressions of sound.

Tinnitus aurium, or subjective noises in the ear, may constitute a very annoying and persistent symptom. These sounds vary markedly in their character, and may be described by the patient as ringing, hissing or singing, or may be compared to the sound of running water or of a train. They are usually compared to some sound which, from his occupation or otherwise, the patient is accustomed to hear. They may be purely aural in origin, being due, for example, to increased pressure on the auditory nerve endings from causes in the labyrinth itself or in the middle or external ear; or they may be due to certain reflex causes, such as naso-pharyngeal catarrh or gastric irritation. Vascular changes such as occur in anæmia, Bright's disease, and heart disease may also be concerned in their production.

Pain, or earache, varies in degree from a mere sense of discomfort to acute agony. The pain associated with a boil in the external meatus is usually aggravated by movements of the jaw, by pulling the auricle, and by pressure upon the tragus. The pain of acute middle-ear inflammation is deep-seated, intermittent in character, and worse at night, and is aggravated by blowing the nose, coughing, and sneezing—acts which increase middle-ear tension through forcing air along the Eustachian tube. Mastoid pain and tenderness are indicative of inflammation in the antrum or cells, and when these symptoms supervene in the course of a chronic middle-ear suppuration, they should always be regarded as of grave import. Severe neuralgia of the ear may simulate the pain of acute mastoiditis, and it must not be forgotten that earache may be traced to a diseased tooth.

A careful examination, not only of the ear, but also of the throat and teeth, should therefore be made in all cases of earache.

Vertigo, or giddiness, may be produced by causes which alter the tension of the labyrinthine fluid, such, for example, as the pressure of wax upon the tympanic membrane, or exudation into the middle ear or into the labyrinth. Giddiness occurring in the course of chronic middle-ear suppuration may be significant of labyrinthine or intra-cranial mischief, but is not necessarily so. Giddiness preceded by nausea suggests a gastric origin; if followed by nausea it points to an aural origin.

Discharge from the ear, or otorrhœa, is occasionally due to an eczematous condition of the skin lining the external meatus. It is then usually of a thin, watery character, and contains epithelial flakes and debris. An aural discharge is, however, most commonly of middle-ear origin. It may be muco-purulent and stringy, or purulent and of thicker consistence. A peculiar, offensive odour is characteristic of chronic middle-ear suppuration. The surgeon should smell the speculum in suspicious cases. He should never accept the patient's statement as regards the absence of discharge, but should satisfy himself by inspection and by the introduction of a cotton-wool wick.

The Hearing Tests.—In testing the hearing a definite routine method should be adopted, the watch, whisper, voice, and tuning-fork tests being systematically employed. Although the patient only complains of one ear, both must be examined. Each ear should be examined separately, and the patient should be so placed that he cannot see the lips of the examiner. While one ear is being tested, the other should be carefully closed with the finger. Each test should be commenced outside the probable normal range of hearing. All the results should be written down at once, and the date of the test recorded, as this is essential for following the progress of the case.

Tuning-fork Tests.—In order to differentiate between deafness due to a lesion in the sound-conducting apparatus and that due to labyrinthine causes, it is necessary to enter into a little more detail. The vibrations of a tuning-fork are conducted to the nerve terminations in the labyrinth both through the air column in the external meatus (air-conduction), and through the cranial bones (bone-conduction). When in a deaf ear the vibrations of a tuning-fork placed in contact with the mastoid process are heard better than when the fork is held beside the ear, the lesion is in the sound-conducting apparatus. When, on the other hand, the vibrations are heard better by air-conduction, the lesion is in the sound-perceiving apparatus. In addition to

these facts we find also that in obstructive deafness low tones tend to be lost first, while in nerve deafness the higher notes are the first to go. This may be investigated by tuning-forks of different pitch or with the aid of a Galton's whistle. Again, in middle-ear deafness, hearing may be better in a noisy place, and may be improved by inflation of the tympanum; while in labyrinthine deafness, hearing may be better in a quiet room, and may be rendered worse by inflation.

Inspection of the Ear.—This should be carried out by the aid of reflected light, the ear to be examined being turned away from the window, lamp, or other source of light which may be employed. A small ear reflector, either held in the hand or attached to a forehead band, and a set of aural specula are required. Before introducing the speculum, the outer ear and adjacent parts should be examined, and the presence of redness, swelling, sinuses or cicatrices over the mastoid, displacement of the auricle, or any inflammatory condition of the outer ear observed. In order to inspect the tympanic membrane, a medium-sized speculum held between the thumb and index finger is insinuated into the cartilaginous meatus, the auricle being at the same time pulled upwards and backwards by the middle and ring fingers, so as to straighten the canal. The tympanic membrane is then sought for and its appearance noted.

The *normal membrane* is concave as a whole on its meatal aspect; it occupies a doubly oblique plane, being so placed that its superior and posterior parts are nearer the eye of the examiner than the anterior and inferior parts. While varying to some extent in colour, polish and transparency, it presents a bluish-grey appearance. The handle of the malleus traverses the membrane as a whitish-yellow ridge, which passes from its upper and anterior part downwards and backwards to a point a little below the centre. At the lower end of the handle of the malleus a bright triangular cone of light passes downwards and forwards to the periphery of the membrane. At the upper end of the handle is a white knob-like projection, the short process of the malleus. Passing forwards and backwards from this are the anterior and posterior folds. The portion of the membrane situated above the short process is known as Shrapnell's membrane. Behind the malleus the long process of the incus may be visible through the membrane. The mobility of the membrana tympani should be tested by inflating the tympanum or by the use of Siegle's pneumatic speculum.

Various departures from the normal may be observed. *Atrophy* of the membrane is characterised by extreme trans-

parency of the whole disc. Circumscribed atrophic patches appear as dark transparent areas, which show considerable mobility and bulge prominently on inflation. *A cicatrix* in the membrane is evidence of a healed perforation, and is also transparent, but differs from an atrophic patch in being more sharply defined from the surrounding membrane. *A thickened membrane* presents an opaque white appearance. *Calcareous or chalky patches* are markedly white, and when probed are hard to the touch; they are often evidence of past suppuration. An *indrawn* or retracted membrane, resulting from Eustachian obstruction, is characterised by increased concavity, undue prominence of the short process of the malleus and of the anterior and posterior folds, and by the handle of the malleus assuming a more horizontal position. An *inflamed* membrane, showing congestion of the vessels about the malleus, or a general diffuse redness is evidence of middle-ear inflammation. A yellow appearance of the lower part of the membrane, limited above by a dark line stretching across the drum-head, is indicative of sero-purulent exudation into the tympanum. The membrane may be bulged outwards into the meatus by the fluid, and thus lie nearer the observer's eye than normal. A *perforation* is usually single, and varies in size from a small pin-head to complete destruction of the membrane. The inner wall of the tympanum may be visible through the perforation, and is recognised by being on a deeper plane than the membrane, and by its hard bony consistence when touched with the probe. The diagnosis of a perforation associated with middle-ear discharge may be further assisted by inspection during inflation, when bubbles of air and secretion are visible. When the perforation is invisible, its existence may be inferred if a small pulsating spot of light can be recognised through the speculum. *Granulations* in the tympanum appear as red fleshy masses of different sizes. When large they constitute *aural polypi*, which are recognised by their proximity to the outer end of the meatus, their soft consistence and mobility, and the fact that the probe may be passed round them. Granulations and polypi always indicate the presence of middle-ear suppuration.

Inflation of the Middle Ear.—Before proceeding to inflate the middle ear the examiner should carefully inspect the nose, naso-pharynx and pharynx. This should be made a routine part of the examination in all cases of ear disease. As inflation is not only an aid in diagnosis, but is also of great assistance in prognosis, it is very necessary that the hearing should be tested and noted before the ear is inflated. There are

three methods of inflating the tympanum: Valsalva's method, Politzer's method, and by means of the Eustachian catheter.

In *Valsalva's inflation* the patient himself forces air into his Eustachian tubes by holding his nose, closing his mouth, and forcibly expiring. This method of inflation has only a limited application and is of very little therapeutic value.

Politzer's Method.—For this a Politzer's air-bag and an auscultating tube, one end of which is inserted into the patient's ear and the other into the ear of the examiner, are required. The nasal end of the bag should be protected with a piece of rubber tubing or be provided with a nozzle. The patient retains a small quantity of water in his mouth until directed to swallow. The nozzle of the bag is inserted into one nostril, while the other is occluded by the fingers of the surgeon. The signal to swallow is then given, and, simultaneously with the movement of the larynx during this act, the bag is sharply and forcibly compressed. Holt's modification of this method consists in directing the patient to puff out his cheeks while the lips are kept firmly closed.

Inflation through the Eustachian Catheter.—For this method, in addition to the Politzer's bag and the auscultating tube, a silver or vulcanite Eustachian catheter is required. The silver instrument has the advantage that it can be sterilised by boiling. The patient is seated facing the light, while the surgeon stands in front of him, and having placed the auscultating tube in position, with his left thumb he tilts up the tip of the patient's nose. The beak of the catheter is now inserted into the inferior meatus, point downwards, and carried horizontally backwards along the floor of the nose until the convexity of the curve touches the posterior wall of the naso-pharynx. When the posterior pharyngeal wall is felt, the point of the instrument is rotated inwards through a quarter of a circle; the position of the point is indicated by the metal ring upon the outer end of the catheter. The finger and thumb of the left hand should now grasp the stem of the catheter just beyond the tip of the nose so as to steady it. It is now gently withdrawn until the concavity of the beak is brought against the posterior edge of the septum nasi. With the right hand the point of the instrument is then rotated downwards and outwards through a little more than half a circle, so that the point slips into the Eustachian orifice and the metal ring looks outwards and upwards towards the external canthus of the eye of the same side. While the instrument is maintained in this position by the left hand, the nozzle of the Politzer's bag is inserted into the funnel-shaped

outer extremity of the catheter, and inflation is gently carried out with the least possible jerking. Before withdrawing the catheter its point must be disengaged from the Eustachian opening by turning it slightly downwards. Difficulties in introducing the catheter may arise from the presence of spines and ridges upon and deviations of the septum, and it may be necessary to pass the instrument under the guidance of the mirror and speculum.

More accurate information is gained from the use of the catheter than from Politzer's inflation, and it is the safer method to employ when a cicatrix or atrophied patch exists in the tympanic membrane, as by the latter method rupture of these areas might occur. Further, the catheter has the advantage of only inflating one ear, and thus preventing any undue strain being put upon the other. In children the catheter can seldom be employed, on account of the difficulty in passing it.

Considerable information may be derived from inflation. If the Eustachian tube is patent, a full clear sound is heard close to the examiner's ear through the auscultating tube. If the Eustachian tube is obstructed, the sound is fainter and more distant. If there is fluid in the tympanum, a fine moist sound may be detected, which must not be confounded with the coarser and more distant gurgling sound associated with moisture at the pharyngeal opening of the tube. If a small dry perforation exists in the tympanic membrane, the air may be heard whistling through it, while if the perforation is large, a sensation which is almost painful may be produced in the examiner's ear. If there is fluid associated with the perforation these sounds may be accompanied with a bubbling noise. The effect of inflation upon the hearing must be carefully tested and recorded.

Affections of the External Ear.

Deformities of the Ear.—The auricle, together with the external auditory meatus, may be *congenitally absent* on one or on both sides. The condition is not amenable to surgical treatment. *Double auricles* are occasionally met with; more frequently rudimentary *auricular appendages*, consisting of skin, subcutaneous connective tissue and nodules of cartilage, occur in front of the tragus, on the lobule, or in the neck. These congenital deformities are due to errors in development of the mandibular arch, and are frequently associated with macrostoma, facial clefts, and other malformations of the face.

Outstanding ears may be treated by excising a triangular or

elliptical portion of skin and cartilage from the posterior surface of the pinna and uniting the cut edges with sutures. Abnormally *large ears* may be diminished in size by the removal of a V-shaped portion from the upper part of the auricle.

The term *hæmatoma auris* is applied to a sub-perichondrial effusion of blood, which may occur either as the result of injury to the auricle, for example, in football players, or as a result of trophic changes in the cartilage and perichondrium. The latter form is not uncommon among the insane. A more or less tense fluctuating swelling forms on the anterior surface of the auricle, presenting in some cases a distinctly bluish discoloration. Inflammation may ensue, and in some cases suppuration and even necrosis of cartilage may follow.

The *treatment* in a recent case consists in applying cold or elastic compression with cotton wool and a bandage, or in withdrawing the effused blood by means of an aspirator. In the event of suppuration supervening, incision and drainage upon general surgical principles must be carried out.

Epithelioma and *rodent cancer* may occur on the auricle and extend along the external auditory meatus. The parotid lymphatic glands are liable to be infected early in cases of epithelioma. The treatment consists in removing the growth freely and in excising the enlarged glands. This may involve sacrificing the facial nerve. In inoperable cases the X-rays may be employed.

Impaction of Wax or Cerumen.—Hypersecretion may result from unknown causes, or it may accompany or be induced by the discharge from a chronic middle-ear suppuration. The association of these two conditions should be borne in mind. An accumulation of wax may be caused by the too zealous attempts of the individual to keep the ear clean, the wax being forced into the narrow deeper part of the meatus.

The chief *symptom* of impacted wax is deafness, which is often of sudden onset. Impaction of wax causes deafness only when the lumen of the auditory canal becomes completely occluded by the plug. Tinnitus aurium and vertigo are sometimes present, and may be very troublesome if the wax rests upon the tympanic membrane. Pain is occasionally complained of, and is usually due to the pressure of the plug upon an inflamed area of skin. Certain reflex symptoms, such as coughing and sneezing, have been met with.

It is only by an objective examination of the ear that the diagnosis can be made. The plug varies in colour and consistence, and may be yellow, brown or black in appearance.

Sometimes from the admixture of a quantity of epithelium it is almost white in colour.

Treatment.—The ear should be syringed with a warm antiseptic or sterilised solution. The advantage of this over ordinary tap water is that, if a dry perforation of the tympanic membrane happens to co-exist, the introduction of septic material may again light up a middle-ear suppuration. The lotion is at a suitable temperature for the patient if the finger can be comfortably held in it. The ear should be turned to the light, a towel placed over the patient's dress, and a kidney basin held under the auricle and close to the cheek. A syringe provided with metal rings for the fingers and armed with a fine ear nozzle should be held with the point inserted just within the aperture of the external meatus and in contact with the roof of the canal. Care must be taken that all the air is first removed from the syringe. To straighten the canal the pinna should be pulled upwards and backwards by the left hand. It may be necessary to exert some considerable degree of force before the plug becomes dislodged, but this must be done with caution. The ear should then be dried out with cotton-wool, and a small plug of wool inserted for a few hours. If pain is complained of, or if the wax is hard and cannot be readily removed, the syringing should be stopped and means taken to soften it by the instillation of a few drops of a solution of bicarbonate of soda (10 grains to the ounce of water or glycerine) or of peroxide of hydrogen several times daily.

Eczema of the external meatus is often associated with eczema of the auricle and of the surrounding parts. Not infrequently there also exists a chronic middle-ear suppuration which may be the cause of the eczema. Intense itchiness is the most characteristic symptom, and a watery discharge may also be complained of. Deafness and tinnitus are dependent upon the accumulation of epithelium and debris. After the ear is syringed the skin may present a dry scaly appearance, while sometimes fissures and an indurated condition of the outer end of the meatus may be noted. Rarely is the outer surface of the tympanic membrane itself involved.

Treatment consists in keeping the ear clean by syringing and careful drying. Probably the best local application is nitrate of silver (10 grains to the ounce of spiritus ætheris nitrosi). This is applied by means of a grooved probe armed with a small piece of cotton-wool. Care should be taken that none of the fluid is allowed to escape upon the cheek, otherwise staining of the skin occurs. A plug of cotton-wool is inserted, and the

solution is reapplied at the end of a week. Sometimes the condition is very intractable.

Occasionally the vegetable parasite *aspergillus* is present in the external meatus, and produces a condition which is very liable to be mistaken for eczema. Strong antiseptic lotions are required to kill the fungus.

Furunculosis, or Boils.—Boils in the ear may arise singly or in crops, and may be associated with eczema of the meatus or with chronic suppuration of the middle ear. Pain is the chief symptom complained of, and it may be very acute. Deafness ensues when the meatus becomes completely blocked by the swelling. The boil occurs in the cartilaginous meatus, and it is to be borne in mind that the skin may present a normal appearance although suppuration has already occurred within it. Palpation of the affected area with the probe causes intense pain. Sometimes œdema over the mastoid, with displacement forwards of the pinna, supervenes and simulates acute inflammation of the mastoid.

Treatment.—If seen in the earliest stages, an attempt may be made to relieve the pain by the application of a 20 per cent. menthol and parolein solution, or by the use of carbolic acid and cocain (5 grains of each) to a dram of glycerine. When suppuration has occurred the best line of treatment is by early incision, transfixing the base of the swelling with a narrow knife and cutting into the meatus.

Foreign Bodies.—It is unnecessary to enumerate all the varieties of foreign bodies which may be met with in the ear. They may be conveniently classified into the animate—for example, maggots, larvæ and insects—and the inanimate—for example, beads, buttons and peas. Pain, deafness, tinnitus and giddiness may be produced, and such reflex symptoms as coughing and vomiting have resulted.

The main practical point consists in identifying the body by inspection. The mere history of its introduction should not be taken as proof of its presence. In children it is advisable to give chloroform so that a thorough examination may be made with the aid of good illumination. If previous attempts to remove the body have caused inflammation of the meatal walls, and if the symptoms be not urgent, no further attempt should be made until the inflammation has been allayed by syringing with warm boracic, and the application of one or more leeches to the tragus. An attempt should always be made in the first instance to remove the body by syringing. If this fail, a small hook should be used, sharp or blunt according to the consistence of

the body. Maggots, larvæ and insects should first be killed by instillations of alcohol and then syringed out.

Tympanic Membrane and Middle Ear—*Traumatic Rupture of the Tympanic Membrane.*—Perforating wounds may result from direct violence caused by the patient—for example, in attempts to remove wax or foreign bodies—or by clumsiness on the part of the surgeon. It is also a comparatively common complication of fracture of the middle fossa of the base of the skull. More commonly, perhaps, the membrane is ruptured from indirect violence due to great condensation of the air in the external auditory meatus, following blows upon the ear, heavy artillery reports, or diving from a height. The injury is followed by pain in the ear, often by considerable deafness and tinnitus, and bleeding is frequently observed by the patient. If early examination of the ear is made, coagulated blood may be found in the meatus or upon the membrane, or ecchymosis may be visible on the latter. A rupture in the membrane following indirect violence is usually lozenge-shaped. During inflation by Valsalva's method the air may be heard to whistle through the perforation. In all such injuries the hearing should be carefully tested, and the possibility of an injury to the labyrinth investigated by means of the tuning-fork tests. Prognosis as regards hearing should be guarded at first. As a rule the rupture heals rapidly, and no treatment is necessary save the introduction of a piece of cotton-wool into the meatus. Syringing should be avoided unless suppuration has already occurred, in which case treatment for this condition must be adopted. As these injuries frequently have a medico-legal bearing, careful notes should be made.

Acute Inflammation of the Middle Ear.—This usually arises in connection with septic conditions of the throat and naso-pharynx. It varies considerably in its severity, and may run a mild or a severe course. It is characterised by pain in the ear, deafness, and a certain degree of fever. In children the symptoms may be such as to simulate meningitis. In the majority of cases it is associated with mastoiditis. When the tympanic membrane is examined in the mild forms of the affection or in the early stages of the more severe type, the vessels about the handle of the malleus and periphery of the membrane are injected, and possibly a number of injected vessels may be seen coursing across the surface of the membrane. In the later stages the whole membrane presents a red surface with the anatomical landmarks indistinguishable, the membrane bulges outwards into the meatus, and if an abscess is pointing, a yellowish area

may be visible upon it. The sudden cessation of pain and the appearance of a discharge from the meatus indicate perforation of the membrana tympani.

The *treatment* of acute otitis media varies with the severity of the attack. The patient should be confined to the house or to bed, alcohol and tobacco should be forbidden, and the bowels must be freely opened. Pain may be allayed by repeated instillations of cocain and carbolic acid (5 grains of each to a dram of glycerine). A few drops of laudanum, hot boracic instillations, or the application of a dry hot sponge, may prove soothing. Two or three leeches may be applied over the mastoid, but should the pain persist or should rupture of the membrane appear imminent, paracentesis must be carried out. After spontaneous perforation or puncture the meatus must be kept clean and inflation carried out daily. Attention must be paid to any affection of the nose or throat which may be present.

Chronic Suppuration in the Middle Ear.—Acute suppuration may pass into the chronic variety, which is characterised by a perforation of the tympanic membrane, a persistent purulent or muco-purulent discharge from the middle ear, and a certain amount of deafness.

Various complications may arise in the course of chronic middle-ear disease, and so long as an individual is the subject of a chronic otorrhœa, he is liable to one or more of these. The complications may be extra-cranial or intra-cranial. Those affecting the middle ear itself include granulations, polypi, cholesteatoma, caries and necrosis of the temporal bone, destruction and loss of one or more of the ossicles, facial paralysis, hæmorrhage from the carotid artery or jugular vein, and malignant disease. As mastoid complications, may be mentioned inflammation and suppuration, leading to destruction of the bone, mastoid fistula, and sub-periosteal mastoid abscess. The intra-cranial complications which may arise are: extra-dural abscess, sub-dural abscess, meningitis, cerebral and cerebellar abscess, and lateral sinus phlebitis with general septicæmia and pyæmia.

The *treatment* of chronic middle-ear suppuration consists in keeping the parts clean by syringing with antiseptic lotions. The instillation of hydrogen peroxide, followed by syringing with boiled water or boracic lotion, and inflation through the Eustachian tube once, twice, or thrice daily, according to the requirements of the case, constitute a routine method. Packing the meatus with antiseptic gauze after washing out may be practised.

Suppuration in the Mastoid Antrum and Cells, *or Acute Suppurative Mastoiditis.*—Acute suppuration may occur in the mastoid antrum in the course of an attack of acute otitis media, or as a result of interference with drainage in chronic suppuration of the antrum or middle ear. As the outer wall of the mastoid is liable to be perforated by cario-necrosis, the pus may find its way externally and form an abscess over the mastoid process behind the ear. In some cases the pus escapes into the external auditory meatus by perforating its posterior wall; in others a sinus forms on the inner side of the apex of the mastoid and the pus burrows in the digastric fossa under the sterno-mastoid—*Bezold's mastoiditis.* If the posterior wall or roof of the antrum is destroyed, intracranial complications are liable to ensue.

Fig. 49.—Acute Suppurative Mastoiditis, with sub-periosteal abscess and great œdema of temporal region and face, displacing the auricle and closing the eye.

The *clinical features* are pain behind the ear, tenderness on pressure or percussion over the mastoid, and marked general constitutional disturbance. There is usually redness and œdematous swelling of the skin, and, when pus forms under the periosteum, the œdema may be so great as to displace the auricle downwards and forwards (Fig. 49). The deeper part of the posterior osseous wall of the meatus may be swollen so that it conceals the upper and back part of the membrane.

Treatment.—When arising in connection with acute otitis, the application of several leeches behind the ear, free incision of the membrane, and syringing with hot boracic lotion may be sufficient. As a rule, however, it is necessary to expose the interior of the antrum by opening through the mastoid cells —*Schwartze's operation.*

In operating for the relief of symptoms in acute cases it is only necessary to open up the mastoid antrum through the cells, and to establish satisfactory drainage by this route. The middle

ear and its contents must not be touched, lest the function of the organ be interfered with.

A curved incision is made over the mastoid about a quarter of an inch behind, and parallel with, the attachment of the auricle. The periosteum is detached and the auricle turned forward until the posterior and superior walls of the osseous meatus are exposed. If a sinus is found, it should be enlarged by means of a gouge, as it almost certainly communicates with the antrum. If there is no sinus, the gouge should be applied in the *supra-meatal triangle*, which is bounded above by the posterior root of the zygoma, below by the upper and posterior segment of the bony external meatus, and behind by an imaginary line joining these (Macewen). The instrument should be directed forwards and inwards to avoid injuring the sigmoid sinus. If the opening be carried too high, the middle fossa of the skull may be opened. At this stage of the operation the facial nerve may be damaged. The antrum and cells having been freely opened up, the cavity is irrigated and packed with iodoform gauze, which is renewed daily till the discharge ceases and the cavity is filled in by granulation.

When mastoid suppuration is associated with chronic middle-ear disease, it is usually necessary to perform the complete radical operation—*Stäcke's operation*—which consists in throwing the antrum, attic, and middle ear into one cavity. After the mastoid antrum and cells have been fully opened up, the soft parts lining the meatus are detached from the upper and back part of the canal. A bent-pointed probe is then passed into the attic of the tympanum and through the aditus, and the bridge of bone between the antrum and the meatus removed with a small chisel or burr. At this stage of the operation the instrument should be directed upwards and forwards to avoid the facial nerve, and care must be taken in removing granulations from this part that the nerve is not injured. The position of the nerve may be determined by going over the part with a probe, facial twitchings resulting if the nerve is touched. If on exposing the tympanum the ossicles are found denuded of mucous membrane, covered with granulations, or carious, they should be removed, together with the remains of the tympanic membrane. The next step is to examine the roof of the antrum to see if there is a perforation leading into the middle cranial fossa. If so, it should be enlarged and drained. Towards the back of the antrum a perforation may be found leading down to the sigmoid sinus. This also should be enlarged. The mastoid flap is then replaced and the cavity packed with iodoform

gauze. To facilitate the packing, and to hasten the healing of the cavity, Ballance recommends that a flap be folded back from the concha, thus enlarging the cartilaginous meatus, and that skin grafts be applied after the surface is covered by granulations.

CHAPTER XV.

THE NOSE AND NASO-PHARYNX.

Fractures of nasal bones—Deformities of nose: *Saddle nose; Partial and complete destruction of nose; Restoration of nose; Rhinophyma*—Intra-nasal affections — Examination of the nasal cavities: *Anterior rhinoscopy; Posterior rhinoscopy; Digital examination.* Cardinal Symptoms of Nasal Affections: Nasal obstruction: *Erectile swelling of inferior turbinals; Nasal polypi; Malignant tumours; Deviations, spines, and ridges of septum; Hæmatoma of Septum*—Nasal discharge: *Foreign bodies; Rhinoliths; Ozæna; Epistaxis; Suppuration in accessory sinuses*—Anomalies of smell and taste: *Anosmia; Parosmia*—Reflex symptoms of nasal origin—Post-nasal obstruction: *Adenoids*—Tumours of naso-pharynx.

Fractures of the Nasal Bones.—These injuries are always the result of direct violence, such as a blow or a fall against a projecting object. They are more common in adults than in children, and in spite of the fact that the fracture is usually compound, through tearing of the mucous membrane, septic complications are rare. The fracture usually runs transversely across both nasal bones near their lower edge, but sometimes it is comminuted and involves also the nasal processes of the superior maxillæ. In nearly all cases the cartilage of the septum is bent or displaced so that it bulges into one or other nostril, and not infrequently a hæmatoma forms in the septum. Sometimes the vertical plate of the ethmoid is implicated, and the fracture in this way comes to involve the base of the skull. The nasal ducts may be injured and the flow of the tears obstructed. This may eventually result in the formation of a lachrymal abscess and fistula.

The *clinical features* are pain, bleeding from the nose, discoloration, and swelling. Crepitus can usually be elicited on pressing over the nasal bones. The deformity sometimes consists in a lateral deviation of the nose, but more frequently in flattening of the bridge—*traumatic saddle nose.* Within a few

hours of the injury the swelling is often so great as to obscure the nature of the deformity and to render the diagnosis difficult. Subcutaneous emphysema is not a common symptom. When it occurs, it is usually due to the patient blowing his nose. The lateral cartilages may be separated from the nasal bones and give rise to clinical appearances which simulate those of fracture. Sometimes the septum alone is displaced laterally, giving rise to symptoms of nasal obstruction.

Treatment.—As the bones unite rapidly it is of great importance that any displacement be reduced without delay, and to facilitate this a general anæsthetic should be administered, or the nasal cavity sprayed with cocain. The bones can usually be levered into position with the aid of a pair of dressing forceps passed into the nostrils, the blades being protected with rubber tubing. After the fragments have been replaced and the septum moulded into position, it is seldom necessary to employ any retaining apparatus, but the patient must be warned against blowing or otherwise handling his nose. In some cases it is advisable to apply pads of gauze to each side of the nose and to fix them in position with strips of adhesive plaster passing from one cheek to the other. If the fragments tend to sink down, they may be supported by moulding a soft lead or gutta-percha splint over the nose and transfixing the splint and the fragments with one or more hare-lip pins. These may be removed on the fourth or fifth day. Appliances introduced into the nose—such as gauze pads, rigid tubes or hollow plugs—are only indicated when the septum is so severely injured that the nose collapses. They are to be avoided if possible, as they are uncomfortable and interfere with proper cleansing and drainage of the nose. The inside of the nose should be smeared with vaseline to prevent crusting of blood, and the nasal cavities should be frequently irrigated.

Deformities of the Nose.—The most common deformity is that known as the *sunken-bridge* or *saddle nose*. It is most frequently a result of inherited syphilis, the nasal bones being imperfectly developed, and the cartilages sinking in so that the tip of the nose is turned up and the nostrils look directly forward. The bridge of the nose may sink in also as a result of necrosis of the nasal bones, particularly in tertiary syphilis, and less frequently from tuberculous disease. A similar, but as a rule less marked, deformity may result from fracture of the nasal bones or from displacement of the cartilages.

When the condition is due to mal-union of a fracture, it may be possible to restore the contour of the nose by dividing the bones with the chisel through a small incision in the skin, and

fixing the parts by means of a splint or with hare-lip pins. When it results from disease, it is much less amenable to treatment. The most satisfactory results hitherto have been obtained by the injection of paraffin. The paraffin, with a melting-point of about 110° F., is slowly injected into the subcutaneous tissue, and while still fluid is moulded to the shape of the nose, care being taken to prevent it passing into the eyelids or on to the cheek. An artificial bridge has been made by turning down from the forehead a flap, including the periosteum and a shaving of the outer table of the skull. In other cases portions of bone or plates of gold, aluminium or celluloid have been implanted.

Portions of the alæ nasi may be lost from injury, or from ulceration such as lupus, syphilis or rodent cancer. After the destructive process has been arrested, the gap may be filled in by a flap taken from the cheek or adjacent part of the nose. When the tip of the nose is lost, it may be replaced by Syme's operation, which consists in raising flaps from the cheeks and bringing them together in the middle line.

The whole of the nose, including the cartilages and bones, may be destroyed by syphilitic ulceration or by lupus. In some parts of India the nose is sometimes cut off maliciously or as a punishment for certain crimes.

Numerous operations have been devised for the restoration of the nose, but the results are not always satisfactory on account of the tendency of the transplanted tissues to contract and shrivel up. In the "Indian operation" a racket-shaped flap, including skin and periosteum, is turned down from the forehead and fixed by sutures to the edges of the gap, which have been previously rawed. Rubber tubes are introduced into the nostrils to support the flap and to enable the patient to breathe through the nose. Plates of bone have been implanted to support the skin flaps and to prevent subsequent contraction. The "Italian or Tagliacotian operation," in which a pedicled flap is cut from the front of the forearm and fixed to the nose, has been almost entirely abandoned. When the deformity cannot be corrected by operation, the appearance of the patient may be greatly improved by his wearing an artificial nose held in position by spectacles.

The term **rhinophyma** has been applied by Hebra to a condition in which the skin of the tip and alæ of the nose becomes thick and coarse, and presents large, irregular, tuberous masses on which the orifices of the sebaceous follicles are unduly prominent—*potato or hammer nose.* The capillaries of the skin are dilated and tortuous, and the nose assumes a bluish-red

colour, and its surface is soft and greasy. The condition is met with in elderly men, and the masses appear to be chiefly composed of sebaceous adenomata. The term *lipomi nasi*, formerly employed, is therefore misleading.

The treatment consists in paring away the protuberant masses until the normal size and contour of the nose are restored, care being taken not to encroach on the cartilages or on the orifices of the nostrils. There is comparatively little bleeding and the raw surface rapidly becomes covered by epidermis.

Examination of the Nasal Cavities.—For the examination of the interior of the nose the following appliances are necessary: A reflector,

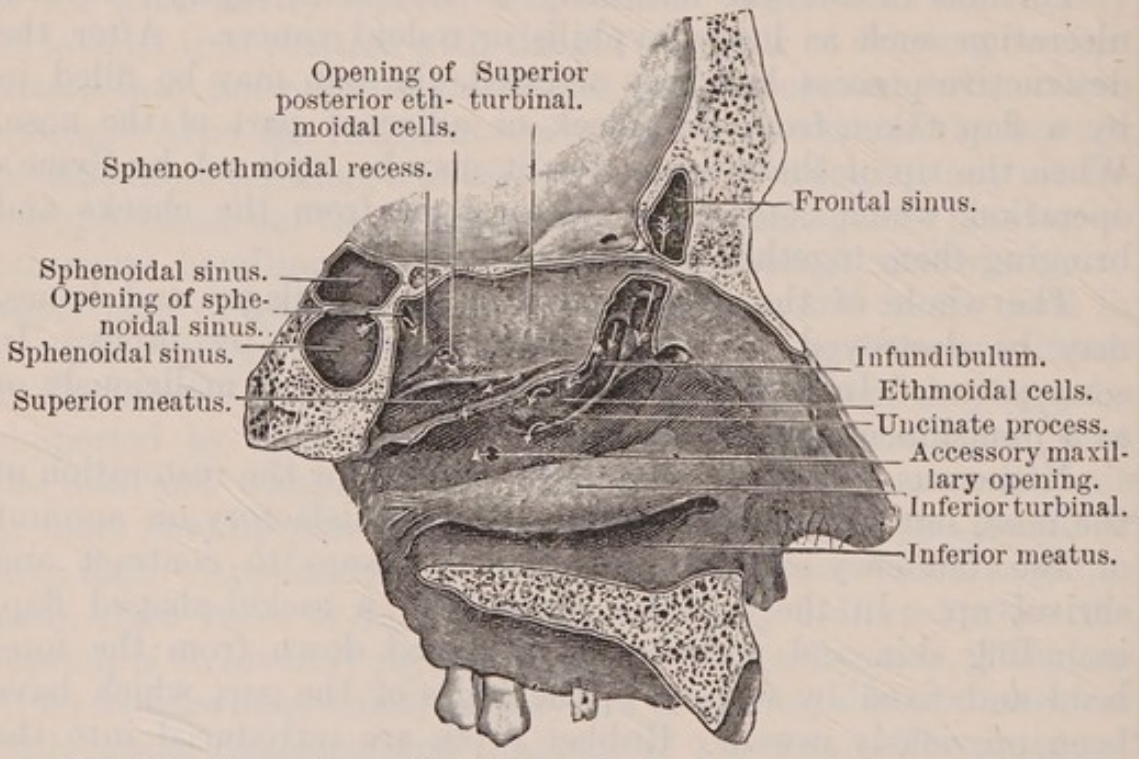

FIG. 50.—The outer wall of left nasal chamber, after removal of the middle turbinated body. (After Logan Turner.)

such as is used in laryngoscopy, attached to a forehead band or spectacle frame, one of the various forms of nasal speculum, a long, pliable probe, a tongue depressor, and a small-sized mirror. As additional aids, a 10 per cent. solution of cocain, a grooved probe as a cotton-wool holder, and a palate retractor should be in readiness. Good illumination is important, and may be obtained from an electric light, or from a Welsbach or Argand burner. The light should be placed close to, and on a level with, the patient's left ear. Both the anterior and posterior nares should be examined.

Anterior Rhinoscopy.—Before the introduction of the speculum the tip of the nose should be tilted up and the interior of the vestibule and the anterior part of the septum examined. In this way the existence of eczema or small furuncules, the presence of dilated or bleeding vessels upon, or a perforation of, the anterior part of the septum may be noted, and the general appearances inspected. After inserting the speculum

into the vestibule and dilating it, the following parts should be sought for and examined :—Close to the floor, and attached to the outer wall of the nasal cavity, is the anterior end of the inferior turbinated body (Fig. 50). This structure overhangs the inferior meatus. It presents a pink appearance, and its size varies in different individuals. At a higher level and on a posterior plane is the anterior end of the middle turbinated body, which is of a paler colour than the inferior, and is only visible when the head is tilted backwards. Between it and the inferior turbinated body is the middle meatus, with which communicate the openings of the antrum of Highmore, the frontal sinus, and the anterior ethmoidal cells. A considerable area of the anterior part of the nasal septum is also visible by anterior rhinoscopy, and between it and the middle turbinal is a narrow chink—the olfactory sulcus.

Posterior Rhinoscopy.—Examination of the posterior nares and naso-pharynx is frequently attended with difficulty. The patient is directed to breathe through the nose, the tongue is depressed with a spatula, and a small-sized laryngeal mirror, comfortably warmed and with its reflecting surface turned upwards, is carefully introduced behind the soft palate. When a good examination of the naso-pharynx is obtained, the following parts may be seen reflected in the mirror: the posterior surface of the uvula and soft palate, and above them, in the mesial plane, the posterior free edge of the septum nasi. On each side of the septum the apertures of the posterior nares, in which may be seen the upper part of the posterior end of the inferior turbinal, the middle meatus, the posterior end of the middle turbinal, the superior meatus, and occasionally a portion of the superior turbinal. On the lateral wall of the naso-pharynx the Eustachian opening and cushion can be seen, while by tilting the mirror backwards the vault of the naso-pharynx can be inspected.

Digital examination of the naso-pharynx may be required, especially in children. The examiner passes his left arm and hand round the back of the child's head, and with one of his fingers presses the cheek inwards between the jaws. His right forefinger is carried along the dorsum of the tongue, passed up behind the soft palate, and a rapid examination made of the post-nasal space.

Cardinal Symptoms of Nasal Affections.—The chief symptoms of nasal disease are: nasal obstruction, nasal discharge, anomalies of smell and taste, and certain reflex phenomena.

Nasal Obstruction.—This may be partial or complete, intermittent or constant, and may be the cause of such symptoms as alteration in the tone of the voice, catarrh of the respiratory passages, snoring, cough, headache, inability to concentrate the attention, alteration in the physiognomy, or deformity of the chest. The half-open mouth, drooping jaw, lengthened appearance of the face, narrow nostrils, and vacant expression are characteristic signs of nasal obstruction.

Nasal obstruction may be due to *intra-nasal* or to *post-nasal* (naso-pharyngeal) causes. Amongst the former may be noted as the more common, erectile swelling and hypertrophy of the mucous membrane covering the inferior turbinated bones, and nasal polypi growing from the middle turbinal and middle

meatal region. Causes originating in the septum include deviations, spines and ridges, and septal hæmatoma and abscess. Obstruction may also be due to the presence of a foreign body in the nasal cavity, to rhinoliths, and to imperfect development of the nasal chambers. Further, tumours, both simple and malignant, and such conditions as tubercle, lupus, syphilis and glanders may interfere more or less with nasal respiration. The most common cause of post-nasal obstruction is the presence of adenoids, while more rarely fibro-mucous polypi, fibrous tumours, malignant disease, and cicatricial contractions and adhesions resulting from syphilis are met with.

Erectile swelling of the inferior turbinated bodies is due to engorgement of the venous spaces contained in the mucous membrane. Obstruction from this cause is usually intermittent in character, and may be unilateral or bilateral. It is influenced by posture, being worse when the patient is in the horizontal position, and also by changes in atmospheric conditions and temperature. It is characterised objectively by a swelling of the mucous membrane, which is pink or red in appearance and of a soft consistence, pitting when touched with the probe, and shrinking on the application of a 5 per cent. solution of cocain. Its soft consistence and the fact that it becomes smaller when painted with cocain differentiate it from true hypertrophy of the mucous membrane. Its situation and immobility, its pink colour, and the shrinkage under cocain distinguish it from the mucous polypus of the nose. The turgescence may involve the whole extent of the mucosa of the inferior turbinated bodies, including their posterior ends. After anæsthetising with cocain, the electric cautery, or the application of fused chromic acid upon a probe, may be employed for the relief of the condition. If a true hypertrophy exist, it is better to remove it with a nasal snare.

Nasal polypi are most commonly of the mucous variety, and are as a rule multiple. They spring from the mucous membrane covering the middle turbinated bone and from the adjacent parts of the middle meatus, but never from the septum. They are usually pedunculated, and as they increase in size they become pendulous in the nasal cavity. They are smooth, rounded in outline, of a translucent bluish-grey colour, soft in consistence, and freely movable. These characters, and the fact that the probe can be passed round the greater part of the polypus, serve to differentiate this affection from the erectile swelling. It must not be forgotten that nasal polypi may be associated with suppuration in one or more of the accessory sinuses. They are frequently present also in malignant disease, and in these cases

they bleed readily. They are best removed by means of the cold snare, with the aid of the speculum and a good light. Several sittings are usually necessary.

Carcinomata and *sarcomata* sometimes grow from the muco-periosteum in the region of the ethmoid. These tumours tend to invade adjacent parts and to cause considerable deformity of the face. They give rise to symptoms similar to those of naso-pharyngeal tumours. The treatment consists in removing the new growth if this be practicable.

Deviations, spines, and ridges of the septum may produce partial or complete occlusion of the anterior naris. In deviation of the septum, the obstructed nostril is more or less occluded by a smooth rounded swelling of cartilaginous or bony hardness, which is covered with normal mucous membrane, while the opposite nostril shows a corresponding concavity or hollowing of the septum. Sometimes the convex side is thickened in the form of a ridge. A simple spine of the septum is usually situated anteriorly, and presents an acuminate appearance, often pressing against the inferior turbinated body; it is hard to the touch. Ridges and spines may be cut or sawn off, or removed with the chisel. Many methods of dealing with a deviated septum have been suggested, such as forcible fracture, excision of a portion of the cartilage, or the formation of a hole in the septum. The chief difficulty is to counteract the resiliency of the cartilage, and so prevent recurrence of the deformity.

Hæmatoma of the septum is usually traumatic in origin. As the result of a blow an extravasation of blood takes place beneath the perichondrium on each side of the septum, and a bilateral, symmetrical swelling, smooth in outline and covered with mucous membrane, is visible immediately within the anterior nares. The blood is usually absorbed and should not be interfered with. If suppuration occurs, however, the swelling becomes soft, fluctuation can be detected, and the patient's discomfort increases. The abscess must then be incised and the cavity plugged. It is sometimes found that a portion of the cartilage undergoes necrosis, leading to the formation of a perforation in the septum.

Nasal discharge may be mucous, muco-purulent, or purulent in character. When it is of a clear, watery nature, it is usually associated with erectile swelling of the inferior turbinated bodies. A purulent discharge may be complained of from one or both nostrils. If unilateral, it should suggest, in the case of children, the presence of a foreign body; in adults, the possibility of suppuration in one or more of the accessory sinuses.

In infants a purulent discharge from both nostrils may be due to gonorrhœal infection or to inherited syphilis. Nasal discharge may be constant or intermittent. It is sometimes influenced by changes in posture; for example, it may be chiefly complained of at the back of the nose and in the throat when the patient occupies the horizontal position, or it may flow from the nostril when the patient bends his head forward or to one side. The discharge may be intra-nasal in origin, or due altogether to naso-pharyngeal catarrh. It varies somewhat in colour and consistence, and may be associated with such intra-nasal conditions as purulent rhinitis following scarlet fever and other exanthemata, or ulceration accompanying malignant disease, syphilis, or tuberculosis. Sometimes it contains shreds of false membrane, for example, in nasal diphtheria; or white cheesy masses as in coryza caseosa. The formation of crusts is significant of fœtid atrophic rhinitis (ozæna) and syphilis, and in these last-named conditions the discharge is associated with a most objectionable and distinctive fœtor. Pus from the maxillary sinus is often fœtid, and the odour is noticed by the patient; while the odour of ozæna is not recognised by the patient, although very obvious to others.

Foreign bodies of various descriptions have been met with in the nasal cavities, particularly of children. They set up suppuration and give rise to a unilateral discharge which is often offensive in character. The surgeon must not be satisfied with the history given by the parents, but with the aid of good illumination, and in young children under general anæsthesia the nose should be carefully inspected and probed. If there is much swelling, the introduction of a 5 per cent. solution of cocain will facilitate the examination by diminishing the congestion of the mucous membrane. No attempt should be made to remove a foreign body from the nose by syringing. If fluid be injected into the obstructed nostril, it is liable to force the body further back, while if injected into the free nostril, it is apt to accumulate in the naso-pharynx and thus to pass into the Eustachian tubes. A fine hook should be passed behind the body and traction made upon it, or sinus forceps or a snare may be employed. Care must be taken that the body is not pushed still deeper into the cavity. Fungi and parasites should first be killed with injections of chloroform water or by making the patient inhale chloroform vapour.

Rhinoliths.—Concretions having a plug of inspissated mucus or a small foreign body as a nucleus sometimes form in the nose. They are composed of phosphate and carbonate of lime, and

have a covering of thickened nasal secretion. They are rough on the surface, dark in colour, and usually lie in the inferior meatus. They give rise to the same symptoms as a foreign body, and are treated in the same way. The stone, which is usually single, may be so large and so hard that it is necessary to crush it before it can be removed.

Ozæna, or fœtid atrophic rhinitis, is characterised by atrophy of the nasal mucous membrane, and sometimes even of the turbinated bone, and is accompanied by a muco-purulent discharge and the formation of crusts having a characteristic offensive odour, which is not recognised by the patient. It is usually bilateral, and the nasal chambers, owing to the atrophy, are very roomy. It may be differentiated from a tertiary syphilitic condition by the absence of ulceration and necrosis of bone, by the odour, and by the fact that it is not influenced by potassium iodide and mercury.

Various methods of treatment are in vogue, but thorough cleanliness is the most essential factor, and this is best effected by regular syringing. Plugging of the nostrils with cotton-wool for half an hour before washing out the nose greatly facilitates the detachment of the crusts. A pint of lukewarm solution, containing a teaspoonful of bicarbonate of soda or of common salt, is then used with a Higginson's syringe, the patient leaning over a basin and breathing in and out quickly through the open mouth. The patient should then forcibly blow down each nostril in turn, the other being occluded with the finger, so that the septic material may thus be blown out without risk of it entering the Eustachian tubes, as may happen when the handkerchief is used in the ordinary way. Antiseptic sprays and ointments may be applied to the mucous membrane after cleansing.

Epistaxis.—Bleeding from the nose may be due either to local or general causes. Among the former may be cited injuries such as result from the introduction of foreign bodies, blows on the face, and fractures of the anterior fossa of the skull, and the ulceration of syphilitic, tuberculous, or malignant disease. Amongst the general conditions in which nasal hæmorrhage may occur are typhoid fever, anæmia and purpura, cardiac and renal disease, cirrhosis of the liver, and whooping cough. Nasal hæmorrhage usually takes place from one or more dilated capillaries situated at the anterior, inferior part of the septum close to the vestibule, and in such cases the bleeding point is readily detected. Occasionally bleeding occurs from one of the anterior ethmoidal veins, and under these circumstances the blood flows downwards between the middle turbinal

and the septum. Before steps are taken to arrest the bleeding, the interior of the nose should, if possible, be inspected and the bleeding point sought for. As a preliminary to the use of local applications the nose should be washed out with boracic lotion or salt solution to remove all clots from the cavity. In many cases this is all that is necessary to stop the bleeding. If the bleeding is not very copious, it may be stopped by applying cold compresses to the face, head and neck, while the alæ nasi are firmly grasped between the finger and thumb. If the blood is evidently flowing from the olfactory sulcus, a strip of gauze soaked in adrenalin, turpentine or other styptic should be packed between the septum and middle turbinated body. If recurrent hæmorrhage takes place from the anterior and lower part of the septum, the application of the electric cautery at a dull red heat, or of the chromic acid bead fused on a probe, is the best method of treatment. Plugging of the posterior nares is rarely necessary, as, in the majority of cases, an anterior plug suffices.

Suppuration in the Accessory Nasal Sinuses.—As already stated, the presence of pus in the nose should always direct attention to its possible origin in one or more of the accessory sinuses. This is especially the case if the discharge is unilateral, though a bilateral affection may also exist. The condition is usually a chronic one, and may be present for months, or even years, without the patient suffering much inconvenience save from the presence of the discharge.

If on examination by anterior rhinoscopy, pus is seen in the middle meatus, suspicion should be aroused of its origin in the antrum of Highmore, frontal sinus, or anterior ethmoidal cells, as all these cavities communicate with that channel. If, on the other hand, the pus is detected in the olfactory sulcus, attention must be directed to the posterior ethmoidal cells and sphenoidal sinus (Fig. 50). Further evidence of its source in the last-named cavities may be gained by finding pus in the superior meatus above the middle turbinal on examination by posterior rhinoscopy.

As the anterior group of sinuses is most frequently affected, and of these most commonly the *antrum of Highmore*, attention should first be turned to this cavity. The complaint of a bad odour or taste, the presence of diseased upper molar teeth, the reappearance of pus in the middle meatus after mopping it away and directing the patient to bend his head well forwards, and opacity on illumination of the suspected cavity are all signs which strongly suggest an affection of the maxillary sinus. Puncture through the thin outer wall of the inferior meatus of

the nose with a fine trocar and cannula, and the washing out of pus after first carefully cleansing the nasal cavity, will establish the diagnosis.

The *treatment* consists in opening the antrum through the canine fossa, and, after curetting its walls, packing the cavity with iodoform worsted. To avoid the risk of reinfecting the cavity from the mouth, an opening may be made into the nose, by removing the anterior portion of the nasal wall of the antrum and part of the inferior turbinated bone, after which the incision in the buccal mucous membrane is closed with sutures.

Suppuration in the *frontal sinus* may be diagnosed after first excluding the antrum, and finding that pus continues to flow into the nose ; the posture test is probably negative, and there may be tenderness upon pressure over the sinus. After removal of the anterior end of the middle turbinated bone it may be possible to catheterise the sinus and blow out or wash out pus from its interior. In some cases the diagnosis can only be made by opening the cavity through an incision in the line of the eyebrow.

The *anterior ethmoidal cells* are frequently affected in conjunction with the frontal, and sometimes with the maxillary sinus, and a diagnosis may only be arrived at by eliminating these. The presence of polypi and granulations, with pus oozing out from between them, and increasing after withdrawal of the probe, and the detection of carious bone are significant of the condition.

Suppuration in the sphenoidal sinus is characterised in many cases by the presence of eye symptoms. Pus in the olfactory sulcus, on the upper surface of the middle turbinal posteriorly, and on the vault of the naso-pharynx is suggestive of sphenoidal suppuration. If removal of the middle turbinated bone permits of inspection of the ostium sphenoidale by anterior rhinoscopy, pus may be seen escaping from the orifice. Exploratory catheterisation or puncture of the anterior wall of the sinus and irrigation may be used as additional aids in diagnosis.

The *posterior ethmoidal cells* are frequently affected along with the sphenoidal sinus. The nasal appearances just noted are present, and if the sphenoidal sinus can be washed out or occluded and pus rapidly reappears, its origin from these cells is probable.

Anomalies of Smell and Taste.—*Anosmia* or loss of smell is not infrequently a symptom of nasal affections. Any lesion which prevents the passage of the odoriferous particles to the olfactory region of the nose interferes with the sense of smell.

In ozæna the sense of smell is lost. Anosmia may also be of central origin. *Parosmia*, or the sensation of a bad odour, may be of functional origin; it sometimes occurs after influenza. It may also be associated with maxillary suppuration. Impairment or loss of the sense of recognising flavours is due to interference with the olfactory nerve.

Reflex Symptoms of Nasal Origin.—It is only necessary to draw attention here to the relation which exists between affections of the nose and asthma. The existence in asthmatics of nasal polypi, erectile swelling of the inferior turbinated bodies, spines of the septum in contact with the inferior turbinal, and the presence of areas upon the mucous membrane which, when probed, produce coughing, call for treatment with the view of modifying the asthma.

Post-nasal Obstruction—Adenoid Vegetations.—The most common cause of post-nasal obstruction is hypertrophy of the normal lymphoid tissue which constitutes the naso-pharyngeal or Luschka's tonsil. *Adenoids* form a soft, velvety mass, which projects from the vault of the naso-pharynx and extends down its posterior and lateral walls, in some cases filling up the fossæ of Rosenmüller behind the Eustachian cushions. They do not grow from the margins of the posterior nares. Adenoids are frequently associated with hypertrophy of the faucial tonsils, and the patient often suffers from granular pharyngitis and chronic nasal catarrh.

These growths are sometimes met with in infants, but are most common between the ages of five and fifteen, after which they tend to undergo atrophy. They may, however, persist into adult life.

Clinical Features.—The most prominent symptom in most cases is interference with nasal respiration, so that the patient is compelled to breathe through the mouth. The facies of adenoids is characteristic; the mouth is kept partly open, the face appears lengthened, the nose is flattened by the falling in of the alæ nasi, the inner angles of the eyes are drawn down, and the eyelids droop, while the whole facial expression is dull and stupid. As the respiratory difficulty is increased during sleep, the patient snores loudly, and his sleep is frequently broken by sudden night terrors. Owing to the disturbed sleep, to imperfect oxygenation of the blood, and to frequent attacks of nasal and bronchial catarrh, the child's nutrition is interfered with, and he becomes languid and unfit for school work.

When the adenoids encroach upon the Eustachian cushions, the patient suffers from deafness, frequent attacks of earache, and

sometimes from suppurative otitis media with a discharge from the ear.

Among the rarer conditions attributed to adenoids are asthma, inspiratory laryngeal stridor, persistent cough, chorea, and nocturnal enuresis.

A *diagnosis* should never be made from the symptoms alone; an attempt should be made to examine the naso-pharynx by posterior rhinoscopy and by digital examination. The interior of the nose must always be examined and any further cause of obstruction excluded.

Treatment.—Thorough removal is the only satisfactory line of treatment, and this should be done under general anæsthesia. The methods of operating are various, but the following brief description will indicate how the adenoid mass may be satisfactorily removed. The following instruments are necessary:—two Gottstein's adenoid curettes, one provided with a cradle and hooks, the other without, a Hartmann's lateral ring knife and one pair of adenoid forceps—Kuhn's or Lœwenberg's, a tongue depressor, a gag, and one or two small throat sponges on holders. The patient having been anæsthetised, his head should be drawn over the end of the table, which is placed close to the window. An assistant standing on the left side inserts the gag and maintains it in position. The operator, being on the patient's right, depresses the tongue and insinuates the curette provided with the hooks, behind the soft palate, carrying it to the roof of the naso-pharynx between the growth and the posterior free edge of the nasal septum. Firm pressure is then made against the vault of the naso-pharynx, and the curette is carried backwards and downwards in the mesial plane, and withdrawn with the main mass of the adenoids caught in the hooks. The unguarded curette is then introduced and several strokes are made with it, the instrument being carried on either side of the mesial plane. Hartmann's lateral ring knife or the index finger should then be passed behind the palate, and the naso-pharynx thoroughly explored and scraped. With the finger, the fossæ of Rosenmüller should be investigated, and if necessary scraped. The curette should not be used on the lateral pharyngeal wall in case the Eustachian orifices and cushions be damaged. Bleeding soon ceases when the head is again elevated, and the patient should be at once laid well over upon his side so that the blood may escape from the mouth.

No local after-treatment is required, and spraying or syringing may prove harmful. The patient should remain in the house

for five or six days. If nasal obstruction has been the outstanding symptom, respiratory exercises through the nose should be carried out for some considerable time; on the other hand, if Eustachian obstruction and deafness have been the main features of the case, a course of Politzer inflation should be conducted after the wound has healed.

Tumours of the Naso-pharynx.—Tumours are occasionally met with growing from the muco-periosteum of the basi-sphenoid and basi-occipital, and projecting from the vault of the naso-pharynx. They may primarily be of the nature of fibromata, but sooner or later they assume the characters of fibro-sarcomata and exhibit malignant tendencies. They usually occur between the ages of fifteen and twenty. At first the tumour is firm, rounded, and of slow growth, but later it becomes softer, more vascular, and grows more rapidly, spreading forwards towards the nasal cavity and downwards towards the pharynx.

Clinical Features.—In its growth the tumour blocks the nostrils, and so interferes with nasal respiration and causes the patient to snore loudly, especially during sleep. It may also bulge the soft palate towards the mouth and interfere with deglutition. In some cases the face becomes flattened and expanded and the eyes are pushed outwards, giving rise to a deformity known as *frog face.* Deafness may result from obstruction of the Eustachian tube. The patient suffers from intense frontal headache, and there is a persistent and offensive mucous discharge from the nose. Profuse recurrent bleeding from the nose is a common symptom, and the patient becomes profoundly anæmic. The tumour can usually be seen on examination with the nasal speculum or by posterior rhinoscopy, and its size and limits may be recognised by digital examination.

Unless removed by operation these tumours prove fatal from hæmorrhage, interference with respiration, or by perforating the base of the skull and giving rise to intra-cranial complications.

Treatment.—These growths are seldom recognised before they have attained considerable dimensions, and owing to the fact that they are permeated by numerous large, thin-walled venous sinuses, their removal is attended with formidable hæmorrhage. Attempts to remove them by the galvanic snare are seldom satisfactory, because the base of the tumour is left behind and recurrence is liable to take place. Electrolysis has been carried out in some cases with encouraging results.

To obtain free access it is usually necessary to perform some osteoplastic operation on the superior maxilla. Annandale has reached these growths from the mouth by splitting the hard and

soft palate and temporarily separating the two halves of the upper jaw. Nélaton gained access by splitting the uvula and soft palate and removing a portion of the hard palate and nasal septum. Other surgeons—Rouge and Ollier—have operated through the nasal cavity by temporarily displacing the nose. The best access is obtained by temporarily resecting the greater part of the superior maxilla, the orbital plate and the muco-periosteum of the hard palate being conserved to diminish the subsequent deformity. In view of the profuse bleeding attending these operations it is advisable to perform a preliminary tracheotomy. The operation is very often fatal on account of the anæmic condition of the patient, the serious loss of blood which occurs during the removal of the growth, and the entrance of blood into the air-passages.

CHAPTER XVI.

THE NECK.

Surgical anatomy — Malformations: *Branchial fistulæ; Cervical auricles*—Wry-neck: *Varieties; Cicatricial contraction*—Injuries: *Contusions — Fractures of hyoid, larynx, etc.; Cut-throat* — Inflammatory affections: *Diffuse cellulitis; Actinomycosis; Boils and carbuncles* — Tumours: *Cystic: Branchial cysts; Cystic lymphangioma; Blood cysts; Bursal cysts — Solid: Lipoma; Fibroma; Osteoma; Sarcoma; Carcinoma*—Cervical rib.

Surgical Anatomy.—In the middle line the following structures may be recognised on palpation: (1) the *hyoid bone*, lying below and behind the body of the lower jaw, on a level with the fourth cervical vertebra; (2) the *thyro-hyoid membrane*, behind which lies the base of the epiglottis and the upper opening of the larynx; (3) the *thyroid cartilage*, to the angle of which the vocal cords are attached about its middle; (4) the *crico-thyroid* membrane, across which run transversely the crico-thyroid branches of the superior thyroid arteries; (5) the *cricoid cartilage*, which is one of the most important surgical landmarks in the neck. It lies opposite the disc between the fifth and sixth cervical vertebræ, and at this level the common carotid artery may be compressed against the transverse process of the sixth cervical vertebra —*the carotid tubercle*. The cricoid also marks the junction of the larynx with the trachea, and of the pharynx with the œsophagus. At this point there is a constriction in the food passage, and foreign bodies are frequently impacted here. At the level of the cricoid cartilage the omo-hyoid crosses the carotid artery—a point of importance in connection with ligation of that vessel. The middle cervical ganglion of the sympathetic lies opposite the level of the cricoid; (6) seven or eight rings of the *trachea* lie above the level of the sternum, but they cannot be palpated individually. The *isthmus* of the thyroid gland covers the second, third and fourth tracheal rings. As the trachea passes down the neck, it gradually recedes from the surface, till at the level of the sternum it lies about an inch and a half from the skin. The *thyroidea ima* artery—an inconstant branch of the innominate or of the aorta—runs in front of the trachea as far up as the thyroid isthmus. The inferior thyroid plexus of veins also lies in front of the trachea.

In children under two years of age the *thymus gland* may extend for some distance into the neck in front of the trachea and carotid vessels, under cover of the depressors of the hyoid bone.

Cervical Fascia.—This fascia completely envelops the neck, and from its deep aspect two strong processes—the prevertebral and pretracheal layers—pass transversely across the neck, dividing it into three main compartments. The posterior or *vertebral compartment* contains the muscles of the back of the neck, the vertebral column and its contents, and the prevertebral muscles. This compartment is limited above by the base of the skull, and below is continued into the posterior mediastinum of the thorax. The middle or *visceral compartment* contains the pharynx and œsophagus, the larynx and trachea with the thyroid gland, and the carotid sheath and its contents. These different structures derive their special fascial coverings from the processes which bound this compartment. The middle compartment extends to the base of the skull and passes into the anterior mediastinum of the thorax as far as the pericardium. The connective tissue space around the vessels is continued into the axilla. The anterior or *muscular compartment* contains the sterno-mastoid muscle and the depressor muscles of the hyoid bone. It extends upwards as far as the hyoid bone and base of the lower jaw, and downwards as far as the sternum and clavicle. The arrangement and limits of the different layers of the cervical fascia explain the course taken by inflammatory products and by new growths in the neck.

Malformations of the Neck—*Branchial Fistulæ.*—The parietes of the neck are formed by the coalescence of the second, third and fourth branchial arches of the fœtus. Any interference with the complete fusion of these arches and with the consequent obliteration of the intervening clefts results in the formation of a branchial fistula. The fistula may be lateral or median. In most cases it is complete, but it may be blind either externally or internally.

The most common variety is the *complete lateral fistula*, the external opening of which is usually placed towards the anterior edge of the sterno-mastoid muscle, about an inch above the sterno-clavicular joint, and the internal in the region of the posterior pillar of the fauces close to the tonsil. The track of the fistula is usually more or less tortuous, and its calibre varies greatly in different cases. It is lined by mucous membrane, the secretion of which is clear and viscous, and the only trouble the patient experiences is the escape of this fluid on to the surface. In rare cases particles of food pass along the fistula. Firm fibrous or cartilaginous nodules, the remains of the branchial arches, are sometimes found in the vicinity of a fistula in any part of its course.

The *treatment* consists in excising the fistulous track in its whole length, but, owing to the long and tortuous course of the fistula, and its relations to important structures, the operation is always a tedious and difficult one, and may be attended with considerable risk. Less radical measures, such as scraping

with the sharp spoon, cauterising or packing, are seldom successful.

Abnormal appendages, composed of skin, connective tissue and yellow elastic cartilage—so-called *cervical auricles*—are sometimes met with in the neck. They are derived from isolated portions of a branchial arch, and are frequently found at the opening of a branchial fistula. *Branchial cysts and branchial carcinoma* are described with tumours of the neck.

Wry-neck or Torticollis.—The term wry-neck or torticollis is applied to a condition in which the head assumes an abnormal attitude, which is usually one of combined lateral flexion and torsion.

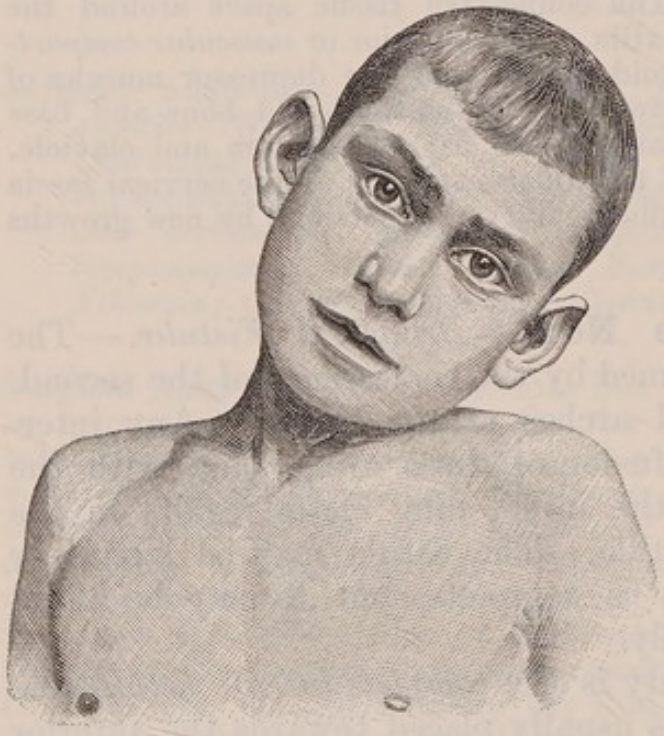

Fig. 51.—Transient Wry-neck, which came on suddenly after sitting in a draught, and passed off completely in a few days.

The varieties to be first described are those of muscular origin. In conditions of health the head is maintained straight and erect by the tonicity of the cervical muscles, and any want of equilibrium between the muscles of the two sides, or between different groups of muscles, results in some degree of wry-neck.

Three varieties of muscular wry-neck are recognised—(1) the acute or transient form; (2) the chronic or permanent form; and (3) the spasmodic form.

Acute or Transient wry-neck comes on suddenly, usually after the patient has been exposed to cold or damp. The sterno-mastoid, and often the trapezius, is contracted, and pulls the head to one side, twisting the face slightly towards the opposite side (Fig. 51). There is tenderness on pressing over the affected muscles, and severe pain on attempting to move the head. Usually in the course of a few days the condition passes off as suddenly as it came on. In some cases the affected muscles have been observed to undergo a certain amount of wasting after the attack.

In the *diagnosis* of this form of wry-neck it is necessary to exclude such conditions as cellulitis, inflammation of the cervical

glands, and disease of the cervical spine, in which the head may assume an abnormal attitude, the position being that which gives the patient greatest comfort.

The *treatment* consists in administering anti-rheumatic drugs, in applying warm dressings, and gentle massage.

Permanent or true wry-neck is due to an organic shortening of the sterno-mastoid muscle. In some cases the trapezius, the splenius, the scaleni, and even the levator anguli scapulæ muscles are also affected.

The sternal head of the sterno-mastoid is always markedly shortened, and stands out as a tight cord. Sometimes the clavicular head is also prominent. The cervical fascia is contracted to a greater or less extent in all cases—a point of importance in connection with treatment.

FIG. 52.—Permanent Wry-neck, showing characteristic attitude of head, hemiatrophy of face on affected side, asymmetry of eyes, mouth, clavicles, and nipples.

(From a photograph lent by Mr. Stiles.)

Opinion is divided concerning the etiology of the condition. By some it is regarded as a truly congenital deformity resulting from an arrest of development from undue pressure on the fœtus *in utero*, or from some ante-natal affection of the muscles or nerves. By others it is believed to result from cicatricial contraction of the muscle following a rupture of its fibres during delivery. There is evidence in support of both views, and it is probable that in some cases the deformity is really congenital, while in others it is acquired in the manner suggested. In some cases errors of refraction, astigmatism and other abnormalities of the eyes play an important part in the production of wry-neck. In rare cases torticollis follows paralysis of one sterno-mastoid.

Clinical Features.—The appearance of the patient is very characteristic (Fig. 52). The shortening of the sterno-mastoid pulls the head towards the affected side, so that the ear is approximated to the shoulder. At the same time the head is rotated towards the opposite side and slightly tilted backwards, with the result that the chin is directed towards the opposite side, and is somewhat raised. The shortened sterno-mastoid

stands out prominently, and, on any attempt to straighten the head, can be felt as a firm, fibrous band. The skin of the affected side of the neck may be thrown into transverse folds. The patient is unable to correct the deformity, but it is usually possible to diminish it by manipulation.

If the condition is not corrected early, all the soft structures on the affected side of the neck undergo organic shortening, with the result that the deformity is accentuated. In aggravated cases a lateral curvature, with the concavity towards the affected side, occurs in the cervical region, the vertebræ becoming wedge-shaped from side to side, and a compensatory curve may develop in the upper dorsal region.

There is often a marked asymmetry of the head and face, the affected side being the smaller. The eye on this side lies on a lower level, and is more oblique than its neighbour, the cheek is flattened, and the mouth is asymmetrical.

Treatment.—When the condition is recognised early, it may be possible to correct the deformity by forcibly stretching the muscle under anæsthesia and fixing the neck in a rigid apparatus. Prolonged treatment by massage, exercises and electricity is necessary to prevent relapse.

In the majority of cases the shortened structures must be divided. Subcutaneous tenotomy—at one time the favourite method of treatment—has almost entirely been replaced by the *open operation*, which enables the surgeon to divide thoroughly all the structures at fault, including the cervical fascia, and at the same time to avoid injuring other structures in the neck. A transverse incision is made over the lower third of the muscle, and each of the heads of origin is thoroughly and completely divided. Any shortened bands of fascia which stand out after division of the muscle are also freely divided. The wound is sutured, and the head fixed in a slightly over-corrected position, by means of an elastic bandage carried under the axillæ and round the body, for a few days till the wound has healed. The patient is then encouraged to move the head freely. Massage, passive movements, douching and electricity must be employed for months after the operation to prevent relapse.

Spasmodic wry-neck is the term applied to a condition in which clonic contractions of certain of the muscles of the neck produce convulsive jerkings of the head. The muscles most frequently at fault are the sterno-mastoid of one side, and the posterior rotators of the head of the opposite side. By these muscles the head is pulled into the position of ordinary permanent wry-neck, and is at the same time slightly retracted. In some

cases there is more or less constant nodding or jerking of the head.

The condition is usually met with in adults of a neurotic disposition who are in a depressed state of health, and is due to some lesion, as yet undiscovered, in the nervous mechanism of the affected muscles—most probably in their cortical centres. By some authorities it is believed that the spasmodic jerkings are originated by certain movements habitually made by the patient in the course of his work. It has been observed in some cases that, as a result of astigmatism and errors of refraction, the patient has acquired the habit of repeatedly tilting his head to enable him to see clearly, and that these movements have become continuous and uncontrollable.

The disease tends to become progressively worse until the patient is incapacitated for work or enjoyment. Sleep even may be seriously interfered with.

Treatment.—Experience has shown that in well-marked cases little benefit is to be derived from drugs, electricity or restraining apparatus. Massage has been temporarily beneficial in some of the milder cases.

Of the operative procedures resection of portions of the spinal accessory nerve on one side, and of the posterior branches of the first three spinal nerves on the opposite side, seems to offer the best prospect of recovery. The spinal accessory is reached through an incision beginning at the tip of the mastoid process and passing downwards and forwards parallel with the lower jaw. The nerve runs obliquely from above downwards and backwards and enters the muscle on its deep aspect. Simple division of these nerves or resection of the spinal accessory alone has not proved permanently curative. In Kocher's experience division of the offending muscles without interfering with the nerves has given good results.

True spasmodic wry-neck must be distinguished from the **hysterical** variety occasionally met with in neurotic females. This, after lasting for weeks, or even months, may pass off completely, but, like other hysterical affections, is liable to recur at intervals.

The **cicatricial contraction** of the integument of the neck, which frequently results from extensive burns (Fig. 33), wounds, abscesses or ulcers, may cause unsightly deformity and fixation of the head in an abnormal attitude, and call for surgical treatment.

Injuries of the Neck.

Contusion of the neck may result from a blow or crush, as, for example, the passage of a wheel over the neck, or from throttling, strangling or hanging. There is always more or less swelling and discoloration, the degree varying with the extent and nature of the injury. In medico-legal cases the distribution of the discoloration should always be carefully noted. When due to throttling, the marks of the individual fingers may be distinctly recognisable, and nail prints may be present. In cases of strangling, the mark of the cord passes straight round the neck, while in suicidal hanging it is more or less oblique and is higher behind than in front. When due to a direct blow, for example by a fist, the discoloration is limited, whereas it is usually diffused all over the neck when due to the passage of a wheel over the part.

From the surgical point of view the clinical importance of these injuries depends on the complications which may be present. When extensive extravasation takes place under the cervical fascia, the effused blood may press upon the air-passages and œsophagus to such an extent as to cause interference with breathing and swallowing. The larynx or the trachea may be so grossly damaged that death results immediately from suffocation, or later from gradually increasing swelling causing obstruction of the glottis. If the mucous membrane of the air-passage is torn, subcutaneous emphysema may develop and spread widely over the body. Sometimes the pharynx or the œsophagus is lacerated, and particles of food escape into the cellular tissue, leading to septic infection in the deeper planes of the neck.

In contusions of the lower part of the neck the cords of the brachial plexus may be injured.

Fractures of the Hyoid, Larynx and Trachea.—The *hyoid bone*, on account of its mobility and the protection it receives from the body of the lower jaw, is seldom fractured. The injury is occasionally met with, however, in old people in whom the great cornu has become ossified to the body of the bone. It is usually produced either by a direct blow, or by transverse pressure as in throttling. The fracture is almost always at the junction of the great cornu with the body, and there is marked displacement of the fragments. The patient usually feels the bone crack, and experiences a sensation as if something hard had stuck in his throat.

The *thyroid and cricoid cartilages* are also liable to be fractured, particularly in old people after calcification or

ossification has taken place. These fractures may be single or multiple, and they usually result from a direct blow, from throttling, or from the passage of a wheel over the neck.

The *trachea* may be lacerated, or even completely torn from the larynx, by the same forms of injury as produce fracture of the laryngeal cartilages.

The *clinical features* common to all these injuries are swelling and discoloration, due to effusion of blood into the cellular tissue of the neck. If the mucous membrane is torn, air may escape into the tissues and produce emphysema. There is always more or less difficulty in breathing, which may amount to actual suffocation. This may come on immediately, or in the course of a few hours from œdema of the glottis. Hæmorrhage may take place into the lungs and cause hæmoptysis, or the blood may escape at once from the mouth. Swallowing is usually difficult and painful, especially in fracture of the hyoid bone. There is also pain on speaking, and the voice is husky and indistinct. Spasmodic coughing is common.

The *prognosis* is always grave on account of the shock attending the accident, the risk of suffocation and of septic pneumonia.

Treatment.—In many cases tracheotomy is immediately called for either to relieve impending suffocation, or to anticipate dyspnœa from œdema of the glottis. In fracture of the hyoid the fragments may be replaced by manipulation through the mouth, after which the neck is fixed by means of cotton-wool and a bandage, or in a poroplastic collar.

Wounds — Cut-throat. — The most important variety of wound of the neck met with in civil practice is that known as "cut-throat"—an injury usually inflicted with suicidal, less frequently with homicidal intent.

All degrees of cut-throat are met with, and the severity of a given case depends chiefly upon the extent to which important vessels and nerves are injured, and upon whether or not the air and food passages are opened.

Suicidal wounds are usually directed from left to right (if the patient be right-handed), and they run more or less obliquely from above downwards across the neck. The wound is usually deepest towards its left end, that is where the weapon enters, and gradually tails off towards the right. In most cases the would-be suicide throws his head so far back at the moment of inflicting the wound, that the main vessels are carried backward under cover of the tense sterno-mastoid muscle, and so escape injury. The knife may even reach the vertebral column without damaging the contents of the carotid sheath.

Homicidal wounds are most commonly inflicted upon infants and children. They are usually more directly transverse, and are of equal depth throughout. The main vessels are generally divided and the œsophagus and trachea opened into. In some cases the spinal canal is opened and the cord and its membranes injured. As the assailant usually succeeds in his object, it is unnecessary to refer further to homicidal wounds.

In a large proportion of suicidal attempts the patient only succeeds in inflicting one or more comparatively superficial wounds across the front of the neck. In many cases the hæmorrhage from these is trifling, but if the external jugular and other large superficial veins be divided, it may be fairly profuse, although it is seldom fatal. The contraction of the platysma causes such wounds to gape widely, and their edges tend to be turned in.

If the *depressor muscles* of the hyoid and larynx are divided, there may be some interference with deglutition and phonation, but respiration is not affected.

The *thyro-hyoid membrane* is frequently divided, and the pharynx thus opened. In such cases the upper portion of the epiglottis is often cut off, and the base of the tongue, the tonsil or the soft palate may be injured. The lingual, facial, and superior thyroid arteries and the hypoglossal nerve are also liable to be divided at this level, but the main vessels of the neck usually escape.

There is pain and difficulty in swallowing, and food and saliva tend to escape through the wound. Particles of food may pass into the air-passages and cause violent fits of coughing.

In more severe cases the knife enters the *air-passages.* Sometimes the thyroid cartilage is divided — as a rule only partially—and the vocal cords are injured; in other cases the trachea is opened, or it may be completely cut across. The bleeding is always serious, as the superior thyroid arteries are usually damaged. Not infrequently the common carotid and the internal jugular vein are also wounded, in which case the hæmorrhage usually proves fatal. The fatal issue may be contributed to by blood entering the air-passages and causing asphyxia, or by air being sucked into the open veins and causing air embolism. The laryngeal branches of the vagus may be divided and paralysis of the larynx ensue.

In all cases there is more or less dyspnœa and persistent coughing. The voice is husky, and the patient can only express himself in a hoarse whisper. There is difficulty in swallowing, and the food may enter the air-passages. When the external

wound is small, there may be a considerable degree of subcutaneous emphysema.

Occasionally, but very rarely, the wound is made *above the hyoid bone*, and opens directly into the mouth. There may then be sharp hæmorrhage from the base of the tongue or from the lingual and facial arteries or their branches in the submaxillary region. There may be asphyxia from the base of the tongue and the epiglottis falling back and obstructing the larynx. There is great difficulty in swallowing.

The *prognosis* in cases of cut-throat depends very largely on the general condition of the patient. The majority of those who attempt to take their own lives are in a low state of health from alcoholic excess, mental worry, privation or other causes, and many succumb even when the wound in the neck is comparatively slight. Shock, loss of blood, asphyxia from blood entering the air-passages, and œdema of the glottis are the most frequent causes of death soon after the injury. Septic cellulitis and septic pneumonia are later complications which may prove fatal.

Treatment.—The first indication in a case of cut-throat is to arrest hæmorrhage. This may be done by applying firm digital compression over the bleeding points. The clots are then removed and the bleeding points sought for and ligatured, the wound being enlarged if necessary to allow of the divided vessels being secured.

If the food and air-passages are intact, it is usually advisable to close the wound after having thoroughly purified it and sutured any muscles which have been divided. Drainage should be provided for at the most dependent angle of the wound.

When the epiglottis is cut across in wounds opening into the pharynx it should be united with a few fine silk sutures. The wall of the pharynx, and the muscles should then be sutured layer by layer and the skin wound closed and drained.

When the air-passages are opened, it is usually advisable to perform tracheotomy, and pack round the tube with sponge or gauze to avoid the risk of œdema of the glottis and to prevent blood entering the lungs. The wound in the larynx or trachea may then be closed with fine silk stitches and the soft tissues brought together layer by layer. The wound should be drained.

During the after-treatment the head should be flexed on the chest to take all tension off the stitches, and care must be taken that the patient does not interfere with the dressings. He must be kept under constant supervision lest he make a further

attempt on his life. In some cases it is necessary to feed the patient through a tube passed into the stomach either through the mouth or through the nose. When the passage of the stomach-tube causes much discomfort, the patient is fed by the rectum.

Wounds of the thoracic duct have been described with affections of the lymphatics, and *wounds of the brachial plexus* with injuries of individual nerves.

Inflammatory Affections.

Diffuse suppurative cellulitis may occur in any of the cellular planes in the neck. When situated in the subcutaneous connective tissue, it is usually the result of infection of an operation or accidental wound, and is, as a rule, comparatively limited in extent.

When it occurs under the cervical fascia, for example, in the course of acute infective diseases, such as scarlet fever, measles or general pyæmia, the pus tends to spread widely throughout the neck, infiltrating the connective tissue spaces around the blood-vessels, the air-passages and the œsophagus. The density and tension of the cervical fascia cause the pus to burrow downwards towards the mediastinal spaces of the thorax, where it may give rise to such complications as empyema, septic pericarditis or gangrene of the lung. In some cases the pus reaches the axilla by spreading along the blood-vessels.

A particularly virulent form — sometimes spoken of as Ludwig's angina—is met with in debilitated subjects as a result of infection of the cellular tissue of the neck with streptococci, which are usually derived from some septic focus about the floor of the mouth.

Clinical Features.—In all forms the process spreads rapidly, and the tissues of the neck become swollen, œdematous and of a dusky red colour. The accumulation of inflammatory products under the dense cervical fascia renders the whole neck indurated and brawny.

The neck is flexed towards the affected side, and there is pain on attempting to move the head and on palpating the swelling. Pus forms early, but, as it is under great tension, fluctuation can seldom be detected. Respiration may be interfered with by the inflammatory products exerting pressure on the air-passages, or by the onset of œdema of the glottis, and tracheotomy may be urgently called for on account of dyspnœa. Swallowing may also be affected by pressure on the pharynx and œsophagus.

In Ludwig's angina the swelling may extend from the submaxillary region towards the back of the mouth, and the tongue may be swollen to such an extent as to be protruded from the mouth. Pressure on the important nerves traversing the neck may give rise to irritative or paralytic symptoms. The main vessels may become thrombosed or eroded—particularly when the cellulitis is associated with scarlet fever—and in the latter case copious hæmorrhage may follow the incision of the abscess.

There is always marked constitutional disturbance in the form of rigors, high temperature, and a small, rapid pulse.

The *prognosis* is always grave, and death may result within a few days from general septic infection.

Treatment.—In the earliest stages hot, antiseptic fomentations should be applied, and antistreptococcic serum may be injected. If the process does not begin to abate within twenty-four hours, and if the swelling becomes brawny in character, incision is urgently called for. One or more incisions should be made through the deep fascia where the signs of inflammation are most intense, and the deeper planes of the neck should be opened up by blunt dissection. The wound is painted with pure carbolic acid, dusted with iodoform, and drained.

Actinomycosis occasionally manifests itself in the neck as an acute phlegmonous inflammation which causes wide destruction of tissue.

Boils and carbuncles frequently occur on the back of the neck where the skin is thick and coarse and is constantly rubbed by the collar.

The affections of the *cervical lymphatic glands* have already been described.

Tumours.

Cystic Tumours.—A great variety of cystic tumours are met with in the neck.

Branchial cysts are formed by the distension of an isolated and unobliterated portion of one of the embryonic branchial clefts. They usually form in connection with the third cleft, and are met with in the region of the great cornu of the hyoid bone, to which the wall of the cyst is almost always attached. Less frequently they take origin in the second cleft, and lie below the mastoid process, in which case the cyst is adherent either to the mastoid or to the styloid process. In some cases these cysts project towards the floor of the mouth. When near the cutaneous surface they resemble *dermoid cysts* in being lined with squamous epithelium and filled with sebaceous material. When

deeply placed, they are lined by cylindrical or ciliated epithelium and contain a glairy mucoid fluid.

Although of congenital origin these cysts do not usually attract attention till about the age of puberty, when they are noticed as small, soft, fluctuating tumours over which the skin moves freely. They grow very slowly, but may attain great dimensions. The only treatment which yields satisfactory results is complete excision.

The cystic lymphangioma, hygroma, or *hydrocele of the neck* has been described with affections of lymphatics (vol. i. p. 302).

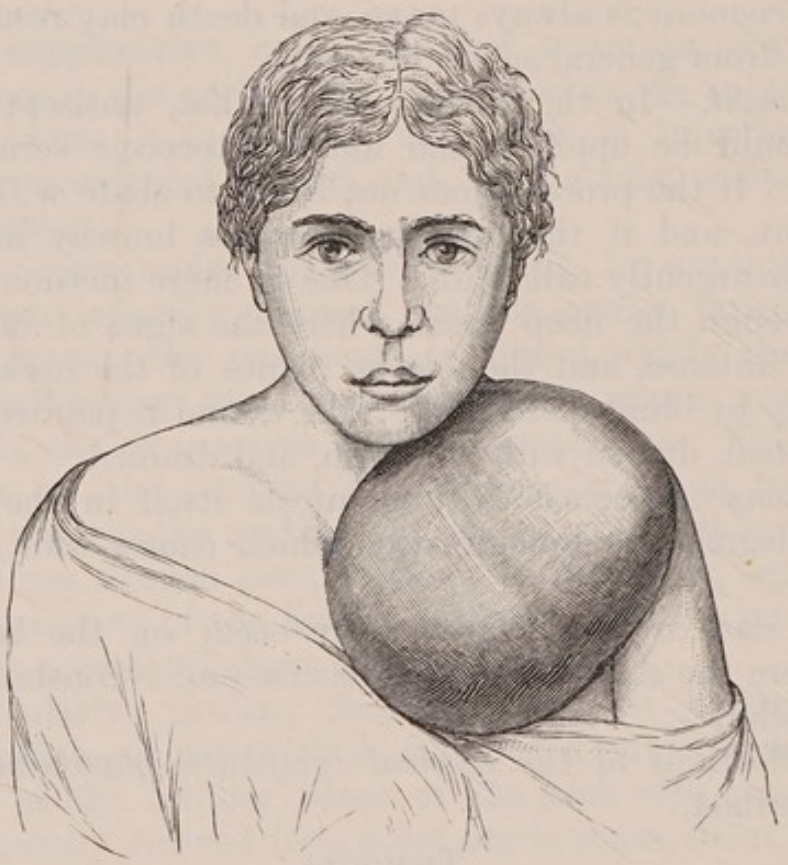

FIG. 53.—Pedunculated Lipoma growing from supra-clavicular region.

Blood cysts sometimes develop in relation to large veins in the neck, at first constituting a diverticulum of the vein, but later becoming isolated. Attempts to excise them are attended with free hæmorrhage, and it is usually necessary to ligature the vein above and below the cyst, and to remove the intervening portion.

Cystic swellings sometimes occur in relation to the supra-hyoid and thyro-hyoid *bursæ*. They may be treated by incision and drainage, or by excision.

Solid tumours, apart from those growing in connection with

the thyroid, the larynx or the lymphatic glands, are not very common in the neck.

Both varieties of *lipoma* are occasionally met with. The *circumscribed* form usually occurs over the nape of the neck or in the supra-clavicular region. It usually attains considerable size, and from its weight becomes pedunculated and hangs down over the patient's back or shoulder (Fig. 53). The treatment consists in enucleating the tumour and removing an elliptical piece of the skin over it.

The neck is one of the most common situations for *diffuse lipomatosis*, which usually begins over the nape and spreads more or less symmetrically till it completely surrounds the neck (Fig. 33, vol. i.). As the new-formed fat is not encapsulated, complete extirpation of the mass is always difficult, and may be attended with severe hæmorrhage.

Fibromata frequently grow from the ligamentum nuchæ, from the periosteum covering the vertebral processes, and from other fibrous structures. They may attain considerable size. Extirpation is sometimes difficult on account of their deep attachments.

Osseous tumours occasionally grow in connection with the transverse processes of the lower cervical vertebræ. They are to be distinguished from cervical ribs.

Sarcomata may develop from any of the fascial structures in the neck, or from the connective tissue surrounding the blood-vessels. They present the same characters as sarcomata in other parts of the body. On account of their deep attachments, there is great difficulty in removing these tumours completely, and when they are found to infiltrate the surrounding tissues the attempt should be abandoned.

Primary carcinomata have been met with growing from accessory processes of thyroid tissue, and in connection with belated remnants of the branchial clefts—*branchial carcinoma*. The tumour is deeply placed under cover of the sterno-mastoid. It presents the same clinical characters as other forms of carcinoma, and runs the same course, but shows a marked tendency to undergo cystic degeneration. It is seldom possible to remove it by operation.

The commonest and most important tumours met with in the neck are those arising in connection with the lymphatic glands and the thyroid, and the various forms of aneurysm springing from the large vessels at the root of the neck. These conditions are described elsewhere.

Cervical Ribs.—A supernumerary rib is sometimes developed

in connection with the transverse process of the seventh cervical vertebra. Such a rib may be complete, attached at one end to the transverse process and at the other to the sternum. More frequently it is incomplete, the anterior end being free or fused with the first thoracic rib about the level of the scalene tubercle. The abnormality is seldom recognised before the age of twenty, and attention is usually first directed to it after some emaciating illness. In most cases the only inconvenience caused by the abnormal rib is a slight fulness above the clavicle. The cords of the brachial plexus are liable to be pressed upon and displaced, and the patient complains of pains down the arm and of perversion of sensation in the distribution of the affected nerves. In some cases atrophy of the whole limb has been observed. The subclavian artery may be lifted up and compressed, or even obliterated, by the rib. The displaced artery may be mistaken for an aneurysm. When serious pressure symptoms are present, the rib may be excised, but this operation should not be performed merely on account of the deformity.

CHAPTER XVII.

THE THYROID GLAND.

Surgical Anatomy — Physiological Hyperæmia — Acute Thyroiditis — Goitre — Varieties: *Parenchymatous, adenomatous, malignant, exophthalmic.*

Surgical Anatomy. — The *thyroid gland* consists of two lateral lobes connected by an isthmus. The lateral lobes lie in contact with the side of the larynx up to the middle of the thyroid cartilage, and with the sides of the first five or six rings of the trachea, and they move with these structures on deglutition. The isthmus lies in front of the second, third, and fourth rings of the trachea. The gland is enclosed in a capsule derived from the cervical fascia, and lies under cover of the depressor muscles of the larynx. The recurrent laryngeal nerve runs in the groove between the thyroid and the trachea. The arteries of supply —the superior and inferior thyroids—are very large for the size of the gland, and enter it at its four corners. The thyroidea ima, when present, goes to the isthmus. Several isolated nodules of thyroid tissue —*accessory thyroids*—are sometimes met with in different parts of the neck. These are liable to the same diseases as the main gland.

The secretion of the gland is absorbed into the general circulation through the lymphatics and veins, and consists of a complex colloid substance which plays an important part in maintaining the normal metabolism of the body, particularly of the central nervous and cutaneous tissues in adults, and of the growing bones in children. The absence of the secretion plays some part in producing the diseases known as myxœdema, cretinism, and tetany.

Physiological Hyperæmia.—The thyroid varies greatly in size even within normal limits, and may become engorged and swollen from physiological causes, particularly in females. Before the onset of menstruation at puberty, for example, the thyroid frequently becomes engorged, and the enlargement may recur with each menstrual period for months or even years. During pregnancy also the gland may become swollen, and in some cases by the efforts of parturition the congestion is so much increased that dyspnœa is produced. Other forms of muscular effort also may produce similar effects. This condition is only

of clinical importance in connection with the differential diagnosis of thyroid swellings, and inasmuch as repeated attacks of congestion are believed to play a part in the production of goitre.

Acute Thyroiditis. — Acute inflammation may occur in a healthy thyroid or in a goitrous or cystic gland, and may either end within a few days in resolution, or go on to suppuration. It is due to infection with pyogenic bacteria, which usually gain access to the gland by the blood stream, as, for example, in typhoid fever, pyæmia, influenza and other acute infective diseases. Direct infection sometimes occurs from an abscess, a cellulitis, or a septic wound in the neck. It has also occurred from a foreign body impacted in the œsophagus ulcerating through and perforating the gland.

One lobe is usually more involved than the other, but the condition may be general. When pus forms, it may be diffused throughout the gland, or may be collected into several small foci.

Clinical Features.—The onset is sudden, and is sometimes marked by a rigor. There is great pain, and a sensation of extreme tension in the front of the neck which causes the patient to flex the head. The temperature is raised, and other signs of fever are present. There is severe headache of a congestive nature, and sometimes vertigo. The swelling takes the shape of the thyroid, and is firm, tense and elastic. The skin is not red, but the subcutaneous veins are dilated. In severe cases there is dyspnœa and pain on swallowing.

When suppuration ensues, all the symptoms are aggravated, and repeated rigors occur. The pus may burst into the cellular tissue of the neck or into the air passages or œsophagus.

Treatment.—In the non-suppurative stage the ordinary treatment of acute inflammation is employed, the neck being fixed by means of wool and bandages or by a poroplastic collar. When pus forms, the abscess should be opened by Hilton's method and drained.

Tuberculous and syphilitic affections of the thyroid are very rare.

Goitre or Bronchocele.

The term goitre is applied clinically to any non-inflammatory enlargement of the thyroid gland. Many varieties are recognised, although the distinction between them is not always well marked. For convenience of description they may be considered under the headings: parenchymatous, adenomatous, malignant, and exophthalmic goitre.

Parenchymatous Goitre. — *Etiology.* — Nothing definite is known regarding the causation of goitre. The disease is endemic in certain hilly districts in England—particularly Derbyshire and Gloucestershire—and in various parts of Scotland. It is exceedingly common in certain valleys in Switzerland. It is met with less frequently in men than in women, and it occurs chiefly during the child-bearing period of life. The condition has been attributed to a great variety of causes, including peculiarities in the soil, pollution of the drinking-water by decomposing vegetable material or by bacteria, deficiency of certain chemical constituents, particularly iodine, in the water, but the evidence on all these points is conflicting. It has also been suggested that the repeated congestion of the thyroid associated, for example, with menstruation and pregnancy, with severe manual labour in a stooping posture, or with the carrying of weights on the head, plays a part in the production of goitre.

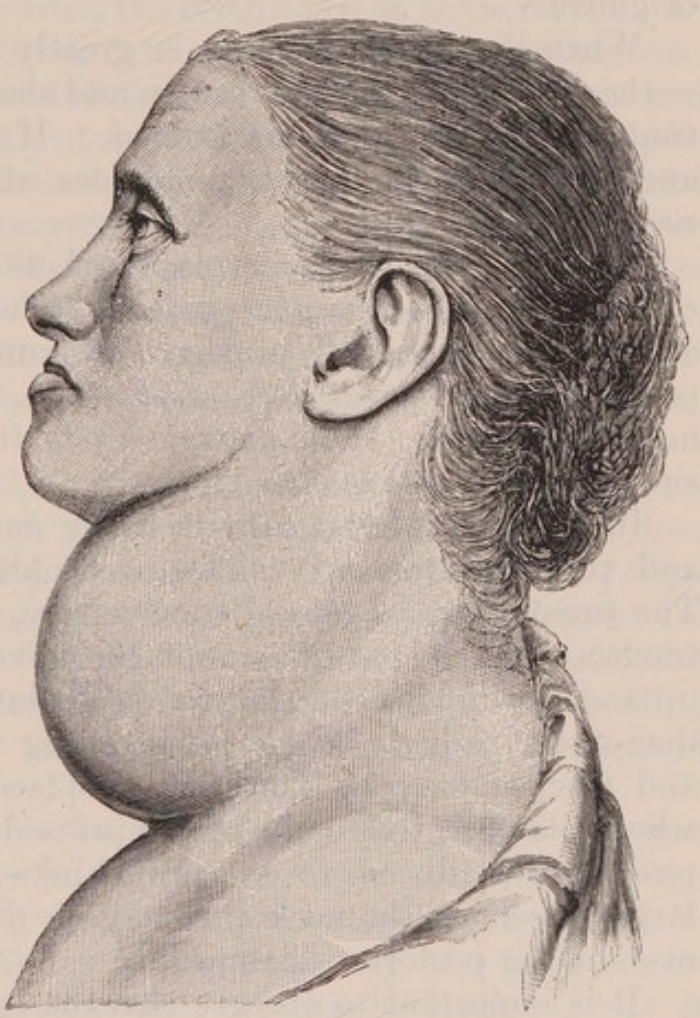

FIG. 54.—Parenchymatous Goitre in a woman, æt. 48.

In the parenchymatous variety both the secreting and the fibrous elements of the thyroid undergo hypertrophy, and the gland as a whole becomes enlarged, and forms a horseshoe-shaped swelling of moderate size in the neck. This swelling is soft, smooth or slightly lobulated on the surface, and is seldom quite symmetrical. In some cases the hypertrophy involves chiefly the isthmus. In others an outlying accessory lobule of thyroid tissue constitutes the bulk of the swelling, and this may extend a considerable distance from the position of the normal thyroid, reaching even behind the sternum into the thorax—*intra-thoracic goitre.*

When the secreting elements increase out of proportion to the stroma, numerous rounded or irregular spaces, filled with a thick, yellow, colloid material, are formed in the substance of the goitre—*colloid goitre.* The majority of these spaces are not larger than a pea, but one or more may enlarge and form cysts of considerable size—*cystic goitre.* These varieties, especially the cystic form, attain greater dimensions than any other form of goitre.

When the fibrous stroma is greatly in excess—*fibrous goitre*—the swelling is smaller, firmer, and shows a greater tendency to contract and compress the trachea. If the sclerosis is extreme, and the secretory tissue undergoes atrophy, myxœdema may result.

In some cases the hyperplasia affects chiefly the blood-vessels of the thyroid—*vascular goitre.* The capillaries, veins and arteries are increased in size and numbers, and the swelling pulsates, and increases in size when the patient makes any muscular effort. Hæmorrhagic cysts frequently develop in the substance of these goitres.

In all varieties the skin is freely movable over the tumour, and the subcutaneous veins are usually large and prominent. The tumour can be moved transversely, carrying the larynx and trachea with it, but it cannot be moved vertically. It moves up and down with the larynx on deglutition—a point of great diagnostic value. When the swelling is unilateral, the larynx and trachea may be markedly displaced to the opposite side, when bilateral, they may be compressed laterally so that the air passage is reduced to a mere chink—*scabbard trachea.* The large vessels of the neck also may be displaced outwards, as far even as the posterior triangle.

It is important to observe that the functional effects produced by the goitre bear no constant ratio to the size of the tumour. In some cases the patient only complains of the disfigurement caused by the swelling. As a rule, however, there is more or less interference with respiration. It may only be shortness of breath on exertion, or the patient may suffer from sudden and severe attacks of dyspnœa, especially when lying on the back during sleep. This may be due to the weight of the tumour pressing on the trachea, which has been softened and distorted by the goitre, or to temporary congestion and engorgement of the mucous membrane of the air passages. In these cases there is marked stridor both on inspiration and expiration, but no aphonia. In other cases the goitre presses upon the recurrent laryngeal nerve, causing spasmodic dyspnœa, hoarseness and

aphonia from abductor paralysis. The presence of these symptoms usually raises the suspicion of malignancy. Occasionally the œsophagus is pressed upon, and there is difficulty in swallowing. Among the less prominent symptoms are palpitation, sudden attacks of syncope, a feeling of fulness in the head, and giddiness.

All these symptoms may suddenly become aggravated, and fatal dyspnœa may ensue from the occurrence of hæmorrhage into the substance of the goitre or into a cyst, or from inflammation.

In *intra-thoracic goitre* the tumour displaces the trachea and causes paroxysmal attacks of breathlessness which may be mistaken for asthma, particularly as symptoms of bronchitis and emphysema are usually present at the same time. In some cases the patient can, by a violent expiratory effort, project the goitre upwards into the neck. When the goitre is fixed in the thorax, the clinical features are those of a mediastinal tumour with lateral displacement of the trachea, and engorgement of the great veins of the neck.

Treatment.—The *medicinal* treatment consists in administering internally such drugs as iodine, potassium iodide, or iron and arsenic, and the local inunction of blue ointment or yellow iodide of mercury ointment. The results of this treatment are not always satisfactory. Kocher has obtained better results by the administration of pure phosphorus. The evidence regarding the benefit derived from the internal administration of thyroid extract is conflicting.

Operative treatment is only called for to relieve pressure symptoms, or with a view to preventing their occurrence in the case of rapidly-growing goitres. It is usually considered advisable to operate if, on making firm pressure on the goitre from side to side, the patient becomes breathless (Kocher). It is seldom justifiable to operate merely for the removal of the disfigurement caused by the swelling.

The operation consists in excising that portion of the thyroid which is causing pressure symptoms—*thyroidectomy*. If the goitre is of moderate size, the transverse curved incision of Kocher, which affords very free access and leaves an almost imperceptible scar, is the best. It is carried over the most prominent part of the swelling, and is prolonged further upwards and backwards over the sterno-mastoid upon the side on which the disease is most marked. The skin, platysma, and deep fascia are divided, the vessels being secured and ligatured before being cut. The sterno-mastoid and sterno-laryngeal muscles thus exposed are hooked aside or divided. The necessity of dividing

the muscles is obviated by employing Kocher's angular incision. This begins over the sterno-mastoid muscle at the level of the thyroid cartilage on the side most affected, is carried to the middle line, and thence vertically downwards towards the sternum as far as may be necessary. The fascia is divided and the muscles retracted. The tumour is exposed by dissecting from its surface the thin layer of connective tissue which overlies it. The goitre is then isolated and "dislocated" by passing the finger round it, care being taken that all vessels are secured before being divided or torn. Special caution is necessary in dealing with the inferior thyroid artery on account of its close connection with the recurrent laryngeal nerve. The isthmus is next isolated and secured by a strong ligature as it is cut across. Finally the posterior edge of the thyroid is separated from its attachment to the trachea, care being taken not to injure the recurrent laryngeal nerve as it passes beneath the lower border of the larynx. To ensure the safety of the nerve it is advisable to cut through the substance of the thyroid, and so leave behind the posterior part of its capsule beneath which the nerve runs.

Risks of the Operation.—The administration of a general anæsthetic is attended with considerable risk, particularly when there is respiratory difficulty, and when the tumour passes behind the sternum. It is therefore advisable to perform the operation under local anæsthesia. Hæmorrhage is seldom a serious risk if care be taken to expose the goitre thoroughly before beginning to isolate it, and to secure all vessels before dividing them. The risk of injuring the recurrent laryngeal nerve has already been referred to. Care should be taken to avoid as far as possible tearing and squeezing the thyroid during the operation, as there is reason to believe that the absorption of large quantities of thyroid secretion from the divided surfaces gives rise to a condition known as *acute thyroidism* during the first few hours after operation. The symptoms of acute thyroidism are marked elevation of temperature, increase in the pulse-rate (150-200), rapid respiration with dyspnœa, flushing of the face, muscular twitchings, and mental excitement. The employment of a drainage tube for the first forty-eight hours after operation may diminish this risk. On no account may the whole of the thyroid gland be removed, as this is followed by symptoms closely resembling those of myxœdema—*operative myxœdema or cachexia strumipriva.* Tetany and certain psychical disturbances are also liable to ensue after thyroidectomy.

Adenomatous Goitre.—In this variety the swelling of the thyroid is mainly due to the growth within its substance of one

or more newly-formed nodules of thyroid tissue. These nodules are enclosed within a capsule and constitute true adenomata. The rest of the gland may be unaffected, or it may be the seat of a diffuse hypertrophy. The adenomata vary greatly in size. Some are solid, others undergo cystic degeneration, the glandular tissue being replaced by a quantity of clear or yellowish fluid, sometimes mixed with blood. The cysts thus formed may be unilocular or multilocular, and intra-cystic papillary vegetations frequently grow from their walls. The walls of the cysts may be thin, soft and flaccid, or thick and firm, or they may even be calcified.

Clinically the tumour is firm and nodular, and the more superficial nodules may be felt to move within the gland. When deeply placed they may not be palpable through the skin, yet they may give rise to serious symptoms by pressing on the air-passages, the recurrent laryngeal nerve, or the œsophagus. Fluctuation may be detected in the cystic adenoma.

Treatment.—As this variety is not amenable to medicinal measures, the only treatment is to enucleate the adenomatous nodules from the gland. *Enucleation* can usually be carried out through the transverse curved incision. The healthy thyroid tissue covering the nodule or cyst is incised and the tumour shelled out. The recurrent laryngeal nerve is seldom disturbed, but the operation may be attended with considerable hæmorrhage, which in some cases can only be arrested by plugging.

Treatment of Sudden Dyspnœa.—In cases where dyspnœa suddenly supervenes and threatens life, it is sometimes possible to relieve the pressure on the trachea by making an incision in the middle line of the neck, dividing the deep fascia, and allowing the goitre to protrude through the wound. If this is insufficient the isthmus may be divided. Should relief not follow, tracheotomy must be performed, and a long tube, or a large-sized gum-elastic catheter with a terminal aperture, passed into the trachea beyond the seat of obstruction.

Carcinoma and sarcoma are sometimes met with in the thyroid, and constitute what is known as *malignant goitre.* The tumour usually develops in a gland which has been the seat of goitre for several years, although it may begin in a previously healthy gland.

Clinical Features.—In many cases it is impossible to distinguish clinically between carcinoma and sarcoma of the thyroid. Sometimes, however, a differential diagnosis is possible. In *carcinoma* the swelling of the thyroid is densely hard, and increases rapidly, infiltrating and surrounding the air-passages,

œsophagus, and large blood-vessels, instead of displacing them as in other forms of goitre. Fixation of the swelling and marked enlargement of the lymphatic glands are characteristic of these growths. There is severe lancinating pain in the swelling, difficulty in swallowing, and severe dyspnœa, which interferes with sleep and is accompanied by constant hawking up of mucus from the air-passages. It usually proves fatal within six months.

Sarcoma is less common, and usually affects one lobe only, forming a large, soft tumour, which grows with great rapidity. It gives rise to the same symptoms as carcinoma. Metastasis to other parts, particularly the lungs, the mediastina and the bones, is common in both forms of malignant goitre.

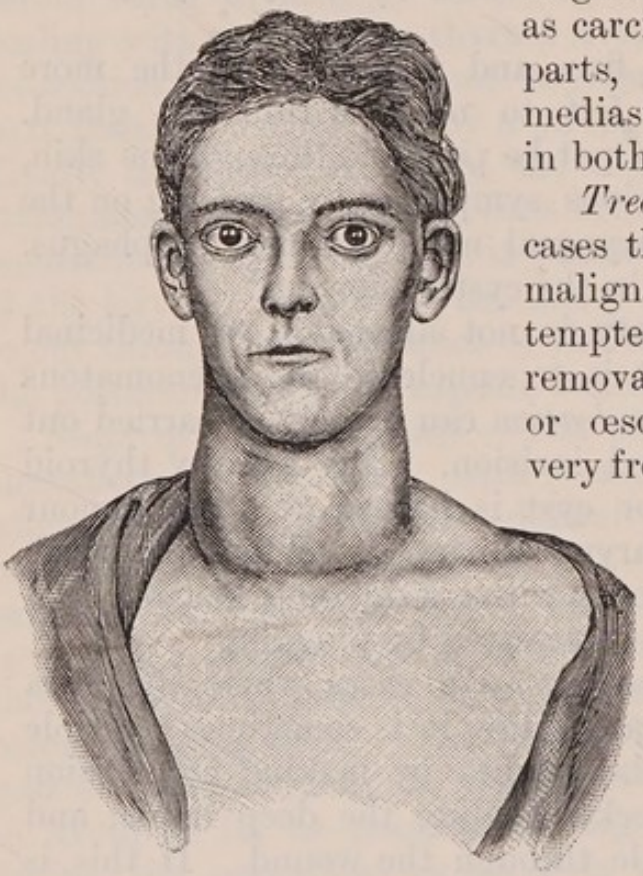

Fig. 55.—Exophthalmic Goitre in a woman, æt. 33.

Treatment.—Except in very early cases the complete extirpation of a malignant goitre is not to be attempted, as it usually involves the removal of a portion of the trachea or œsophagus, and the operation very frequently proves fatal. Operative interference in the form of tracheotomy is often called for, however, for the relief of respiratory embarrassment. The operation is one of considerable difficulty on account of the depth of the trachea from the surface, and in some cases it is necessary to enucleate the portion of the tumour overlying the trachea before a tube can be introduced. Hæmorrhage may be avoided by dividing the tissues with the Paquelin cautery.

Exophthalmic Goitre.—*Graves' Disease or Basedow's Disease.*—This is essentially a medical affection, and in most cases is treated by medical measures.

Among the more prominent symptoms are palpitation and irregular action of the heart, throbbing of the arteries of the head and neck, functional cardiac murmurs, anæmia, and excessive nervous excitability. The eyes are staring, the eyeballs are usually protruded from the orbit, and when the patient looks from a higher to a lower object the upper lids lag behind the

globe in its downward movement—von Graefe's symptom (Fig. 55). The thyroid is usually more or less enlarged and pulsatile, and thrills and bruits may be heard over it on auscultation. In some cases the enlargement of the thyroid, and in others the eye symptoms, are scarcely appreciable, while the general symptoms are well marked.

The disease has been variously attributed to excessive absorption of thyroid secretion, and to lesions as yet undetermined in the cervical sympathetic ganglia or in the medulla.

While the affection is most common in women between the ages of twenty and forty, it is also met with in men. It is frequently hereditary, and seems to be induced in many cases by overwork, worry, or severe nervous shock.

Surgical Treatment.—Excision of one lobe of the thyroid has been followed in many cases by marked alleviation of the symptoms, and in a few by permanent cure. The operation should be performed under local anæsthesia, as the administration of a general anæsthetic is attended with great risk.

Recently operations have been carried out on the cervical sympathetic cord, the three ganglia with their connecting nerve fibres being excised on both sides of the neck. As the operation is a severe one, only one side should be operated on at a time. The recorded results are so far satisfactory, but the procedure is still on its trial.

CHAPTER XVIII.

THE ŒSOPHAGUS.

Surgical anatomy—Methods of examination—Wounds—Swallowing of caustics—Impaction of foreign bodies—Rupture—Inflammatory affections: *Œsophagitis; Peri-œsophagitis; Tuberculosis; Syphilis*—Varix—Cicatricial stricture—Malignant stricture—Spasmodic stricture—Paralysis—Malformations: *Congenital; Acquired; Dilatation; Diverticula.*

Surgical Anatomy.—The œsophagus extends from the level of the cricoid cartilage to about the level of the lower end of the sternum. For clinical purposes it is useful to remember that the distance from the upper incisor teeth to the commencement of the œsophagus is about five or six inches, and that the œsophagus measures from nine to ten inches. The whole distance, therefore, from the teeth to the stomach is from fourteen to sixteen inches.

The cervical portion of the œsophagus, extending from the cricoid cartilage to the upper edge of the sternum, measures about two inches. It lies behind and to the left of the trachea, and in the groove between the gullet and the trachea on each side runs the recurrent laryngeal nerve. The thoracic portion is about seven inches long, and traverses the posterior mediastinum lying somewhat to the left of the middle line. It is crossed by the left bronchus, and below this level has the pericardium immediately in front of it. The left pleura is closely related to the anterior surface of the œsophagus throughout, while the right pleura passes behind it in its lower part. This accounts for the frequency with which growths in the œsophagus invade the right pleura. The œsophagus passes through the diaphragm about an inch above the cardiac opening of the stomach.

The narrowest parts of the œsophagus are its upper opening at the level of the cricoid, the point at which it is crossed by the left bronchus, and the point where it passes through the diaphragm. It is at these points that foreign bodies most frequently become impacted.

Methods of Examination.—It is sometimes possible to detect an impacted foreign body or a distended diverticulum in the cervical portion of the œsophagus by *palpation.* New growths confined to the œsophagus can seldom be felt through the skin, but if the tumour extends above the level of the cricoid and implicates the pharynx, it may form a palpable swelling behind the larynx.

Introduction of Bougies.—Œsophageal bougies or probangs are used for diagnostic purposes in cases of suspected stricture, and to aid in the

detection of foreign bodies. Various forms are employed, of which the most generally useful are the conical-pointed gum-elastic or silk-web bougie, and the olive-headed metal bougie, consisting of a flexible whalebone stem, to which one of a graduated series of aluminium or steel bulbs is screwed. For some purposes the sponge probang—which consists of a small round sponge fixed on a whalebone stem—is to be preferred.

For the passage of an œsophageal bougie the patient should be seated on a chair with the head thrown back and supported from behind by an assistant. The bougie is lubricated with butter or glycerin, and is held like a pen. With the left forefinger the surgeon depresses the tongue while he passes the bougie towards the back wall of the pharynx and guides it over the epiglottis. As soon as the instrument engages in the opening of the œsophagus, the patient usually hacks and coughs, but this stops in a few seconds, and if he is now directed to swallow, the instrument may be carried down the œsophagus, or can be passed on by gentle pressure. The spasm induced by the introduction of the instrument may sometimes be prevented by getting the patient to take full deep breaths somewhat rapidly. Great gentleness must be exercised, and no attempt should be made to force the instrument past any obstruction. It is necessary to guard against the fallacy of catching against the hyoid bone.

Before passing bougies it is necessary to make certain that the symptoms are not due to the pressure of an aortic aneurysm on the œsophagus. Cases have been recorded in which a thin-walled aneurysm has been perforated by an œsophageal bougie. The existence of ulceration or suppuration also contra-indicates the use of bougies.

It is to be borne in mind that in some cases the passage of a bougie may be attended with a considerable degree of shock, and cases are on record in which this has proved fatal without any gross lesion having been produced.

The *œsophagoscope*—a form of speculum which enables the œsophagus to be illuminated by an electric lamp—is sometimes employed, but has not proved of great value.

In cases of stricture *auscultation* during deglutition sometimes aids the diagnosis. The stethoscope is placed at various points along the left side of the dorsal spine, and abnormal sounds may be heard as the fluid swallowed impinges against the stricture or trickles through it.

For the detection and localisation of opaque foreign bodies the *Röntgen rays* are of great value.

Wounds of the œsophagus inflicted from without, for example, stabs, cut-throat or gun-shot injuries, are comparatively rare, and are almost invariably accompanied by lesions of other important structures in the neck which rapidly prove fatal. It is more common to meet with wounds inflicted from within, for example, by the swallowing of rough and irregularly shaped foreign bodies, or by unskilful attempts to remove such bodies or to pass bougies along the œsophagus. The severity of the lesion varies from a scratch of the mucous membrane to a complete perforation of the tube. The less severe injuries are attended with slight pain on swallowing and a sensation as if something had lodged in the œsophagus. In more severe cases

there is bleeding, followed by severe attacks of coughing and expectoration of blood-stained mucus. When the œsophagus is perforated, diffuse cellulitis of the neck or of the posterior mediastinum may ensue. In the treatment of these injuries the chief point is to give the œsophagus rest by feeding the patient for a few days entirely by the rectum.

Swallowing of Caustics.—The œsophagus is frequently damaged by the patient swallowing strong chemicals, such as sulphuric acid, nitric acid, carbolic acid, or caustic potash. These escharotic substances usually produce their worst effects at the two ends of the œsophagus, but in some cases the whole length of the tube suffers. The mucous membrane alone may be destroyed, or the muscular and even the fibrous coats may also be implicated. The damaged tissue undergoes necrosis, and when the sloughs separate, raw surfaces are left, and are very slow to heal.

If not rapidly fatal from shock and concomitant lesions of the air-passages, these injuries are usually attended with intense pain, severe thirst, and vomiting of blood. Shreds of mucous membrane of varying size are often ejected in the vomit. There is pain on swallowing, and not infrequently complications such as cellulitis, perforation of the œsophagus, or peri-œsophageal abscess follow. Later, cicatricial contraction takes place at the injured portions, producing one of the most intractable forms of fibrous stricture.

The *treatment* consists in administering fluids which will neutralise the poison taken, for example, solutions of carbonate of potash, of soda, or of magnesia when an acid has been swallowed, or vinegar diluted with water in the case of an alkali. When carbolic acid has been swallowed, the patient should have a large quantity of olive oil administered. The stomach should be washed out with a copious stream of water, the stomach tube being passed with the greatest gentleness to avoid perforating the softened œsophageal wall. Subsequently the patient should be fed for some days by the rectum.

As soon as the ulceration of the œsophagus has healed, say in three or four weeks, conical gum-elastic bougies should be passed every three or four days to prevent cicatricial contraction. As the calibre of the tube is restored, the instruments may be passed less frequently, but for some years—it may be for the rest of the patient's life—a full-sized bougie should be passed at least once a month. The œsophagus is rarely injured by the swallowing of hot fluids, as the effects seldom extend beyond the pharynx.

Impaction of Foreign Bodies in the Œsophagus.—Foreign bodies, such as imperfectly masticated portions of meat, fragments of bone, coins, pins, or artificial tooth-plates, are frequently impacted in the pharynx or in the œsophagus. For obvious reasons the accident is most liable to occur in children, lunatics, and those who are under the influence of alcohol. It sometimes happens also during the administration of anæsthetics, if the patient vomits solid substances. The object is most likely to lodge at one or other of the points where the tube is normally constricted.

Clinical Features.—When the object is bulky or of irregular shape, for example, a bolus of unmasticated food or a large tooth-plate, it is most likely to lodge in the pharynx, blocking the openings of both the œsophagus and the larynx, and giving rise to sudden, and it may be rapidly fatal, suffocation. The patient is immediately asphyxiated, the face becomes blue and engorged, and violent efforts are made to eject the object by retching and coughing. The object can usually be seen through the mouth, and touched with the finger.

Smaller bodies, such as coins, bones, or pins, usually enter the œsophagus. The patient has sudden pain at the point of impaction, which is increased on attempting to swallow, the face becomes congested, and severe retching and coughing are set up. The respiration is not necessarily impeded. Even after the foreign body has been ejected, the patient has for some considerable time the sensation that it is still present. This may be due to a scratch of the mucous membrane, in which case the swallowing of a few drops of cocain solution will cause the sensation to disappear, or it may be due to spasm set up by the irritation.

The position of foreign bodies in the œsophagus may be determined by external palpation, or by the careful use of an olive-headed metal bougie. The obstruction to the passage of food may be partial or complete, according to the shape of the body and the manner in which it is impacted. Irregular bodies, such as tooth-plates, may become fixed by sharp edges or hooks piercing the mucous membrane, and may lie in such a way that they arrest solids but allow fluids to pass. Valuable information may sometimes be obtained as to the shape, site and mode of impaction by the use of the Röntgen rays.

The impaction of foreign bodies may be followed by various complications, for example, ulceration and perforation of the wall of the œsophagus, leading to septic cellulitis of the neck or mediastinum; perforation of the air-passages, leading to septic pneumonia; injury of the thyroid gland, setting up acute sup-

purative thyroiditis ; or perforation or erosion of the large vessels of the neck, giving rise to fatal hæmorrhage.

Treatment.—When the object is impacted in the *pharynx* and is causing suffocation, the mouth must be forced open by an extemporised gag, the finger passed into the back of the throat, and the body hooked out. If this be impossible, and if suitable forceps be not at hand, it may be necessary at once to perform laryngotomy to enable the patient to breathe. The body should then be removed by means of pharyngeal forceps.

When the foreign body is lodged in the *œsophagus*, the symptoms are less urgent, and there is time to investigate the condition and to make suitable arrangements for dealing with it. In this connection it may be mentioned that drunkards frequently suffer from a form of spasm of the œsophagus which simulates clinically the impaction of a foreign body, and this fact should be borne in mind, as it may prevent needless search being made for bodies which have never been swallowed.

The measures adopted vary with the nature of the body, its site, and the way in which it is impacted, and on these points valuable information may be obtained by the use of the X rays.

A bolus of food, for example, or a small smooth object which is likely to pass safely along the alimentary canal, if it cannot be extracted with forceps, may be pushed on into the stomach by the aid of a bulbous-headed or sponge probang. This must be done very gently, especially if the body has been impacted for any length of time, as the inflammatory softening of the œsophageal wall may predispose to rupture.

Small, sharp or irregular objects, such as fish bones, tacks or pins, may be dislodged by the "umbrella probang"—an instrument which, after being passed beyond the foreign body, is expanded into the form of a circular brush which carries the foreign body out among its bristles.

Coins usually lodge edgewise in the œsophagus, and are best removed by means of a special instrument known as a "coin-catcher," which is passed beyond the coin, and on being withdrawn catches it in a specially constructed flange. In emergencies a loop of stout silver wire bent so as to form a hook makes an excellent substitute for a coin-catcher.

The removal of solid objects is greatly facilitated by carrying out the manipulations in the dark room with the aid of the X-rays and the fluorescent screen.

Irregular bodies with projecting edges or hooks, such as tooth-plates, tend to catch in the mucous membrane, and attempts to withdraw them by forceps or other instruments are liable to

cause laceration of the œsophagus. When situated in the upper part of the œsophagus these should be removed by the operation of *œsophagotomy*. An incision three or four inches long is made a little in front of the anterior edge of the left sterno-mastoid muscle. The trachea and the carotid sheath having been exposed and separated from one another, the œsophagus is palpated, a bougie having first been passed through the mouth to facilitate its recognition and to aid in localising the foreign body. The œsophagus is then opened in its long axis, rather towards its posterior aspect, to avoid the recurrent laryngeal nerve (which on the left side lies in front of the œsophagus), and, after the foreign body has been removed, is sutured with chromic gut. Lest there should be leakage subsequently, the wound in the neck should be left open to admit of free drainage. For the first few days after operation the patient is fed by the rectum, and for a few days more through a soft tube passed into the stomach. After this he may have fluids and soft solids by the mouth.

If the foreign body is lodged near the lower end of the œsophagus, it may be necessary to perform *gastrotomy*, making an opening in the anterior wall of the stomach large enough to admit suitable forceps, or, if necessary, the whole hand, in order that the body may be extracted by this route.

Bodies impacted half-way down the tube may not be within reach of an opening either in the œsophagus or the stomach, and it becomes necessary to perform the operation of *mediastinal œsophagotomy*, which consists in resecting portions of several ribs close to the left of the spine, pushing aside the pleura, and opening the œsophagus. As it is seldom possible to suture the wound in the œsophagus accurately, there is great risk of mediastinal cellulitis following this operation.

Rupture of the œsophagus has been described as occurring during violent attempts to eject a foreign body by vomiting, and as a result of diseased conditions of the œsophageal wall. The accident is, however, very rare, and has usually proved fatal by setting up left-sided empyema or cellulitis.

Inflammatory affections of the œsophagus due to pyogenic infection (*œsophagitis*), and of the cellular tissue around it (*peri-œsophagitis*), are rare apart from those forms due to the swallowing of caustics and to direct injury of the walls of the tube by foreign bodies.

A chronic form of œsophagitis occasionally occurs above a stricture and in alcoholic subjects. It is attended with severe pain and difficulty on deglutition, and attacks of vomiting.

Tuberculous lesions are also occasionally met with. They

are usually the result of direct spread from the bronchial glands, and the most prominent symptoms are pain during and after taking food, dysphagia, vomiting, and sometimes severe hæmatemesis. These symptoms are most marked when the condition has gone on to ulceration, and the disease is liable to be mistaken either for gastric ulcer or for cancer of the œsophagus. The œsophagus is sometimes invaded by the spread of tuberculous disease from the larynx.

Syphilitic affections of the œsophagus are rare, and give rise to symptoms similar to those of tubercle.

Varix of the veins of the lower end of the œsophagus occasionally occurs in cases of cirrhosis of the liver. The only surgical interest attaching to the condition is that it may give rise to severe hæmatemesis, and is therefore liable to be mistaken for gastric ulcer.

Cicatricial Stricture.—The commonest and most serious form of cicatricial or fibrous stricture of the œsophagus is that which follows the swallowing of caustics. The narrowing is usually most marked at the upper or at the lower end of the œsophagus, but several contractions may be met with along the tube, or it may even be stenosed throughout its whole length. The strictures may be circular, linear, or irregular, and the opening is often eccentric, rendering the tube tortuous and the passage of instruments exceedingly difficult.

Less frequently a stricture results from injury caused by an impacted foreign body, or in extracting it by operation or otherwise. In such cases the stricture is usually in the middle part or at the upper end of the tube. Localised thickening of the walls producing a certain degree of stenosis sometimes follows the healing of a syphilitic gumma or an ulcer, and is also said to occur as a result of habitual drinking of raw spirits.

Clinical Features.—The symptoms appear at intervals, varying from months to years, after injury. The most prominent is a gradually increasing difficulty in swallowing. At first the patient observes that he requires to add fluids to his solid food in order to swallow it with ease. Later he is unable to swallow solids, and finally has difficulty even with fluids. He is usually able to indicate the point at which he feels the food suddenly stop in its passage along the œsophagus. The difficulty may be temporarily aggravated by a passing congestion of the mucous membrane.

In the later stages regurgitation of unaltered food occurs, immediately after swallowing when the stricture is high up in the œsophagus, after a varying interval when it is near the

lower end. Between meals the patient hawks up a quantity of viscid saliva mixed with mucus. There is pain, referred to the epigastrium or between the shoulder-blades, especially if there is ulceration above the stricture and the patient requires to force the food through. Owing to the insufficiency of the food and fluids which enter the stomach, the patient suffers from hunger and thirst, and progressively emaciates. Perforation may occur above the stricture and set up a septic cellulitis of the neck.

The *diagnosis* is made by a consideration of the history, and may be confirmed by the use of œsophageal bougies.

By beginning with a full-sized olive-headed bougie and passing smaller and smaller instruments until the whole length of the œsophagus has been explored, the site, number, size, and shape of the strictures may be learned.

Treatment.—Before an attempt is made to dilate the stricture by bougies, the patient should be laid up in bed for a few days, and fed upon bland fluid diet or by enemata, to diminish congestion and allay spasm of the œsophageal walls. If the stricture is only moderately tight, it may be dilated by graduated bougies passed every third or fourth day till the normal calibre is restored, after which a full-sized instrument should be passed at least once a month for the rest of the patient's life.

In some cases of resilient stricture the method of continuous dilatation is to be preferred. A Symond's intubation tube is passed through the stricture and left in place for thirty-six or forty-eight hours, by which time the stricture is sufficiently dilated to admit of a larger tube being introduced. Larger and larger tubes are passed until the calibre of the œsophagus is restored. During the treatment the patient is fed through the tube.

If it is impossible to pass any instrument from the mouth, the œsophagus may be opened in the neck and bougies passed through the wound. Attempts to divide the stricture from within by shielded knives (*internal œsophagotomy*) are not to be recommended on account of the risk of septic cellulitis.

In cases of impermeable stricture near the lower end of the œsophagus the stomach should be opened and *retrograde dilatation* practised, a bougie being passed from the stomach to the mouth and fixed in position. The wound in the stomach is closed, and gradual dilatation of the stricture subsequently carried out.

Another method, suggested by Abbe, consists in performing a preliminary gastrostomy, passing a bougie with a stout silk string attached, and securing the end of the string, which is

then used as a saw with which to divide the stricture. A larger bougie is then passed, either from the mouth or from the stomach, and fixed in position, and after the lumen has been restored the stomach is closed.

If none of these measures succeed, *gastrostomy* must be performed, and the patient fed directly through the fistula. This opening need not be permanent, as it frequently happens that the rest afforded to the œsophagus so far diminishes congestion and spasm that a bougie can be passed. The stricture may then be dilated and the opening in the stomach allowed to close.

Carcinoma of the Œsophagus—Malignant Stricture.—Carcinoma is by far the most common variety of tumour met with in the œsophagus, and is also the most common cause of dysphagia. The tumour is nearly always a squamous epithelioma.

Fig. 56. — Malignant Stricture of Pharynx and Upper End of Œsophagus.

Carcinoma implicating the lower part of the pharynx and the upper part of the œsophagus (Fig. 56) is not uncommon, particularly in women. It tends to spread to the larynx, and forms a swelling in the neck, which can usually be distinctly felt behind the larynx.

When confined to the œsophagus the disease usually occurs in males, between the ages of forty and sixty, and its appearance in most cases seems to be associated with some chronic form of local irritation, such, for example, as chronic œsophagitis, the habitual use of raw spirits, hot fluids or irritating foods, or the presence of a cicatricial stricture.

The growth may appear at any part of the œsophagus, but is most common towards the upper and lower ends of the canal. Not infrequently more than one growth is present. The tumour usually spreads over a considerable area of the wall before it completely encircles the tube, so that for a considerable time the canal remains permeable. The margins of the ulcer are raised, rounded, and indurated.

The tumour tends to invade surrounding structures, such as the pleura, trachea, bronchi, and large blood-vessels. The vagus and recurrent laryngeal nerves also may be implicated. The bronchial and cervical lymphatic glands are usually infected, but the disease does not often spread by metastasis to the internal organs.

Clinical Features.—In their general characters the clinical features resemble those of cicatricial stricture. Dysphagia is the most prominent symptom. It usually comes on gradually, but in some cases is quite sudden in onset. It differs from the dysphagia due to cicatricial stricture in that it is often markedly intermittent. This may be due to a projecting mass of tumour growth becoming displaced, or more probably to a temporary diminution of congestion and relaxation of spasm, which play an important part in causing the dysphagia. There is regurgitation of food, which is mixed with blood and discharge from the tumour. In some cases there is actual vomiting of the stomach contents, which adds greatly to the patient's discomfort. There is excessive salivation, and as the patient cannot swallow the saliva he has constantly to expectorate. Sharp lancinating pain is usually complained of behind the sternum, in the epigastrium, or between the shoulders. The patient seldom complains of actual hunger, even when the amount of food which enters the stomach is exceedingly small.

Persistent cough and dyspnœa are present when the tumour invades the air-passages; when the recurrent laryngeal nerve is implicated there is cough, hoarseness of the voice, and aphonia. Severe and even fatal hæmorrhage may follow the erosion of large blood-vessels. Among the other complications which ensue when the tumour spreads beyond the œsophagus are cellulitis, pleurisy, pneumonia, and pericarditis.

The patient emaciates out of all proportion to the interference with taking food, and usually dies within twelve months of the onset of symptoms from starvation, septic absorption, or left-sided empyema.

The *diagnosis* may be confirmed by the use of a bougie, but great care is necessary in passing the instrument lest the wall of the œsophagus be perforated. Auscultation over the left side of the spine while the patient swallows fluid may be of some value in diagnosis.

Treatment.—Complete excision of the malignant disease is impossible except in cases in which it is seated in the upper end of the tube. The treatment, therefore, is entirely palliative, and is directed towards securing that the patient shall have sufficient nourishment and shall be relieved of suffering.

The systematic use of bougies to dilate the stricture and permit of the patient swallowing food and saliva is attended with considerable risk, and is not to be recommended.

Intubation.—In suitable cases—that is, cases in which the tumour is low down in the œsophagus and the lumen is not

excessively small—the introduction of a short Symond's tube may give great relief for a time, by enabling the patient to swallow food and saliva. The tube is made of gum elastic and measures about six inches in length, the calibre varying with the size of the stricture. The upper end is funnel-shaped, while the lower end has a terminal aperture. The tube is passed beyond the stricture by means of a special whalebone guide, the expanded upper end resting on the face of the stricture and preventing it passing right through. For further security against it being swallowed, and to facilitate its withdrawal, silk threads are attached to the upper end of the tube, brought out through the mouth, and attached to the cheek or ear. To prevent the thread being bitten through it should be passed between two sound teeth. The tube should be removed and cleaned once in two or three weeks.

In a large proportion of cases it becomes necessary to perform gastrostomy, and this should be done as soon as the patient has difficulty in swallowing fluids and begins to suffer in his general health from want of food. The operation is a simple one, and may be performed under local anæsthesia. It usually prolongs life for about three months, although we have known cases in which the patients lived for over two years.

Other tumours of the œsophagus — myomata, fibromata, adenomata, cysts, and sarcomata—are so rare as not to call for further mention.

Spasm of the œsophagus, œsophagismus or spasmodic stricture, is a condition in which the lumen of the tube is temporarily narrowed by spasmodic contraction of the muscular coat without any discoverable organic lesion. It most frequently occurs in neurotic females, and is probably in many cases of the nature of a reflex contraction set up by irritation of some branch of the vagus. In a considerable number of cases it has been associated with cancer of the liver. It is occasionally met with in habitual drunkards, and may give rise to symptoms which closely simulate those of an impacted foreign body. Paget has described under the name of "stammering with the œsophagus" an allied condition in which the patient occasionally has great difficulty in swallowing, especially when excited and in company.

The dysphagia associated with œsophagismus is intermittent, the attacks coming on suddenly, often in the middle of a meal, particularly when the patient is excited. Other signs of hysteria or neurosis are present, and it is usually found that a full-sized bougie can be passed, at least under chloroform. The *treatment*

is mainly medicinal, antispasmodic drugs, such as belladonna and bromides, being especially useful. A full-sized bougie may occasionally be passed with benefit.

Paralysis of the œsophagus sometimes occurs after diphtheria, and in the course of certain diseases of the central nervous system, particularly bulbar paralysis. The chief symptoms are dysphagia, hiccough, and an irritating cough.

Malformations.—*Congenital Malformations*—such as imperforate gullet, stricture, diverticulum, or fistulous communication between the œsophagus and the trachea—are rare, and are seldom within the reach of surgical treatment.

Acquired Malformations.—Two forms are recognised—general dilatation and diverticula.

General circumferential *dilatation* of the œsophagus is sometimes met with. As a rule it is associated with paralysis or organic stricture.

Diverticula may be produced by pressure from within the œsophagus, or by traction on its walls from without.

When due to pressure from within, the diverticulum or pouch is usually situated at the junction of the pharynx with the œsophagus. At this level the posterior wall of the canal is normally weak, and the pressure on this weak area causes it to bulge so that a pouch is gradually formed. All the coats of the œsophagus may enter into the formation of the pouch, or the mucous coat may be herniated through the muscular. The pouch extends downwards between the spinal column and the œsophagus, and as it increases in size it presses on the œsophagus and so causes dysphagia.

Diverticula produced by traction from without are usually on the anterior aspect of the œsophagus about the level of the bifurcation of the trachea, and are most frequently due to the cicatricial contraction of tuberculous bronchial glands which have become adherent to the œsophagus.

Clinical Features.—In all these conditions dysphagia and regurgitation of food are the most prominent symptoms. The length of time the food remains in the œsophagus varies greatly. In some cases it is returned almost immediately after being swallowed, in other cases it collects for hours, or even days, before being returned. The regurgitation is distinguished from true vomiting of stomach contents by the fact that the material brought up is free of pepsin and hydrochloric acid, and by observing that articles of food, taken it may be some days before, are returned unaltered. When the food lodges for any length of time it undergoes decomposition, and the patient's

breath becomes very offensive. Eructations of this decomposed material add greatly to the patient's discomfort.

When a diverticulum is present, the patient has a peculiar sense of oppression in the region where the food accumulates, and in many cases a distinct swelling can be recognised in the neck after the patient has taken a meal. Pressure over this swelling may cause the food to regurgitate into the mouth. It is sometimes possible to pass one œsophageal tube into the stomach and another into the diverticulum. In several cases the diagnosis has been verified by filling the pouch with a solution containing bismuth and then taking a radiogram, the pouch showing as a dark shadow. Foreign bodies are liable to lodge in the pouch and cause ulceration, and even perforation.

Treatment.—The palliative treatment consists in carefully regulating the diet, and in some cases it is advisable to feed the patient through a tube passed into the stomach. The operative treatment consists in excising the diverticulum through an incision in the neck similar to that made for œsophagotomy (Butlin). The œsophagus is closed by Lembert sutures and the external wound drained.

CHAPTER XIX.

THE LARYNX, TRACHEA, AND BRONCHI.

Examination of the larynx—Operations on the air-passages: *Sub-hyoid pharyngotomy; Thyrotomy; Laryngotomy; Tracheotomy; Intubation of the larynx; Laryngectomy*—Cardinal Symptoms of Laryngeal Affections: (1) Interference with the voice: *Hoarseness; Aphonia*—(2) Dysphagia—(3) Interference with respiration: *Diphtheritic laryngitis; Acute œdema of the larynx; Bilateral abductor paralysis; Syphilitic affections; Tuberculosis*—Tumours: *Papilloma; Epithelioma; Sarcoma*—Foreign bodies in the air-passages: *In the pharynx, larynx, trachea, bronchi.*

Examination of the Larynx.—For this purpose the examiner requires a laryngeal reflector with forehead attachment, one or two sizes of laryngeal mirror, a tongue cloth, and the means of obtaining good illumination. The source of light should be by preference placed opposite to and on the same plane with the patient's left ear. The forehead reflector is placed over the observer's right eye so that he may look through the central aperture, while at the same time he throws a good circle of light into the patient's mouth. The patient should be seated with the head thrown slightly back; the tongue is protruded and covered with the cloth and held lightly but firmly between the finger and thumb of the left hand. A full-sized mirror, warmed so as to prevent the condensation of the breath upon it, is inserted with the reflecting surface turned downwards, and pressed gently against the soft palate so as to push that structure upwards. The handle of the instrument is carried towards the left angle of the mouth and is somewhat depressed. By slightly altering the plane of the reflecting surface of the mirror the different parts of the larynx are in turn brought under inspection. The movements of the vocal cords should be observed during both respiration and phonation. For this purpose the patient should be directed to phonate the vowel sound "eh." In addition to these movements the general appearance of the larynx should be observed, and any deviations from the normal noted.

In the upper part of the mirror the epiglottis usually comes first into view. It is of a pinkish yellow colour, and presents a thin, sharply-defined free margin. In front of the epiglottis are the median and lateral glosso-epiglottic folds passing forwards to the base of the tongue, and enclosing the two valleculæ. Extending backwards and downwards from the lateral margins of the epiglottis are the two ary-epiglottic folds

which reach the arytenoid cartilages posteriorly. Between the two layers of mucous membrane of which the ary-epiglottic folds are composed are the cartilages of Wrisberg and Santorini. Situated between the two arytenoid cartilages is the inter-arytenoid fold of mucous membrane which forms the upper margin of the posterior wall of the larynx. This structure, along with the ary-epiglottic folds laterally and the epiglottis in front, constitutes the boundary of the upper aperture of the larynx. In the interior of the larynx the true vocal cords form the most prominent features, being conspicuous as two flat white bands. The vocal cords form the boundary of the rima glottidis or glottic chink. Above each true cord, and parallel with it, the false cord or ventricular band is evident as a pink fold of mucous membrane. Between the false and true cord on each side is a linear interval, which indicates the entrance to the ventricle of Morgagni.

Bronchoscopy and Tracheoscopy.—Direct examination of the trachea and larger bronchi may be made by the introduction through the mouth and rima glottidis, or through a tracheotomy wound, of metal tubes of varying size. This method of examination has been developed by Killian of Freiburg, who has employed it in a number of cases for the detection and extraction of foreign bodies in the lower air-passages. The tube may be passed under general anæsthesia or after cocainisation of the pharynx and larynx.

Operations on the Air-Passages

Sub-hyoid pharyngotomy consists in opening the pharynx by means of a mesial, vertical incision carried through the thyro-hyoid membrane. It is performed for the removal of foreign bodies and new growths in the vicinity of the upper aperture of the larynx. If additional room is required, for example in the case of tumours involving the epiglottis, the incision may be extended to the symphysis menti and the hyoid bone divided in the middle line. It is usually necessary to perform a preliminary tracheotomy to prevent blood entering the air-passages, and to diminish the risk from œdema of the glottis.

Thyrotomy consists in splitting the thyroid cartilage in the middle line for the removal of papillomata or of foreign bodies from the interior of the larynx, or for exploratory purposes in cases of cancer. A mesial incision is made from the hyoid bone to the cricoid cartilage, the muscles are separated, and the thyroid split longitudinally.

After completing the intra-laryngeal part of the operation, the two halves of the cartilage are subsequently sutured in position, special care being taken to approximate accurately the vocal cords in order to avoid interference with phonation. The stitches should not penetrate the whole thickness of the cartilage. A preliminary tracheotomy is usually advisable, but the

tube need not be worn for more than twenty-four or forty-eight hours.

Laryngotomy consists in opening the larynx below the glottis by dividing the crico-thyroid membrane. It is only performed as an emergency operation in cases of sudden asphyxia, induced, for example, by the impaction of a foreign body, or by spasm or œdema of the glottis. A vertical mesial incision, about an inch and a half long, is made so as to expose the membrane, the edges of the sterno-hyoid and sterno-thyroid muscles are separated, and a transverse incision carried through the membrane close to the upper border of the cricoid cartilage to avoid injuring the crico-thyroid arteries, which cross the membrane at a higher level. The opening is held open by the handle of the knife or by forceps until a short oval tube is inserted. In children the available space is so small that it may be necessary to divide the cricoid cartilage and one or two rings of the trachea to enable the tube to be introduced.

When there is no urgency, tracheotomy is to be preferred to laryngotomy, as the latter operation is sometimes followed by interference with phonation.

Tracheotomy is the operation of choice for the relief of laryngeal obstruction. It is frequently employed also as a preliminary measure in severe operations on the mouth and larynx, to enable steps to be taken to prevent blood and discharges entering the air-passages, and to facilitate the administration of the anæsthetic. The trachea may be opened either above or below the thyroid isthmus, which usually covers the third and fourth tracheal rings. The *high operation* is to be preferred as a rule as being more easily performed, and attended with less risk from hæmorrhage and from septic complications in the connective tissue planes of the neck. The *low operation* is indicated, however, in cases of malignant disease of the larynx, and for the removal of foreign bodies from the bronchi. The essential steps of the two operations are the same.

In children it is usually advisable to administer a general anæsthetic, but this must be done with great care, as the dyspnœa may suddenly become extreme and necessitate the operation being rapidly completed. In adults the operation can usually be performed under local anæsthesia.

A roller pillow is placed behind the neck to put the parts on the stretch, and an incision is carried from the lower margin of the cricoid cartilage downwards for about two inches. The sterno-hyoids and sterno-thyroids are separated, any blood-vessels met with are secured with forceps before being divided, and the

trachea exposed by dividing transversely the layer of deep fascia which passes from the cricoid to the isthmus of the thyroid. If the isthmus cannot be pulled downwards sufficiently, it may be divided in the middle line. All active bleeding having been arrested, the larynx is steadied by inserting a sharp hook into the lower edge of the cricoid cartilage, and the trachea is opened by thrusting a short, broad-bladed knife through the exposed rings. The back of the knife should be directed downwards, and the opening in the trachea enlarged upwards sufficiently to admit the tracheotomy tube. In children it is sometimes found necessary to divide the cricoid for this purpose (*laryngo-tracheotomy*). The slit in the trachea is then opened up with appropriate forceps, and the outer tube inserted and fixed in position with tapes. The inner tube is not fixed, so that it may be coughed out if it becomes blocked, and that it may be frequently removed and cleaned by the nurse. The tube should be discarded as soon as the patient is able to breathe by the natural channel.

Intubation of the Larynx. — This procedure is employed as a substitute for tracheotomy, especially in children suffering from membranous and œdematous forms of laryngitis. As experience is required to carry out the manipulations successfully, and as its use is attended with certain risks which necessitate that the surgeon should be constantly within call, the operation is more adapted to hospital than to private practice. O'Dwyer's apparatus is that most generally employed. The operation consists in introducing through the glottis, by means of a specially constructed guide, a small metal or vulcanite tube furnished with a shoulder which rests against the false vocal cords. The part of the tube which passes beyond the vocal cords is bulged to prevent it being coughed out.

A simpler method of attaining the same object consists in passing a gum-elastic catheter with a terminal aperture, as recommended by Macewen and Annandale.

Laryngectomy.—Excision of the larynx is called for chiefly in cases of malignant disease. A preliminary tracheotomy is performed some days before, and if there are any enlarged glands in the neck these may be removed at the same time.

To prevent the entrance of blood into the air-passages, the patient is placed in the Trendelenburg position, or the tracheotomy tube may be replaced by a Hahn's tube which is surrounded by compressed sponge. A vertical incision is carried from the hyoid bone to the level of the tracheotomy wound, and at each end of this incision, horizontal incisions are made so as

to enable the tissues overlying the larynx to be reflected to each side. The trachea is then cut across just above the tube. The larynx is next separated from the pharynx from below upwards, care being taken to avoid injuring the pharynx. The cavity left after removal of the larynx is packed with gauze and treated by the open method. The patient is fed for some days through a tube passed into the œsophagus, and by means of nutrient enemata.

An artificial larynx may subsequently be inserted, but as a rule this apparatus is not required, as the voice, although "whispered," is quite distinct.

Cardinal Symptoms of Laryngeal Affections.

The cardinal symptoms of laryngeal affections are interference with the voice, pain on swallowing, and interference with respiration. Laryngeal cough of a croupy or barking character may be present, and is usually associated with a lesion of the posterior wall or inter-arytenoid fold. Hæmoptysis is seldom of laryngeal origin, and unless the bleeding spot is visible in the mirror, the source of the bleeding is much more likely to be in the bronchi or lungs.

Interference with the Voice.—*Hoarseness* is due to an affection of the vocal cords, and may be of inflammatory origin, as in simple laryngitis, or due to some specific cause, such as tuberculosis or syphilis. It may arise also from such conditions as prevent the proper approximation of the vocal cords, as in tumours and certain forms of paralysis. Huskiness of voice occurring in a middle-aged person, lasting for a considerable period, and being unattended by any other local or constitutional symptom, should always arouse suspicion of malignant disease, and calls for a careful examination of the larynx. Should this reveal a congested condition of one vocal cord, associated with some infiltration, and should the mobility of the cord be impaired, suspicion of the malignant character of the affection is still further increased. The hoarseness in these cases is sometimes greater than the local appearances would seem to account for.

Aphonia, or loss of voice, sudden in origin and sometimes of a transient nature, frequently occurs in females, and is usually functional or hysterical in nature. Although the patient is unable to speak, she is quite able to cough and to laugh. In these cases there is a bilateral paralysis of the adductor muscles, so that the cords do not approximate on attempted phonation;

or the internal tensors may be paretic, leaving an elliptical space between the cords on attempted phonation. If the arytenoideus muscle alone is paralysed, a triangular interval is left between the cords posteriorly. There is no inflammation or other evidence of local disease.

The *treatment* of functional aphonia should be general and local; tonics such as strychnin, iron, and arsenic should be administered, while the intra-laryngeal application of electricity usually effects a sudden cure. In obstinate cases the use of the shower bath and cold douching, the administration of chloroform, and even hypnotism may be tried.

An examination of the lungs should be made in all cases of adductor paralysis, as this functional condition may be met with in early pulmonary tuberculosis.

Dysphagia.—Pain on swallowing, due to causes originating in the larynx, is usually associated with ulceration of the mucous membrane covering the epiglottis, ary-epiglottic folds, or arytenoid cartilages, that is, in connection with those parts with which the food is brought in direct contact. The most frequent causes of such ulceration are tubercle, syphilis, and malignant disease.

The differential diagnosis of these conditions is often difficult, and it may be impossible to arrive at any definite conclusion merely from local inspection. Careful inquiry into the previous history and into the condition of the lungs and sputum should not be neglected, and the results of anti-syphilitic treatment should be closely watched.

The *treatment* of dysphagia, apart from that of the disease associated with it, resolves itself into the use of local sedative applications, such as a weak cocain or eucain spray before meals, insufflations of acetate of morphin and boracic acid, and the use of a menthol spray. One of the best anæsthetic applications is orthoform powder, introduced by means of the ordinary laryngeal insufflator. Its action is more prolonged than that of any of the others, often lasting for from twenty-four to forty-eight hours.

Interference with Respiration.—It is only necessary here to refer to such causes of interference with respiration as may call for surgical treatment.

The chief forms of *laryngitis* to be considered in connection with the production of dyspnœa, are membranous or diphtheritic laryngitis and acute inflammatory œdema.

Diphtheria of the larynx may be primary, but in the majority of cases it is secondary to that in the fauces and pharynx. Careful inspection of these parts may reveal the

presence of false membrane, which materially assists in the diagnosis. In addition to the general symptoms there may be huskiness of the voice and a croupy cough. Gradual increase of dyspnœa and cyanosis indicates the spread of the false membrane. Laryngoscopic examination may reveal the presence of patches of membrane, and so corroborate the diagnosis. It must not be forgotten that a membranous exudation may be produced by other organisms than the Klebs-Löffler bacillus, to wit, the streptococcus and the bacillus coli.

Treatment.—Diphtheria antitoxin should be administered in all cases, as there is no doubt that a lower rate of mortality has prevailed since the introduction of the serum treatment. The use of medicated steam and spraying the throat with peroxide of hydrogen may also be employed. Careful watch must be kept lest the necessity for intubation or tracheotomy arise in the event of respiration becoming seriously interfered with.

Acute Œdema of the Larynx.—Œdema of the larynx may be inflammatory or non-inflammatory in origin. The former is the more common, and it may arise in connection with previously existing disease of the larynx, such as tubercle or syphilis, or it may be secondary to acute septic conditions at the base of the tongue, or in the fauces or pharynx; more rarely it results from inflammation in the cellular tissue or glands of the neck. The non-inflammatory form may be a local dropsy in renal or cardiac disease, may be induced by pressure upon the large cervical veins, and in some cases it appears to follow the administration of potassium iodide in the treatment of laryngeal affections.

The œdema consists of a fluid exudation into the loose submucous areolar tissue, and may be of a simple serous character or may become sero-purulent. The situations mainly involved are the glosso-epiglottic fossæ between the base of the tongue and the epiglottis, the ary-epiglottic folds, and the false cords. If the inflammatory process commence in front of the epiglottis, this structure becomes swollen and rigid, and often livid in colour—points which are readily discerned on examination with the mirror, or even without its aid in some cases. The patient complains of great pain on swallowing, and has the sensation of a foreign body in the throat. Should the inflammation spread thence to the ary-epiglottic folds, or, on the other hand, starting primarily in the larynx, give rise to œdema of these structures, dyspnœa becomes a prominent and grave symptom. The patient may become rapidly cyanosed, the inspirations assume a noisy, stridulous character, and great distress and imminent suffocation supervene. If laryngoscopic examination is possible, the

ary-epiglottic folds may be found greatly swollen and the upper aperture of the larynx partially occluded. Digital examination may detect the swollen condition of the parts. The urine should be examined for albumin and tube casts.

Treatment depends to some extent both upon the situation and amount of the œdema and upon the gravity of the patient's condition. In the milder forms the sucking of ice, the inhalation of medicated steam, or spraying with a solution of adrenalin, and the application of poultices to the neck may suffice to relieve the condition. Scarification of the epiglottis and ary-epiglottic folds with a knife, followed by free bleeding, may give complete relief. Diaphoretic and purgative treatment should not be neglected. In any of these conditions, however, tracheotomy may suddenly be called for.

Bilateral Abductor Paralysis.—Both recurrent laryngeal nerves may be interfered with by such conditions as enlargement of the thyroid gland, tumours of the œsophagus, intra-thoracic tumours and aneurysm, or by injury leading to paralysis of the posterior crico-arytenoid muscles which open the glottis. A gradually increasing inspiratory dyspnœa is developed, which at first is only noticed on exertion, when the desire for air is increased, but it later becomes permanent, and even during sleep the stridor may be marked. Suffocation may become imminent. When the larynx is examined with the mirror, the vocal cords are seen to lie near each other, and on inspiration their approximation is still greater.

The *treatment* of bilateral abductor paralysis depends upon the cause. In the majority of cases tracheotomy is called for sooner or later.

Syphilitic Affections of the Larynx.—*Secondary syphilitic* manifestations in the form of congestion of the mucous membrane, mucous patches, or condylomata are occasionally met with, and give rise to a peculiar huskiness of the voice. These conditions usually disappear rapidly under the influence of mercury.

In *tertiary syphilis*, whether inherited or acquired, the most common lesion is a diffuse gummatous infiltration which tends to go on to ulceration and to lead to wide-spread destruction of tissue. It usually attacks the epiglottis, the arytenoids, and the ary-epiglottic folds, but may spread and implicate all the structures of the larynx. Syphilitic ulcers are usually single, deep, and crateriform; the base is covered with a dirty white secretion, and the surrounding mucosa presents an angry red appearance. When the perichondrium becomes invaded, necrosis of the cartilages is liable to occur.

Hoarseness, dyspnœa, and, when the epiglottis is involved, dysphagia are the most prominent symptoms.

Cicatricial contraction leading to stenosis usually ensues, and may cause persistent dyspnœa, and, if the vocal cords are destroyed, aphonia.

The usual *treatment* for tertiary syphilis is employed, but on account of the tendency of potassium iodide to increase the œdema of the larynx, this drug must be used with caution. Intubation or tracheotomy may be called for on account of sudden urgent dyspnœa or of increasing stenosis. The stenosis is afterwards treated by gradual dilatation with bougies.

Tuberculosis.—The larynx is comparatively seldom the primary seat of tubercle. In the majority of cases the patient suffers from pulmonary phthisis, and the laryngeal mucous membrane is infected from the sputum. The disease may take the form of isolated tubercle nodules in the vicinity of the arytenoid cartilages, of superficial ulceration of the vocal cords and adjacent parts, or of a diffuse tuberculous infiltration of all the structures surrounding the upper aperture of the larynx. The mucous membrane becomes œdematous and semi-translucent, and under it miliary tubercles may be seen. These coalesce and break down, leading to the formation of multiple superficial ulcers. The parts adjacent to the ulcers are pale in colour. Perichondritis may occur and be followed by necrosis of cartilage and the formation of abscesses in the larynx or in the neck.

The voice becomes hoarse or may be lost, there is persistent and intractable cough, and in some cases dyspnœa supervenes. When the epiglottis is involved, there is pain and difficulty in swallowing.

In the presence of advanced pulmonary phthisis the treatment is chiefly palliative, but if the disease in the lungs is amenable to treatment, and the laryngeal disease limited, excellent results have been obtained by local measures. The X-rays have been employed with some success. Tracheotomy may be called for on account of urgent dyspnœa.

Tumours.—The commonest form of simple tumour met with in the larynx is the *papilloma*. It may occur at any age, and is comparatively common in children. It most frequently springs from the vocal cords and adjacent parts, forming a soft, pedunculated, cauliflower-like mass of a pink or red colour. The tumour may form a fringe hanging from the edge of the cord, or may spread until it nearly fills the larynx. In children the growths are frequently multiple and show a marked tendency

to recur after removal. They sometimes disappear spontaneously about puberty.

The most prominent symptoms are hoarseness, aphonia, and dyspnœa, which in children may be paroxysmal.

The *treatment* consists in removing the growth by means of laryngeal forceps or snare under cocain and adrenalin anæsthesia. For the removal of multiple papillomata in children it is usually necessary to open the larynx by thyrotomy or by laryngotomy. In a certain number of cases it has been found that the tumour disappears after the larynx has been put at rest by the operation of tracheotomy.

Cancer.—*Epithelioma* of the larynx is a comparatively rare affection. It is almost always primary, and usually occurs in males between the ages of forty and seventy. It is important to distinguish between those cases in which the growth first appears in the interior of the larynx—on the vocal cords, the ventricular bands, or in the sub-glottic cavity (*intrinsic cancer*)—and those in which it attacks the epiglottis, the ary-epiglottic folds, or the posterior surface of the cricoid cartilage (*extrinsic cancer*).

Clinical Features.—In the great majority of cases of *intrinsic* cancer the first, and for many months the only, symptom is huskiness of the voice, which may go on to complete aphonia before any other evidence of the disease becomes manifest. As the growth increases and fills the cavity of the larynx, there is difficulty of breathing, and spasmodic attacks of dyspnœa, so urgent as to call for tracheotomy, may supervene. When ulceration of the growth takes place, these symptoms may be temporarily relieved. The patient coughs up quantities of frothy mucus tinged with blood, and the breath has an offensive odour. The larynx becomes broadened, and perichondritis, followed by the formation of abscess, may ensue. So long as the disease remains confined to the interior of the larynx, and there is no pain or difficulty in swallowing, there is but little disturbance of the general health, and the lymphatic glands show no tendency to become infected. On laryngoscopic examination the posterior parts of the vocal cords are found to be congested, dusky red and swollen, and there is more or less impairment of mobility of the cord from which the tumour springs. In doubtful cases a portion of the growth should be removed for microscopic examination.

When the growth spreads into the tissues of the neck, the patient's sufferings are greatly increased. The œsophagus may be invaded by the disease spreading from the box of the larynx,

with resulting dysphagia ; the nerve trunks may be pressed upon, causing intense neuralgic pains ; the lymphatic glands become infected and break down, and the growth fungates through the skin. The general health deteriorates and death results, usually from septic pneumonia set up by the passage of food particles into the air-passages, from septic absorption, or from hæmorrhage. The duration of this form of the disease varies from one to three years.

In cases of *extrinsic* cancer the early symptoms are much more marked, pain and difficulty in swallowing and the secretion of frothy, blood-stained mucus being among the earliest manifestations. The cervical glands are infected early, sometimes even before there are any signs of laryngeal disease. Difficulty of breathing is also an early symptom on account of the growth obstructing the entrance of air. Tracheotomy may therefore be called for. In other respects the course and terminations are similar to those of intrinsic cancer.

Treatment. — This consists in performing a preliminary tracheotomy, and some days later removing the growth. In early and limited cases of intrinsic cancer this may be done by splitting the thyroid cartilage, cutting away the tumour, and closing the larynx again. In more extensive growths a partial, or even a complete, excision of the larynx may be necessary. Cases of extrinsic cancer are less amenable to operation, owing to the early infection of glands and the invasion of adjacent structures.

In cases in which excision is impracticable the sufferings of the patient may be alleviated by performing low tracheotomy, and by feeding with the stomach tube or by nutrient enemata. In some cases the difficulty of feeding the patient may make it necessary to consider the question of performing gastrostomy.

Sarcoma of the larynx gives rise to the same symptoms as cancer, and can seldom be diagnosed from it before operation.

Foreign Bodies in the Air-Passages.—Foreign bodies impacted *in the pharynx* usually consist of large unmasticated pieces of meat or large tooth-plates, and they occlude both the food and the air-passages, frequently causing sudden and fatal suffocation. They are described with affections of the œsophagus.

The bodies most frequently impacted *in the larynx* are small tooth-plates in the case of adults, and buttons, beads, sweets, coins, and portions of toys in children. These are drawn from the mouth into the air-passages during a sudden inspiratory effort, for example, while laughing or sneezing. If the glottis is completely blocked, rapidly fatal asphyxia ensues. If the

obstruction is incomplete, the patient experiences severe pain, difficulty of breathing, and a terrifying sensation of being choked. The irritation of the foreign body causes spasmodic coughing and retching, and may induce spasm of the glottis, which proves fatal.

Small round bodies may lodge in the upper aperture or in one of the ventricles, and give rise to hoarseness and repeated attacks of dyspnœa and spasmodic cough. Wherever the body is situated, the symptoms may suddenly become urgent from its displacement into the glottis, or from the onset of œdema of the glottis. The position of the body may often be ascertained by the use of the X-rays.

Treatment.—If the symptoms are urgent, tracheotomy must be performed at once, and an attempt made to remove the foreign body thereafter. In less severe cases the throat should be sprayed with cocain, the larynx examined with the mirror, and an attempt made to extract the body by means of intra-laryngeal forceps. As these manipulations are liable to induce sudden spasm of the glottis, the means of performing tracheotomy must always be at hand. If it be found impossible to remove the body through the mouth, laryngotomy or tracheotomy should be performed, and the body extracted through the external opening, or pushed up into the pharynx and removed by this route.

The foreign bodies which are most likely to become impacted *in the trachea* are tooth-plates with projecting hooks, and small coins. If the body remains movable in the trachea, it is apt to be displaced when the patient moves or coughs, and it may be driven up against the glottis and set up violent attacks of coughing and spasmodic dyspnœa. The X-rays often prove helpful in determining the position of the foreign body.

Treatment.—Tracheotomy should be performed at once and the edges of the tracheal wound held widely open with retractors, the patient being inverted, or coughing induced by tickling the mucous membrane with a feather. The foreign body is usually expelled, but it may be inhaled into one of the bronchi.

Foreign Bodies in the Bronchi.—Rounded objects which pass through the larynx usually drop into one or other of the bronchi, usually the right, which is the more vertical and slightly the larger. The body may act as a ball-valve, permitting the escape of air with expiration, but preventing its entrance on inspiration, with the result that the portion of lung affected becomes collapsed. The physical signs of collapse of a portion or of the whole lung may be recognised on examination of the chest. In some cases the body is frequently dislodged and driven up into the larynx, causing severe dyspnœic attacks and spasms of coughing.

The irritation caused by the foreign body in the bronchus may set up bronchitis or pneumonia, and abscess of the lung may supervene. In some cases the physical signs closely simulate those of pulmonary phthisis.

The *treatment* consists in performing low tracheotomy and attempting to remove the body with curved forceps, bent wires or other suitable appliances, or with the aid of the bronchoscope. Attempts have been made to reach foreign bodies in the bronchi by opening the chest, but the results have not been encouraging.

CHAPTER XX.

THE CHEST.

Surgical Anatomy—Injuries of the chest wall: *Contusions; Non-penetrating wounds; Fracture of ribs and costal cartilages; Dislocation of ribs and cartilages; Fracture of sternum*—Injuries of thoracic viscera: *Hæmothorax; Pneumothorax; Hæmoptysis; Emphysema*—Injuries of the pleura—Contusion and laceration of lung—Penetrating wounds of lung—Hernia of the lung. SURGICAL DISEASES OF THE CHEST: Diseases of chest wall: *Pyogenic; Tuberculous; Syphilitic; Tumours*—Pleural effusions: *Non-purulent; Purulent; Empyema; Bilateral empyema; Tuberculous empyema; Old-standing empyema with infected sinuses*—Pulmonary cavities: *Pulmonary abscess; Gangrene of lung; Bronchiectasis; Phthisical cavities; Hydatid cysts.* THE HEART: Injuries—Pericardial effusions. THE DIAPHRAGM: Injuries—Diseases. THE MEDIASTINA.

Surgical Anatomy.—The upper edge of the sternum lies opposite the disc between the second and third dorsal vertebræ, and distant from it about two and a half inches. The junction of the manubrium with the gladiolus is marked by a prominent ridge which lies opposite the second costal cartilage. The lower end of the sternum is opposite the ninth dorsal vertebra. The obliquity of the ribs is such that the anterior end of a given rib lies opposite the posterior end of the rib three lower in the series, for example, the anterior end of the fourth rib is on the same level as the posterior end of the seventh.

Posterior to the angles of the ribs the intercostal vessels and nerves cross the intercostal space obliquely, and are therefore liable to be injured in tapping or incising the chest. Anterior to the angles they lie in the groove on the under and inner aspect of the rib, and are safe from injury, if incisions and exploratory punctures are made close to the upper margin of the rib.

The internal mammary vessels lie a finger's-breadth external to the edge of the sternum. The left innominate vein and the main branches of the arch of the aorta are situated behind the manubrium, while the arch itself and the bifurcation of the trachea are behind the junction of the manubrium with the body of the sternum.

The apices of the lungs extend for a distance of about two fingers'-breadths above the middle third of the clavicle. A line drawn from the junction of the sternum with the ensiform cartilage to the last rib

indicates the lower reflection of the pleura. The lower border of the lung lies about two fingers'-breadths higher than the pleural reflection.

Injuries of the Chest Wall.

For clinical purposes it is necessary to distinguish between those injuries of the chest which are confined to the soft tissues of the parietes, and those in which the ribs or sternum are fractured; also between those which are complicated by lesions of the internal organs and those which are not. When there is a wound of the soft parts, it is further necessary to discover whether or not it penetrates the thoracic cavity. Severe shock, which may even prove fatal, may follow a blow over the chest without there being any evidence either before or after death of a gross lesion of the bones or viscera.

Simple contusion of the chest wall produced by a crush, a fall or a blow, or in a run-over accident, is one of the most common casualties met with in hospital practice. The patient suffers from a considerable degree of shock even when the violence is comparatively slight. There is marked pallor, the pulse is weak, and the respiration short, shallow and rapid. As there is tenderness over the part struck, and a sharp, stabbing pain when the patient coughs, sneezes or takes a long breath, the condition is liable to be mistaken for a fracture of the ribs. Extensive extravasation of blood into the connective tissue planes is frequently met with, particularly in the pectoral region.

Children suffer less from such injuries than adults, probably on account of the greater elasticity of the ribs and the more rounded shape of the chest, but the respiration often remains markedly accelerated (60-70), without dyspnœa or cyanosis, for several days after the injury.

The *treatment* is directed to the relief of symptoms, and consists in combating the shock, and securing rest in bed for several days.

Non-penetrating wounds are sometimes attended with subcutaneous emphysema, air being sucked into the wound by the movements of the chest. In other respects they present the same characters and call for the same treatment as similar wounds elsewhere.

Fracture of the Ribs.—Fracture of the ribs may be the result of direct or of indirect violence, or of muscular action. When due to a direct blow the rib gives way at the point struck, and, if the force be sufficiently severe, the fragments may be driven inwards and cause injury of the pleura, lungs, diaphragm

or liver. Although protected to some extent by the clavicle, the first rib may be broken by a severe downward blow driving that bone against it. Indirect violence, as by a crush between buffers or the passage of a wheel over the chest, is much the most frequent cause. Here the rib usually gives way towards one or other end—just in front of the angle being the commonest situation. It has been shown that the fracture is due to a force acting in the long axis of the rib and driving one segment past the other, and that the rib does not break, as is frequently stated, like an over-bent bow (E. H. Bennett). The ribs most frequently fractured are the fourth to the eighth. Owing to their shortness and mobility the floating ribs are not often fractured. It is comparatively rare for fracture to be limited to a single rib; as a rule two or more are broken.

Fracture due to a severe muscular effort, such as coughing or the straining of parturition, usually implicates the anterior portions of one or more of the ribs between the seventh and the eleventh, and is of the sub-periosteal variety.

Old age, wasting diseases, and those conditions which, like rickets or mollities ossium, lead to undue softness or brittleness of the bones, predispose to fracture. In certain types of insanity also, particularly in general paralytics, fracture of the ribs is specially prone to occur. In asylum practice such fractures may be wrongly attributed to roughness on the part of attendants.

Clinical Features.—The patient is often conscious of something giving way with a snap at the moment of fracture. There is a sharp, stabbing pain on coughing or sneezing, and at the end of inspiration on taking a deep breath. The respiration is usually shallow and rapid. Tenderness is elicited on pressing directly over the seat of fracture, or over the affected rib at a distance from the break, also on compressing the chest antero-posteriorly. When asked to point to the seat of pain the patient usually does so by placing the tip of his thumb over the spot—a gesture which is characteristic. Crepitus and mobility of the fragments cannot always be detected. As any displacement which may exist is usually inwards, the fracture is very rarely rendered compound by fragments piercing the skin. Union invariably occurs with a considerable amount of callus, which is most abundant on the inner aspect of the rib.

Fractures of the ribs may be complicated by subcutaneous emphysema and by other evidence of injury to the pleura and lung.

The *treatment* of uncomplicated cases of fracture consists in

confining the patient to bed, and in controlling, as far as possible, the movements of the affected side of the chest. A roller bandage may be firmly applied round the chest, or the injured side may be strapped. The strapping is applied in strips, each about a couple of inches wide, and long enough to extend a little more than half-way round the chest. The strips are applied across the line of the ribs in an imbricated manner from below upwards, each strip being fixed in position while the chest is in full expiration. The strapping should be covered by a roller bandage, and should be worn for about three weeks.

Fracture of the costal cartilages is usually the result of direct violence, such as a fall against a projecting object, but it may occur from muscular action. While it may be met with in young subjects, the ossification of the cartilages which occurs with advancing years renders it more common in the aged. The fifth to the eighth cartilages are those most frequently broken. Union takes place by osseous callus, usually without much deformity.

The symptoms closely resemble those of fractured rib, and the treatment is carried out on the same lines.

Dislocations of the ribs from the vertebræ and of the costal cartilages from the sternum are rare, and, as they result from severe forms of violence, they are usually complicated by internal injuries.

Fracture of the Sternum.—Considering its exposed position and the frequency with which it is subjected to violence, the sternum is comparatively seldom fractured. This is largely due to its mobility, and to the elasticity of the ribs and costal cartilages, which disperse the force and enable the sternum to yield before a blow. The injury is more common, however, than the statistics of fractures would appear to indicate. It often accompanies fractures of the spine, in many cases being unattended with displacement or other external evidence of injury, and, being overshadowed by the more serious lesion, escapes notice during life, and is only discovered on post-mortem examination.

The fracture may be due to a direct blow over the sternum, or to indirect violence, such as forcible and excessive bending of the back either forwards or backwards. In cases of forcible forward flexion the fracture is sometimes due to impact of the chin against the manubrium.

The most common situation of the fracture is at or just below the junction of the manubrium with the body of the bone, and the break may be transverse or slightly oblique. The

displacement varies considerably; in the majority of cases the upper fragment passes backwards and is overlapped by the lower; less frequently the opposite occurs (Fig. 57); and in some cases there is no displacement.

Clinical Features.—When the fragments are displaced and overlap one another, there is a marked prominence over the sternum, with extravasation of blood around it, and the projecting edge of the anterior fragment—usually the lower one—can be palpated through the skin. When no displacement exists, there may only be a slight staining of the skin from extravasated blood. As movement causes pain, the head and neck are inclined forward and held rigid, and as there is also pain on taking full breaths, the respiration is shallow and rapid. When there is marked displacement, or when extensive effusion of blood has taken place into the anterior mediastinum, the respiration may be seriously impeded. By the aid of the stethoscope crepitus may be recognised when the patient takes a deep breath.

FIG. 57.—Oblique Fracture of the Body of the Sternum, with backward and upward Displacement of the Lower Fragment. Result of forward flexion of the trunk. There was also a compression fracture of the lumbar vertebræ.

This fracture is usually complicated by injury to the internal organs. In all cases in which it has been produced by forcible bending of the trunk, the possibility of a coexisting fracture of the spine should be borne in mind.

The *treatment* consists in placing the patient at rest in bed with a firm pillow behind the back. When overlapping exists, an attempt should be made to reduce the deformity by bending the patient backward over a rounded object, such as a large firm cushion. If the displaced fragments continue to interfere with respiration after time has been allowed for any rent in the pleura to heal, the fracture may be exposed by incision, the displacement reduced, and the fragments wired in position. Union in the deformed position, however, is not attended with any serious inconvenience.

The *ensiform cartilage* may be separated from the body of

the sternum and driven inwards, causing pain, shortness of breath, and sometimes vomiting. It may be necessary to cut down and remove it.

Injuries of the Thoracic Viscera.

Any of the injuries of the chest wall above described may be complicated by lesions of the pleura, the lungs, the heart, or the diaphragm, and the coexistence of such internal injuries adds materially to the gravity of the condition. These internal complications may be associated with the escape into the pleural cavity of blood—*hæmothorax*, or of air—*pneumothorax;* with spitting of blood—*hæmoptysis*, or with the escape of air into the subcutaneous cellular tissue—*surgical emphysema.*

Hæmothorax may be due to the rupture of an intercostal or internal mammary artery, a laceration of the pleura, lung, or diaphragm, or a wound of the heart or great blood-vessels.

The clinical features are those of internal hæmorrhage, with evidence of fluid in the pleural cavity—in the shape of dulness, loss of the breath sounds and vocal fremitus—and of pressure on the lung. The patient becomes extremely restless, constantly changing his position; the breathing is rapid and laboured, and the pulse small, quick and irregular. If there is a penetrating wound, blood may escape each time the patient coughs or moves in bed. The effused blood does not coagulate, and in many cases is rapidly reabsorbed.

It sometimes happens that several days after an injury a considerable quantity of serous fluid is poured out into the pleural cavity, and this must not be mistaken for a hæmothorax.

Pneumothorax, or the escape of air into the pleural cavity, may be a result of laceration of the lung by a fragment of a broken rib, or by a foreign body, such as a knife-blade or a bullet. It has also resulted from puncture of the lung by an exploring needle.

There is at first severe pain in the chest, and the patient becomes restless, short of breath, and cyanosed. The lung is more or less collapsed, and the prominent physical signs are bulging of the intercostal spaces, hyper-resonance on percussion, loss of vocal fremitus, and faintness or absence of the breath sounds and of vocal resonance. The heart, the liver, or the spleen may be displaced.

As the air which enters the pleura is free of bacteria, septic complications seldom ensue. When the wound in the lung

heals, the air becomes absorbed, the lung expands again, and in the course of four or five days the symptoms disappear.

In many cases there is both air and blood in the pleural cavity, and the condition is known as *hæmo-pneumothorax*.

Hæmoptysis.—When spitting of blood follows upon an injury, it usually indicates a laceration of the lung substance, particularly when the blood appears immediately after the accident, is profuse in quantity, frothy from admixture with air, and of a bright red colour. Mere contusion of the lung, however, is sometimes followed by hæmoptysis.

Fig. 58.—Surgical Emphysema of neck, face, and arm, following severe crush of chest. The patient was a comparatively spare man.

(Mr. Hodsdon's case.)

Surgical emphysema, or the escape of air into the subcutaneous tissue, is frequently met with after injuries of the chest. It is more likely to follow small punctured wounds, especially if they be valvular, than extensive lacerated wounds. The air may escape directly into the tissues of the chest wall through a rent in the pleura caused by a fragment of broken rib or a pointed instrument. When the lung is contused while the pleura remains intact, the air may escape along the peribronchial connective tissue into the mediastinum, and thence into the root of the neck.

The air is pressed out of the lung during expiration, and it may spread over a wide area of the body (Fig. 58). The skin in the emphysematous area is slightly raised and tense, and a peculiar crepitant feeling is imparted to the fingers on palpation. Near the point where the air escapes the skin is sometimes discoloured by extravasated blood. In some cases the air is very rapidly reabsorbed, in others it remains in the tissues for a considerable time.

Injuries of the Pleura.—One or both layers of the pleura may be lacerated by a severe contusion of the chest wall without fracture or external wound. More frequently the tear is produced by a fragment of a broken rib. The injury may be followed by hæmothorax, pneumothorax, or subcutaneous emphysema. After such injuries there is frequently some hyperæmia of the pleura, attended with pain, friction sounds, and effusion of serous fluid

into the cavity—so-called "traumatic pleurisy." As a rule this fluid is reabsorbed, but if it is infected with bacteria, for example by tapping with an imperfectly sterilised instrument, it is liable to become purulent.

Penetrating wounds, produced, for instance, by pointed instruments or bullets, are more liable to be followed by septic complications. Extensive open wounds, such as result from machinery accidents, explosions, or from the patient being impaled on a railing, are attended with collapse of the lung.

Injuries of the Lung.—*Contusion and laceration* of the lung may occur without fracture or any other gross lesion of the chest wall, but as a rule they are associated with fracture of one or more of the ribs, and are often directly due to fragments of the broken bones being driven into the lung substance. In most cases the tear in the lung is of considerable extent, and as it implicates the visceral pleura, hæmothorax and pneumothorax almost always occur. Hæmoptysis is usually present, but may be absent even when the lung is severely lacerated. If the parietal pleura is ruptured, subcutaneous emphysema may develop over the chest wall, while, if the pleura is intact, it may appear at the root of the neck. Shock is always a prominent feature, and for some hours the patient may remain collapsed, cyanosed, almost pulseless, and apparently moribund, and then recover rapidly. In other cases death results from hæmorrhage and asphyxia due to blood entering the air-passages.

In *penetrating wounds* of the lung, caused, for example, by a stab or the entrance of a bullet, the patient presents the same general symptoms as in contusion and laceration. The open wound, however, permits of the escape of blood, which in many cases is very profuse. There is often considerable difficulty in determining whether the blood is coming from a divided intercostal or internal mammary artery or from the lung tissue itself. A consideration of the position of the external wound, the presence or absence of other symptoms of injury of the lung, and the way in which the blood escapes—whether in a continuous stream, or only when the patient coughs or moves—will aid in settling this point. The fact that the blood is mixed with air is not conclusive evidence that it comes from the lung, as the air may have been sucked into the chest by the respiratory movements. The risk of septic infection of the pleura is increased in penetrating wounds, and empyema, septic pneumonia, and gangrene of the lung are liable to ensue.

Treatment.—In all cases in which the thoracic viscera have been injured, the patient must be kept absolutely quiet in bed in

a warm room. He is usually most comfortable when propped up in a sitting or reclining position. Steps are taken to combat shock, but stimulation must be employed with discretion on account of the risk of increasing hæmorrhage. If the ribs or sternum be fractured, the treatment already described for these injuries may be employed, unless, as is often the case, the necessary manipulations are contra-indicated by the general condition of the patient.

The further treatment will depend upon the symptoms present. In many cases of *hæmothorax*, for example, no special treatment is required, as the bleeding does not continue long and the effused blood is rapidly reabsorbed; but if the effusion is causing dangerous pressure on the lung, it is advisable to withdraw some of it by aspiration. Care should be taken not to withdraw all the fluid from the chest, lest the rapid expansion of the lung should displace clots or open up the tear in the lung tissue and restart the bleeding. When the heart is embarrassed by the fluid in the pleura, marked benefit usually follows the withdrawal of ten or twelve ounces of blood from the systemic circulation by venesection. When the fluid is not reabsorbed by the end of a fortnight, it may be withdrawn by a fine aspirating needle. By this time the wound in the lung will have healed and the risk of renewed hæmorrhage be past. The occurrence of septic infection is an indication for incising the pleura, resecting portions of one or more ribs, and establishing drainage. *Pneumothorax* seldom calls for special treatment. When severe dyspnœa is present, relief may follow the escape of air through a trocar and cannula introduced into the pleura, provided the wound in the lung has healed. *Hæmoptysis* is treated by giving the patient ice to suck and by injecting ergotin or morphin. *Surgical emphysema* usually disappears spontaneously.

In the treatment of *penetrating wounds* the primary indications are to arrest external hæmorrhage, to purify the wound and remove any foreign bodies which may be present. When the bleeding takes place from a divided intercostal artery, it is usually necessary to enlarge the wound, or even to resect a portion of a rib, to enable the bleeding point to be secured. Sometimes the bleeding can be stopped by passing a ligature round the rib and its accompanying intercostal vessels. Desault's method of pushing a cul-de-sac of sterilised gauze between the ribs, packing it tightly with strips of lint or gauze, and then pulling upon it, so that the pad thus formed presses upon the bleeding vessel, is sometimes successful. Bleeding from the internal mammary artery can only be arrested by exposing the vessel and securing it by a

ligature either at or above the bleeding point. Below the level of the fifth intercostal space this operation is not possible. External hæmorrhage having its origin in the lung is exceedingly difficult to arrest by local measures. Plugging the pleural cavity with gauze is practically useless. If the hæmorrhage is serious, it may be justifiable to resect portions of one or more ribs and deal directly with the injured lung.

The opinions of authorities differ regarding the expediency of exploring penetrating wounds with the probe. The majority agree that except in the case of gun-shot wounds—and sometimes even in them—the probe should be avoided. The external wound should be purified, being enlarged if necessary for the purpose of removing portions of clothing, fragments of broken ribs, or other foreign bodies which may have been driven in. A drainage-tube or gauze packing is then introduced.

Bullets or other foreign bodies lodged in the lung may be extracted later, after having been accurately localised by aid of the Röntgen rays.

Hernia of the Lung.—In exceptional cases a portion of lung prolapses through a penetrating wound of the chest, either at the time of the accident or within a few hours of its occurrence. The protruded tissue is at first normal in appearance and crepitates when handled, but soon becomes congested and swollen, and, if tightly constricted at its base, is liable to slough. If seen early, an attempt should be made to reduce the prolapse, the opening through which it comes being enlarged, if necessary, and subsequently sutured to prevent recurrence. When the herniated portion has become gangrenous, it should be cut away after a ligature has been placed round its base.

Apart from an open wound, a piece of lung may become herniated through a weak portion of the chest wall, for example, the scar left after the healing of a penetrating wound. The most common situation for such a hernia is the anterior part of the lower intercostal spaces. It is usually the thin, mobile edge of the lung which is protruded, and it is furnished with a sac derived from the pleura. The condition is usually produced by coughing, or other form of violent expiratory effort, and it has been met with in trombone and cornet players. The swelling is soft, smooth and crepitant. It increases on expiration and diminishes on inspiration, yields a vesicular murmur on auscultation, and is resonant on percussion. Reduction is rarely possible without operation, and this is seldom called for, as the condition does not cause serious inconvenience. The swelling may be protected from external pressure by a suitable pad.

Surgical Diseases of the Chest.

Diseases of the Chest Wall.—*Pyogenic inflammations* of the ribs and sternum are comparatively rare. They are sometimes met with in association with compound fractures, in empyema, and in certain general infective diseases, particularly typhoid.

Cold Abscess and Sinuses of the Chest Wall.—The chest wall is a common seat of chronic abscess. It may originate from tuberculous disease of the ribs or sternum, from the parietal pleura, or less frequently from the breast or vertebral column. The abscess tends to burrow widely, and to come to the surface at a considerable distance from its seat of origin, hence the sinuses which result from the rupture of the abscess are long and tortuous. In some cases the abscess is of an hour-glass shape, one compartment bulging beneath the skin, the other against the parietal pleura, with a narrow communication between them crossing the intercostal space. Similarly in disease of the sternum, pus may accumulate on both aspects of the bone, and the larger accumulation may be found in the anterior mediastinum. These conditions are more common in adults than in children, there is little or no impairment of health, and the patient complains chiefly of the persistence of discharge and the breaking out of fresh sinuses.

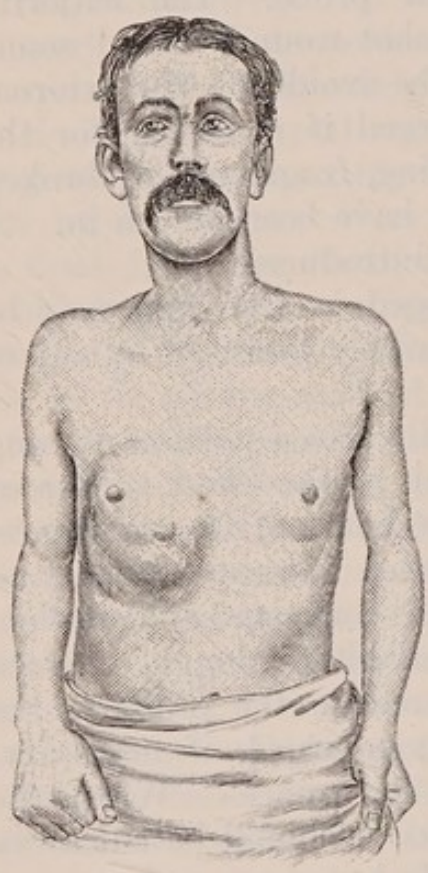

Fig. 59.—Cold Abscess of Chest Wall originating in Tuberculous Disease of Ribs.

The *treatment* of these conditions is carried out on the same lines as for similar affections elsewhere, but to ensure that all outlying foci of disease are removed, the operation must sometimes be very extensive, involving the resection of segments of several ribs or of portions of the sternum.

Syphilitic gummata are met with chiefly in the sternum, and require to be differentiated clinically from sarcoma and from tuberculous disease.

Tumours.—Simple tumours of the chest wall are comparatively rare, the subcutaneous lipoma being that most frequently

seen. Chondromata and osteomata are occasionally met with growing from the ribs and sternum.

Of primary *malignant* tumours the sarcoma and the chondro-sarcoma are the most common types. The former occurs most frequently in the sternum, attacking patients in middle life, and being very vascular and pulsatile, it is liable to be mistaken for a thoracic aneurysm eroding the bone. The chondro-sarcoma usually appears on the ribs near their junction with the cartilages, and is met with chiefly in early adult life. Both forms tend to spread towards the thoracic cavity and rapidly implicate the pleura, lungs, or diaphragm. They are comparatively painless, and may present few physical signs even when the thoracic viscera are extensively invaded. In some cases the position and extent of the growth may be recognised by skiagraphy, in others these points can only be determined by an exploratory incision.

Treatment.—If, on exploration, it is found that the parietal pleura alone is involved, the removal of the tumour may be undertaken. The soft parts are reflected by turning up a large U-shaped flap, and the ribs divided well beyond the limits of the growth, which is then rapidly removed. The lung usually collapses, but if the flap be accurately stitched in position so that the cavity is completely closed, it expands again in the course of a few hours.

The chest wall may be invaded secondarily by a sarcoma originating in the pleura or lung, or by a carcinoma of the breast.

Pleural Effusions.—An effusion into the pleural cavity may be serous, sero-fibrinous, or purulent, and the fluid may collect in a localised area of the pleural sac shut off by adhesions, or may occupy the whole cavity.

Serous and sero-fibrinous effusions are usually due to pleurisy, tuberculous disease of the pleura, or injuries of the chest. The fluid is usually reabsorbed, but when it persists, or exerts injurious pressure on the lung, or displaces the heart and impedes its action, it may be withdrawn.

This is done by means of the aspirator, the needle being inserted in the seventh or eighth interspace a little outside the angle of the scapula. Rapid withdrawal of the effusion is to be avoided, as it may induce bleeding from the inflamed and vascular pleura or lung tissue, may give rise to syncope from too sudden diminution of the intra-thoracic pressure, or may occasion acute œdema of the lung.

Hydrothorax is a condition in which, as a result of extreme feebleness of the circulation in advanced stages of cardiac, renal

and other diseases, a passive effusion of serous fluid takes place into the pleural cavity. It is usually bilateral, and is not attended with fever or pain. In malignant disease, in phthisis, and in certain bacterial diseases of the lungs, the fluid may be deeply stained with blood. Sometimes air escapes with the fluid, particularly in phthisical patients, and the condition is known as *hydro-pneumothorax*. When the lungs or heart become embarrassed by the pressure of the fluid, aspiration is called for.

Empyema.—The term empyema is applied to any collection of pus in the pleural cavity. For clinical purposes it is convenient to distinguish between the pyogenic and the tuberculous forms of the disease. In either form the pus may be localised by pleuritic adhesions (*encysted empyema*), or may be diffused throughout the pleural cavity.

Pyogenic Empyema.—In children, the condition is usually due to the serous effusion resulting from acute pleurisy or pneumonia becoming purulent, and the organism most frequently present is the pneumococcus. In adults the pus may originate in the same way, or may form in the course of such acute infective diseases as typhoid, scarlet fever or general pyæmia. Sometimes empyema results from infection of the effusion following an injury of the chest. The organisms vary with the primary disease, those most frequently found in pure culture being the streptococcus and the pneumococcus. Staphylococci, typhoid bacilli, and saprophytic organisms are less frequently found, and when present are usually associated with one another.

In another class of cases empyema results from the bursting into the pleura of an abscess formed in an adjacent viscus or cavity. As examples may be cited the rupture of an abscess or gangrenous area of the lung, a hepatic or subphrenic abscess, or an abscess of the chest wall. The organism present in these cases depends on the nature of the primary abscess, and the infection is usually a mixed one. The lung is usually collapsed, either partially or completely, and lies back in the vertebral groove, where it becomes bound down by pleuritic adhesions. Flaky lymph collects on the surface and, becoming organised, leads to great thickening of the pleura.

Clinical Features.—The clinical features of empyema vary considerably according to the nature and source of the infection, the age of the patient, and the duration of the disease. Certain symptoms, however, are common to all cases: these are immobility of the affected side of the chest, flattening and sometimes even bulging of the intercostal spaces, dulness on percussion, and

absence of the breath sounds and vocal fremitus. There is usually some dyspnœa, and the pulse is accelerated. The temperature is generally raised, rigors are common, and there is often profuse perspiration. The patient usually emaciates rapidly. The heart may be displaced by the fluid, particularly in left-sided empyema. The liver and spleen may also be displaced. As most of these symptoms may be caused by a serous effusion into the pleura, the diagnosis of empyema is seldom certain until pus is withdrawn by means of an exploring needle.

The *pneumococcal* form is the least serious, and is that most frequently met with in children as a sequel of pleuro-pneumonia. In early cases the effusion is usually thin and sero-purulent, but when the condition has lasted for some time, thick flakes of lymph form and adhere to the surface of the pleura. The pus is often localised to the lower portion of the chest and encysted by adhesions, and the physical signs above mentioned may not be prominent. In children well-marked bronchial breathing may be heard even in the presence of a large purulent effusion.

The *streptococcal* form is frequently met with after scarlet fever and influenza. It usually occurs in adults, and the prognosis is more serious than in the pneumococcal form. The pus contains thick flaky masses, and the pleura is liable to become thickened and form adhesions which divide the cavity into loculi.

The clinical features of empyemata due to *mixed infections* vary with the virulence of the organisms present.

If left untreated, empyema may prove fatal by the pressure exerted on the lungs or heart, by spread of the inflammation to the pericardium or peritoneum, or by general septic absorption. The pus may burst through the chest wall—usually at the outer edge of the pectoralis major in the fifth interspace—and so establish a sinus; or it may burrow through the lung into the bronchi, and so give rise to a purulent expectoration. Occasionally it burrows behind the attachments of the diaphragm, and may point in the lumbar, gluteal or iliac regions.

Treatment.—While repeated *aspiration* may occasionally effect a cure, especially in children and in the pneumococcal variety of the disease, it is not to be relied upon, and is only to be employed in exceptional circumstances, for example when, on account of extreme weakness, the patient is unable to stand a more severe operation.

The most satisfactory method of treatment is by *incision and resection of a portion of rib.* By this means efficient drainage can be secured, the cavity can be thoroughly explored,

septa can be broken down, and masses of lymph removed from the pleura. The operation should, wherever possible, be performed under local anæsthesia. Care should be taken that the free movement of the healthy side of the chest is in no way impeded, and that the patient's head is kept low to avoid the risk of syncope. The patient should lie flat on his back, the affected side of the chest projecting beyond the edge of the table. The presence and situation of the pus having been determined by an exploratory puncture, an incision is made down upon the rib to be resected. In cases of generalised empyema this will be the seventh, eighth or ninth rib in the mid- or posterior axillary line.

The incision, which is about two and a half inches long, is made in the long axis of the rib, and is carried down to the bone, dividing the periosteum freely. The skin should be pulled up slightly over the rib before the incision is made, to ensure that, when the chest falls in after withdrawal of the pus, the opening in the soft tissues will be opposite the opening through the rib. The periosteum is then raised from the bone all round with a curved separator, care being taken of the intercostal vessels which run in the groove on the under edge of the rib. With a suitable pair of rib forceps a portion of rib about an inch and a half long is resected. The pleura is opened by pushing a director through it, and the finger introduced through the opening thus made. Before the pus escapes, the cavity should be explored with the finger, to determine its extent and the condition of the lung. The pus is allowed to flow out slowly, in order that the heart and lungs may gradually accommodate themselves to the altered conditions of pressure within the thorax. It is not advisable to scrape the walls of the cavity, and irrigation is to be avoided unless the pus is very fœtid. When irrigation is employed, care must be taken that the outflow is as free as the inflow, in order that there may be no accumulation of fluid, which by its weight may impede the action of the heart and lungs. The fluid should be at the body temperature. Neglect of these precautions has led to serious and, in some cases, to fatal results.

Two large-sized rubber tubes are introduced side by side so that they project about a quarter of an inch within the parietal pleura. The advantage of two tubes is that the risk of blockage is diminished, and that, at the subsequent dressings, one tube can be removed at a time, the other keeping the wound open and facilitating reintroduction. The outer end of each tube should be transfixed with a large safety-pin to prevent its being sucked

into the pleura during inspiration. To ensure its remaining in position the tube may be fitted with a rubber flange at each end.

During the *after-treatment* the patient should lie on the affected side as much as possible to promote the escape of the discharge. To prevent the suction of air into the pleural cavity, the end of the tube should be covered with a piece of oiled-silk protective, which acts as a valve; or a syphon, or valvular tube may be employed. The expansion of the lung should be further encouraged by breathing exercises, or by the use of some wind instrument. The wound is dressed once or twice daily according to the amount of discharge. The tubes are left in as long as the discharge is purulent, and when it becomes serous they may be discarded. The sooner the patient can be got into the open air the better.

Bilateral Empyema.—Owing to the risk of collapse of the lung on opening the pleura in cases where no adhesions have formed, it is seldom advisable in cases of double empyema to operate on both sides at once. The safest procedure is to incise and drain one side, and at the same time to aspirate the other. In the course of a few days the second side may be operated upon.

Tuberculous Empyema.—This may originate as a serous effusion associated with tuberculous pleurisy, or from the rupture of a phthisical cavity into the pleura, in which case it is sometimes complicated by pneumothorax. The pus is usually encapsulated by the greatly thickened pleura, and the condition is practically a cold abscess.

When the condition is due to rupture of a phthisical cavity, the onset is acute, and is attended with constitutional disturbance; in other cases it is insidious, and the progress of the disease slow. The lung ultimately becomes collapsed from the pressure of the fluid. Operative treatment is much less satisfactory than in the pyogenic forms. The lung usually fails to expand, and the sinuses continue to discharge, and if septic infection occur, symptoms of hectic fever supervene and the patient gradually loses strength.

Old-Standing Empyema with Infected Sinuses.—It frequently happens, particularly in the tuberculous form in adults, that an empyema continues to discharge for many months, and constitutes what is known as a chronic empyema.

The obliteration of the cavity is effected, under ordinary conditions, partly by the expansion of the lung, so that the visceral and parietal pleuræ are brought into contact, partly by the elevation of the diaphragm and the displacement of the other

lung and the heart, and partly by falling in of the chest wall. The persistence of the discharge in most cases is due to the fact that these processes have not been sufficient to obliterate the cavity, and a space with rigid walls is left between the lung and the parietes. The pleura, which lines this space, is greatly thickened and is covered with granulation tissue. The pus escapes through one or more sinuses, either continuously or at intervals as it accumulates in the lower part of the cavity. In some cases the discharge is kept up by a drainage-tube or other foreign body having been inadvertently left in the pleural space.

While some patients are able to continue at work for many years in spite of a constant discharge, the majority succumb sooner or later to septic poisoning, hectic fever or waxy disease. To obviate these risks it is advisable to remedy the condition by removing a sufficient amount of the chest wall to enable the parietes to fall in and lead to the obliteration of the cavity—*thoracoplasty*. In the majority of cases this may be done by the Estländer-Schede operation, which consists in excising subperiosteally portions of several ribs, the number and length of the portions resected depending on the size and shape of the cavity to be obliterated. One or more incisions are made over the ribs to be dealt with, or a large horseshoe-shaped musculocutaneous flap, extending from the fourth to the ninth or tenth rib, is turned up, and the exposed ribs resected. The periosteum, the intercostal muscles, and the thickened parietal pleura are then removed, and the cavity packed with gauze before the flap is replaced. When the lung is firmly bound down in the vertebral groove, the procedure known as "decortication of the lung" may be carried out as an addition to thoracoplasty. This consists in peeling off the thickened pleura from the surface of the lung (Delorme).

Pulmonary Cavities.—Under this heading we may for convenience include pulmonary abscess, gangrene of the lung, bronchiectasis, phthisical cavities, and hydatid cysts.

The *diagnosis* is always a matter of difficulty, and in many cases it is all but impossible to determine the exact position and extent of a cavity. The physical signs are often misleading, and Tuffier has pointed out that, if we trust to stethoscopic evidence, we are apt to place lesions above the level of the root of the lung too high, and lesions below that level too low. The nature of the expectoration should be noted, but it is to be borne in mind that the quantity expectorated bears no constant relation to the size of the cavity. An exploratory puncture

made with an aspirator needle is the most certain diagnostic measure we possess. The X-rays have been found useful in a certain proportion of cases in determining the site, extent and number of cavities in the lung.

Pneumotomy.—As the operative procedure is practically the same for all forms of pulmonary cavities, it may be described now. Local anæsthesia is to be preferred. The operation consists in exposing the area of lung in which the cavity is believed to lie, by an incision sufficiently large to permit of the subperiosteal resection of about three inches of two or more ribs. If no adhesions exist around the area thus exposed, the pleural cavity must be shut off before incising the lung. This is done by passing, with a fully curved Hagedorn needle, a ring of sutures through the lung substance and parietal pleura so as to bring the two layers of the pleura into apposition. The lung is then incised with a knife or thermo-cautery, the opening dilated with dressing forceps, the cavity evacuated, and drainage tubes inserted. Irrigation is not advisable.

Pulmonary abscess when acute is usually a sequela of septic pneumonia. Chronic abscess may be due to the bursting of an empyema or of a hepatic abscess into the lung. The result of pneumotomy in such cases is on the whole satisfactory. Pyæmic abscesses are usually multiple, and therefore not amenable to surgical treatment.

Gangrene of the lung usually results from acute septic pneumonia, pulmonary apoplexy, or embolism of the terminal branches of the pulmonary artery. The gangrenous area is usually near the base, and the pleural cavity is generally protected by adhesions over or around it. The results of operation are satisfactory, particularly in cases following pneumonia.

Bronchiectasis consists in a dilatation of the bronchial tubes resulting in the formation of fusiform or saccular cavities in the lung, in which secretions accumulate and decompose. It is rarely amenable to operation.

Phthisical Cavities.—As incision and drainage of a tuberculous abscess in the lung is no more likely to result in cure than similar treatment of a cold abscess elsewhere, it is not to be wondered at that so far the results of operation in this disease have been disappointing. Limited cavities in the apex of the lung have been treated by resection of portions of the overlying ribs to admit of the walls of the cavity falling in.

For **hydatid cysts** of the lung, incision and drainage have proved highly satisfactory.

Pneumonectomy.—Operations for the removal of tuberculous

areas in the lung or of malignant tumours have been unsuccessful in the majority of cases in which they have been attempted.

The Heart.

Injuries.—In considering wounds of the heart it is necessary to distinguish between those which implicate only the walls of the organ and those which penetrate its cavities. Non-penetrating wounds are usually caused by stabs, or by a sharp fragment of a broken rib being driven into the heart. Penetrating wounds may also result from stabs, but are most frequently due to gun-shot injuries, and the bullet may either pass right through the heart or lodge in its substance. Needles sometimes pass into the heart, either through the chest wall or from the œsophagus, without doing much damage, and they may lodge and remain for long in the substance of the organ without causing any symptoms.

Owing to the comparative thinness of the walls of the auricles, wounds of these cavities are more speedily fatal than those of the ventricles, as the hæmorrhage takes place much more rapidly. From its exposed position the right ventricle is the cavity most frequently injured.

Clinical Features.—Penetrating wounds usually prove rapidly fatal from hæmorrhage. The blood may escape in great quantity from the external wound, or may fill up the pericardium and arrest the heart by pressing upon it. In cases which are not immediately fatal the patient is profoundly collapsed, shows extreme pallor, and is often agitated and restless. Dyspnœa and other signs of "air hunger" are present. The heart's action is tumultuous, irregular and feeble, and on auscultation, whizzing, blowing, and other abnormal sounds may be heard. There may be signs of effusion of blood into the pericardium, or into the left pleura, as this cavity is often traversed by the wound.

If the bleeding is arrested, recovery may take place by organisation of a clot in the wound, or by the formation of adhesions with the pericardium. In a considerable number of recorded cases, death has occurred suddenly in from ten to fourteen days after the injury, from softening and displacement of occluding clots, either as a result of septic complications, or from the patient exerting himself too soon. In other cases septic pericarditis has been the cause of death.

Treatment.—The primary indication is to reduce the force of the heart's action as much as possible, in order that hæmorrhage may cease and a reparative clot form in the wound. To this

end absolute rest, bodily and mental, must be ensured, and morphin may be freely given if necessary. Exploration of the wound by finger or probe must be avoided, lest clots be disturbed and the bleeding start afresh. Low diet is given and thirst is relieved by enemata. Within recent years numerous operations have been performed with the object of suturing wounds of the heart, with results which are distinctly encouraging. The heart is exposed by resecting the fourth, fifth and sixth costal cartilages, and the wound sutured with fine catgut, care being taken not to perforate the whole thickness of the wall, as hæmorrhage is apt to take place along the tracks of the stitches. The pericardium is sutured after having been emptied of clots. The external wound is drained. Needles embedded in the wall of the heart may be extracted after having been localised by the X-rays.

Pericardial Effusions.—When a *serous* effusion is exerting dangerous pressure on the heart and impeding its action, relief may be given by tapping the pericardium. A fine exploratory needle is introduced through the fifth interspace on the left side, about an inch from the sternum to avoid the pleura and internal mammary artery. When there is an excessive amount of fluid present it is not advisable to withdraw it all at one time.

Purulent effusions are best treated by incision and drainage. The embarrassed condition of the heart usually forbids the use of a general anæsthetic. Before beginning the operation the heart may be relieved by tapping the pericardium. An incision is then made in the fourth or fifth left interspace, and, if necessary, a portion of one of the adjacent costal cartilages is resected. The pericardium is opened and a drainage tube inserted.

Care must be taken to avoid injuring the left pleura, which overlaps the pericardium to its outer side. The internal mammary artery is also liable to be injured in separating the costal cartilage.

The Diaphragm.

Injuries.—*Open wounds* are usually the result of gun-shot injuries, stabs, or sabre cuts. As the lung does not extend as far down as the pleura, or the pleura as far as the diaphragm, it is possible for the diaphragm to be wounded alone, or along with the pleura, while the lung escapes.

Subcutaneous rupture is rare. It usually occurs on the left side, and is produced by a sudden and great increase of the intra-abdominal pressure, as, for example, when a patient is crushed under a heavy weight, or is making violent muscular

efforts in vomiting or during parturition. The jagged end of a fractured rib, and an unskilfully manipulated œsophageal bougie, have also been known to cause this injury.

Clinical Features.—So far as the symptoms of injury to the diaphragm can be dissociated from those of the concomitant visceral lesions, they are localised pain, hæmorrhage and shock. The pain is aggravated on deep inspiration or coughing, and causes the patient to restrain the action of the muscle as far as possible. Risus sardonicus, which is supposed to be peculiarly related to morbid conditions affecting the diaphragm, may be present. In many cases the abdominal viscera are displaced, and clinical evidence of their presence in the thoracic cavity is forthcoming. When the alimentary canal is ruptured, septic complications ensue.

As this muscle never is, and never can be at rest, its wounds either fail to close, or heal with a thin, weak and stretchable cicatrix, which readily favours the formation of a hernial protrusion. When bowel is prolapsed, it is liable to become strangulated either at the time of the accident or later. In many cases the diagnosis is overlooked, and the lesion is only discovered after death.

The *treatment* is covered by that of the associated lesions of the lung, pleura, stomach, or other organs. Suture of the rent from the thoracic side has been practised.

Diaphragmatic hernia is described on p. 420.

Diaphragmatic pleurisy may closely simulate the onset of acute perforative peritonitis and other abdominal conditions—particularly appendicitis.

Perforations of the diaphragm may take place either from the thoracic or abdominal side. An empyema, suppurative pericarditis or mediastinitis, for example, may burst through the diaphragm and infect the peritoneal cavity or the retroperitoneal connective tissue. When adhesions have formed, the pus may form a subphrenic abscess, or may burst directly into the alimentary canal. On the other hand, a subphrenic abscess may burst into the pleura, the pericardium, or the mediastinum.

The Mediastina—**Mediastinitis.**—Acute suppurative inflammation of the cellular tissue of the mediastina may be due to infection from a suppurating mediastinal or bronchial gland, to infected wounds of the chest wall, or to the spread of an abscess from adjacent parts, for example, a deep cervical abscess or an empyema. The diagnosis is always extremely difficult and the condition is seldom amenable to surgical treatment.

Masses of tuberculous or malignant bronchial glands are

liable to press upon the air-passages and recurrent laryngeal nerve, particularly in children, and to give rise to difficulty in breathing, hoarseness and a crowing cough. Such glands may also press upon the œsophagus and interfere with swallowing, or they may, after forming adhesions with its walls, drag upon it and give rise to one form of "traction diverticulum."

CHAPTER XXI.

THE BREAST.

Surgical Anatomy — Clinical examination — Malformations: *Amazia; Micromazia; Polymazia; Diffuse hypertrophy; Gynecomazia*— Affections of nipple and areola: *Paget's disease*—Inflammatory affections: *Physiological engorgement; Puerperal mastitis and mammary abscess—Varieties of abscess; Chronic mastitis—Varieties; Tuberculosis; Actinomycosis* — Neuralgia — Cysts: *Galactocele; Involution cysts; Hydatid cysts*—Tumours: *Non-malignant: Fibro-adenoma — Duct papilloma — Malignant:* Sarcoma — Carcinoma: *Scirrhus; Atrophic; Colloid; Adeno-carcinoma; Acute cancer.*

Surgical Anatomy.—The breast of the nulliparous female may be taken as the type. It is made up of (1) the *parenchyma* or gland tissue proper; (2) the *stroma* or connective tissue framework, which supports the parenchyma, and in which the blood-vessels, lymphatics and nerves ramify; and (3) the mammary *fat* which lies in and around the stroma. Collectively these elements form a gland which consists of a central part—the *corpus mammæ*, and a number of *peripheral processes*, which radiate in all directions into the surrounding adipose tissue. On the superficial aspect of the breast some of these processes pass, in the *suspensory ligaments of Cooper*, to the deeper layer of the corium; while on the deep aspect others pass into the pectoral fascia, and sometimes even into the pectoral muscle.

The mammary gland lies embedded in the superficial fascia of the chest wall, and extends vertically from the lower border of the second rib to the lower border of the sixth costal cartilage; and horizontally from the edge of the sternum to the mid-axillary line. It overlies portions of the pectoralis major, pectoralis minor, serratus magnus, and external oblique muscles, from which it is separated by that portion of the deep fascia of the thorax known as the *pectoral fascia*. From the upper and outer quadrant a process of mammary tissue—referred to by Spence as the "axillary tail"—passes into the axilla under cover of the pectoralis major as far as the third rib.

The milk ducts open on the summit of the nipple. The nipple is surrounded by the dark-coloured areola, in which are numerous small rudimentary milk glands. During pregnancy these glands become enlarged and form prominences on the areola.

The *blood-supply* of the breast is derived chiefly from the long thoracic or external mammary branch of the axillary artery, and from the second,

third, and fourth perforating branches of the internal mammary. The venous blood returns to the axillary, cephalic, and external jugular veins.

The *nerve-supply* to the skin over the breast is derived from the descending cutaneous branches of the cervical plexus, and the lateral and anterior cutaneous branches of the second to the sixth intercostal nerves. The gland itself is supplied with sensation through the perforating terminal branches of the fourth, fifth, and sixth intercostals.

A knowledge of the *lymphatic system* of the breast is of great importance in relation to the question of the spread of cancer. The anastomosis between the different sets of lymphatic vessels in the breast being very free, malignant disease in any part of the mamma is readily disseminated throughout the gland and to surrounding structures. According to Stiles the cutaneous lymphatics anastomose with the trunks which accompany the main lactiferous ducts in a large lymphatic plexus under the areola—the subareolar plexus of Sappey. The lymphatics of the subcutaneous fat which overlies the mamma occupy for the most part the ligaments of Cooper, and receive lymph, on the one hand from the deeper layers of the true skin, and on the other from the lymphatics in the more superficial parts of the breast. Then again the lymphatics of the posterior part of the gland and of the pectoral fascia communicate with one another. Eventually the lymph passes by large efferent trunks through the deep fascia to the lymphatic glands, the most important of which are situated in the axilla. These glands are arranged in groups: (1) the *pectoral* group, lying under the edge of the pectoralis major in the line of the long thoracic artery; (2) the *axillary* group, accompanying the axillary vessels; (3) the *subscapular* group, lying far back in the axilla with the vessels of the same name; (4) the *infra-clavicular* group, lying in relation to the costo-coracoid membrane; and (5) the *supra-clavicular* group, lying above the clavicle. Some of the efferent lymphatics from the inner and upper part of the breast pass through the chest wall and open into (6) the *sternal glands* lying alongside the internal mammary artery.

Clinical Examination of the Breast.—To permit of a thorough examination of the breast, the patient should be seated on a chair with the whole thorax exposed. After inspecting the breasts, and noting any asymmetry or other abnormal appearance which may be present, the parts are examined by palpation, the surgeon standing either by the side of the patient or behind her. First the condition of the skin may be noted, to determine if there be any abnormal attachment to the breast, or to any tumour which may be present. Dimpling of the skin is in some cases visible to the eye, but in others can only be detected on an attempt being made to pinch up or to stretch the skin. The condition of the nipple must also be noted to see if it be unduly adherent to the breast or retracted. As the two nipples are often not equally prominent, inquiry should always be made of the patient as to the history and duration of any apparent retraction which may be observed. The breast should then be palpated, its size, disposition, and consistence being noted, first by grasping it between the fingers, and then by pressing firmly against it with the flat of the hand. Should any tumour be detected, its size, shape, and consistence must be determined, as well as its relation to the skin, the nipple, and the gland tissue. The arm should be abducted to a right angle in order to put the pectoral muscle on the stretch, and the mobility of the breast on the chest wall tested, by moving the gland first from side to side, and then

up and down. At the same time it may be observed whether the tumour can be moved independently of the breast or only with it. The consistence of a tumour in the breast is best determined by pressing it back against the chest wall with the flat of the hand while the patient's arm is abducted. The condition of the various groups of lymphatic glands in the axilla and above the clavicle should next be noted.

Malformations.

Complete absence of one or both breasts—*amazia*—occasionally occurs. It is usually met with in males, and is generally unilateral, affecting most frequently the left side. The sternal fibres of the pectoralis major and the subjacent portion of the chest wall are often imperfectly developed in these cases, and sometimes the whole upper extremity on the affected side is defective. Congenital absence of the nipple—*athelia*—is more common than amazia, and is usually bilateral.

The condition known as *micromazia*, in which the infantile type of mamma persists after puberty, is also more common than amazia. It is usually associated with a deficiency in the organs of generation, as well as in the pectoral muscles and chest wall.

The occurrence of supernumerary breasts—*polymazia* or *polymastia*—or of supernumerary nipples—*polythelia*—is by no means uncommon. These accessory structures are usually situated on the chest wall, the upper part of the abdominal wall, or in the axillæ, but they have been met with on the shoulder, the buttock, the thigh, and in other extraordinary positions. As a rule they are functionless. Removal is only called for when the supernumerary organ, for example an axillary mamma, gives rise to pain or discomfort when in a state of physiological engorgement.

Diffuse hypertrophy of the breast is comparatively seldom met with in this country, but is not uncommon in the tropics. The enlargement, which is due chiefly to an increased development of the fibrous and fatty elements of the breast, and to a less extent of the glandular tissue, is almost always bilateral, and usually manifests itself either at the age of puberty or in the early months of pregnancy. Sometimes the breasts attain an enormous size, hanging down over the abdomen, and in some cases even reaching to the thighs. Pain is seldom a prominent feature, but the patient may be seriously inconvenienced by the size and weight of the organs. As a rule the glands are functionless. Sometimes the hypertrophy of the mammæ is associated with lymphatic elephantiasis of the legs.

In the early stages, and particularly when it is unilateral, this condition is liable to be mistaken for a cystic fibro-adenoma or a rapidly growing sarcoma. In most cases the only available treatment is amputation of the breasts. An interval should be allowed to elapse between the operations on the two breasts, as the operation is a severe one, and is usually attended with considerable bleeding. The larger breast should be removed first, as it has been observed that after the operation the other breast sometimes undergoes atrophy. In cases where operation is impracticable, the treatment consists in administering iodides, putting the patient on a spare and dry diet, and supporting the breasts by suitable bandages.

The term *gynecomazia* or *gynecomastia* is applied to a hypertrophy of the mamma which is occasionally met with in the male. The condition may be unilateral or bilateral, and affects chiefly the stroma of the gland. The breasts seldom become larger than an ordinary nulliparous female breast. It is frequently associated with congenital malformations of the sexual organs. If the deformity is marked, the mammæ may be excised.

Affections of the Nipple and Areola.

One or both nipples may be **abnormally small or depressed**, either congenitally or as a result of cicatricial contraction, with the result that suckling is rendered difficult, and the irritation produced by the efforts of the child causes cracks and fissures to form, and so predisposes to mastitis. As a rule the nipple can be withdrawn sufficiently to enable it to be used for nursing, by systematic gentle traction and the use of a breast pump.

Cracks and fissures of the nipple are of importance from the fact that they are often the starting-point of acute mastitis and mammary abscess. They usually develop during lactation, as a result of injury inflicted by the child while suckling, or in association with eczema of the areola. On account of the soft and delicate nature of the areolar skin, the moist condition of the parts, and the repeated irritation to which they are subjected, these fissures are prevented from healing, and are liable to become infected with micro-organisms, which are so abundant in the cutaneous glands in this region. The infection spreads along the lymphatics to the breast, setting up acute mastitis, which may end in suppuration. The pain caused by suckling is frequently so severe as to cause the patient to desist from nursing, with the result that the gland becomes engorged and the tendency to inflammation is thereby increased.

Fissures can usually be prevented by adopting *prophylactic measures* during the later months of pregnancy. Care must be taken, for example, that the corsets do not press unduly on the parts; and the nipple, if retracted, should be gradually withdrawn by traction or by suction with a breast pump. It must be kept scrupulously clean by frequent washing with a mild antiseptic lotion, and after being dried should be bathed with methylated spirit or eau-de-Cologne. During lactation the parts should be washed with boracic lotion after nursing, dried, and dusted with boracic powder. If the fissures are very painful, they may be painted with cocain, and an artificial nipple should be worn during suckling. Any inflammatory condition of the child's mouth should be corrected, lest it prove a source of infection of the nipple.

Syphilitic affections of the nipple are comparatively rare. A *primary chancre* is occasionally met with on the nipple or areola of a healthy woman who has acted as wet-nurse to a syphilitic infant. One or both nipples may be affected, and it is not uncommon for the sores to be multiple. The chancre is seldom typical, and varies from a shallow fissure to a large indurated and ulcerated surface. The axillary glands are enlarged, hard, and shotty, and other evidence of syphilitic infection is soon manifest.

Paget's Disease of the Nipple and Areola.—In 1874 Paget first described a peculiar inflammatory affection of the skin of the nipple and areola, which, in the great majority of cases, is followed by the development of cancer in the breast, the tumour being of the ordinary scirrhus variety. The disease is to be regarded as a superficial carcinoma of the skin. In the majority of cases it begins around the orifices of the milk ducts as a bright red excoriation, which gradually spreads over the areola and on to the skin of the breast, till it forms a florid patch which, in Paget's words, has an appearance "like that of an acute balanitis." The epidermis covering this patch desquamates, the part becoming red and thin, and discharging a yellow, viscid fluid, which dries on the surface and forms scabs and crusts, particularly towards the edges of the patch. The affected area is slightly raised and indurated, and its sinuous margin is sharply defined. When picked up between the fingers and thumb it has a peculiar parchment-like feeling. The nipple also is indurated, and may be retracted or even destroyed by ulceration. In some cases the cancerous condition of the skin is due to spread along the ducts from a tumour in the substance of the breast.

The disease is usually met with in women between fifty and

sixty. It runs a slow course, there is no vesication or itching as in ordinary eczema, but the condition is attended with tingling or burning pain.

The *treatment* is the same as for cancer of the breast—complete removal of the gland and its lymphatic connections.

Other *tumours* of the nipple, such as papillomata, angiomata, epitheliomata and sarcomata have been observed, but they are rare.

Inflammatory Affections of the Breast.

It is necessary to distinguish between those morbid conditions of the breast which result merely from physiological engorgement of the gland, and those which are truly inflammatory in nature.

Physiological engorgement of the breast frequently occurs in newly-born infants—so-called *mastitis neonatorum*—as a result of the disintegration of certain of the epithelial elements from which the breast is developed. The gland becomes swollen, firm and tender, and a few drops of milky fluid may be expressed from the nipple. It may happen that the nurse, acting upon the popular belief that it is necessary under these conditions to "break the nipple strings" by vigorous rubbing, irritates and infects the parts, with the result that suppurative inflammation is set up.

About the time of *puberty* also, and particularly in females, one or both breasts may become engorged, tense and painful—*mastitis of adolescents*. A similar condition exists during *pregnancy*. An extreme degree of physiological engorgement may also occur during *lactation*, when, for example, the milk is retained owing to imperfect formation of the nipples, blocking of the ducts, or failure of the child to suck—*milk engorgement*.

The breast becomes swollen and painful, the skin over it is congested, and the superficial veins prominent. On palpation it is found to be firm, knotty and tender. The temperature may be raised to 100° or 101° F.

These conditions are only related to inflammation as predisposing factors, and in so far as they furnish a suitable nidus for the development of any organisms which may gain access to the breast. The clinical features of true inflammation are absent, and only appear if bacterial infection ensues.

In puerperal cases the most important step in treatment is the withdrawal of the milk, which may be effected by the aid of a breast pump if the child is unable to suckle. The child

should be weaned, and the further secretion of milk arrested by the administration of saline purgatives and of potassium iodide and belladonna. The breast should be protected by a wool dressing and supported by an ascending spica bandage, the arm on the affected side being supported. If suppuration occurs the abscess must be opened and drained.

It occasionally happens that an acute congestion of the breast occurs in association with an attack of mumps or of one of the other acute infective diseases. The condition is usually transient, and seldom ends in suppuration.

Puerperal Mastitis and Mammary Abscess.—In a considerable proportion of cases of acute physiological engorgement of the breast occurring in puerperal women, a suppurative inflammation supervenes, and ends in the production of a mammary abscess. This usually occurs in women between the ages of twenty and thirty, and as a rule during the first six weeks of lactation. Infection usually takes place through a crack or fissure of the nipple, and the organisms are derived either from the surrounding skin or from the mouth of the suckling, and gain access to the breast tissue by way of the lymphatics or along the milk ducts. The staphylococcus aureus is the organism most frequently found.

The abscess may form under the areola—*pre-mammary abscess;* in the substance of the breast—*intra-mammary abscess;* or in the areolar tissue between the breast and the pectoral muscle—*retro-mammary abscess.*

Clinical Features.—A *pre-mammary abscess* may begin as a superficial cellulitis, or as a suppurative inflammation of a sebaceous gland or mammary lobule under the areola. Pus forms rapidly, often with comparatively little pain or constitutional disturbance, and the abscess soon bursts through the skin.

The *intra-mammary abscess* is the form most frequently met with. For one or two days the patient complains that a particular part of the breast feels hot, tense and tender, and that on attempting to use the organ for nursing she has severe lancinating pain in it. Eventually the pain becomes constant, and assumes a throbbing character. The temperature may rise to 102° or 103° F., and there is usually a feeling of chilliness or even a rigor.

At first there is a diffuse redness over the breast, and a deep-seated swelling, which is uniformly firm and tense, may be recognised. With the onset of suppuration the redness becomes more dusky, and over the seat of the abscess the swelling becomes soft and more prominent, until at last fluctuation can

be detected. In the deeper parts of the breast the pus may burrow in various directions and form a multiloculated abscess cavity. Finally the pus finds its way to the surface, usually in the region of the areola, where the skin becomes thin and glazed and ultimately gives way.

Occasionally both breasts are affected, either simultaneously or more frequently one after the other.

The retro-mammary abscess is usually of the chronic variety, and results from tuberculous disease of the ribs, from suppuration in a hæmatoma, or from the bursting of an empyema through the chest wall. The whole breast is pushed bodily forward by the pus behind it, and stands out in bold relief from the chest, and fluctuation can be detected towards the periphery of the gland. If left to point, the pus usually reaches the surface at the most dependent part of the periphery of the breast, the situation varying, of course, with the attitude assumed by the patient. The commonest situation is at the lower and outer part of the breast.

Treatment.—A *pre-mammary* abscess should be opened by a small incision, radiating from the nipple, and drained by means of a few strands of iodoform worsted.

As soon as an *intra-mammary* abscess can be diagnosed with certainty, it also should be incised. As the communication between the deeper part of the abscess and the part which points on the surface is often a long narrow channel, the whole abscess has roughly the shape of a "collar-stud." It is not sufficient, therefore, merely to open the superficial part of the abscess. The whole cavity should be freely incised—the incisions always radiating from the nipple, to avoid cutting across the ducts—and counter-openings should be made, if necessary, to ensure efficient drainage. The finger should be passed into the abscess and the septa broken down. After clearing out all pus and sloughs, glass or rubber drainage tubes are inserted. These should be removed as early as possible to prevent the formation of persistent sinuses. If bleeding is troublesome, the wound should be packed. If sinuses have formed, they should be slit up, scraped, purified with pure carbolic acid, and packed with iodoform worsted. In some cases the breast is so completely disorganised that complete removal is the only efficient means of treatment.

A *retro-mammary* abscess should be opened at the lower and outer part of the breast.

Chronic Non-tuberculous Abscess.—A chronic non-tuberculous abscess is occasionally met with in the breast of married

women past middle life, and is liable to be mistaken for a cyst or a new growth.

Such an abscess may be due to infection of a hæmatoma resulting from injury, to suppuration in a retention cyst, or to recrudescence of a former acute abscess—*residual abscess.* The organisms may be introduced either by way of the lymphatics or through the blood-stream.

Clinically, it forms a firm elastic swelling in the substance of the breast, and, the wall of the abscess being thick and fibrous, fluctuation may not be detectable. There is slight tenderness on pressure, and sometimes a throbbing pain. The skin over the abscess may be œdematous, the nipple is often retracted, and a purulent fluid may sometimes be expressed from it. The axillary glands are usually enlarged and tender.

The *treatment* consists in cutting down upon the abscess, and if possible dissecting it out entire. If this be impossible, it is opened, the walls scraped, and the cavity packed with iodoform worsted.

Chronic Mastitis.—The term **chronic interstitial mastitis** is applied to an affection of the breast which is of the nature of a fibrosis, and which primarily implicates the stroma of the gland. The inter-lobular and inter-acinous connective tissue becomes densely sclerosed, and the fatty tissue and parenchyma are largely replaced by fibrous tissue. There is little or no proliferation of the epithelial elements, and there is no tendency to the formation of cysts.

This form of the disease is comparatively rare, and it runs a very chronic course. It is met with in married, as well as in single women, usually about the time of the menopause. As a rule only one breast is affected, and there is no history of a definite injury or of a previous inflammation. For a time—it may be several months, or even two or three years—the whole breast gradually increases in size and becomes firmer than normal, without forming adhesions to the pectoral fascia or to the overlying skin. Eventually it ceases to grow, and the gland undergoes cicatricial atrophy, causing retraction of the nipple and puckering of the skin by dragging on the ducts and suspensory ligaments of Cooper. The condition is usually painless, and the axillary glands are not enlarged. It is very liable to be mistaken for a diffuse carcinoma, and in many cases the differential diagnosis is all but impossible without the evidence afforded by an exploratory incision.

Treatment.—In the early stages the application of a belladonna plaster or of the liniment of the iodide of potassium

sometimes proves useful. Mercurial inunction and the internal administration of iodides should be tried when there is reason to suspect a syphilitic element. When these means are ineffectual, an exploratory incision should be made, and if the diagnosis remains uncertain, the gland should be excised.

Circumscribed Chronic Interstitial Mastitis.—It is not uncommon to find a localised patch of chronically indurated breast tissue in women who have prolonged suckling unduly, or who have sustained some injury to the mamma. A similar condition may be met with after an abscess has been evacuated, after suppuration in an operation wound, or when a foreign body, such as a needle, is embedded in the breast.

The importance of recognising this condition lies in the fact that it is very liable to be mistaken for a scirrhous carcinoma. The differential diagnosis is always difficult, and in many cases can only be made by exploratory incision. The points upon which we may rely are that in chronic interstitial mastitis the nodule is tender on pressure, is less hard and dense than a scirrhous tumour, and its outline is not so well defined. The swelling can be recognised best by picking it up between the fingers and thumb; when it is pressed firmly against the chest wall with the flat of the hand it is less distinct and appears to be lost in the rest of the mammary tissue. It can be lifted up from the subjacent pectoral fascia, and, except when it results from an old abscess, is not attached to the skin. A scirrhous tumour on the other hand is densely hard, has a well-defined outline, and these points are best appreciated when the mass is pressed against the chest wall. It is seldom tender on pressure, and the skin is usually tacked down to the tumour.

In both conditions the nipple may or may not be retracted, and the axillary glands may or may not be enlarged.

Chronic lobular mastitis affects chiefly the parenchyma, that is, the acini and ducts of the gland, but the inter-acinous connective tissue is also implicated to some extent. As the disease progresses, proliferative and degenerative changes take place in the epithelial elements, with the result that numerous cysts form in the parenchyma—hence the term *multiple cystic disease*, which is sometimes applied to this condition. In some cases small fibro-adenomatous nodules form in the inter-acinous connective tissue as a result of hyperplasia and sclerosis. Small warty growths frequently project into the interior of the cysts.

The lobular form of mastitis is more common than the interstitial. It usually occurs in women between the ages of thirty and forty who have not borne children, and affects both

breasts either simultaneously or one after the other. There may be a history of dysmenorrhœa, or of some ovarian or uterine disturbance, but there is seldom any definite local cause discoverable.

At first the patient merely experiences a sensation of fulness and uneasiness in the breast, later there are stinging pains which shoot through towards the shoulder or down the arm, and the breast becomes tender to the touch. These symptoms are worst during menstruation. On palpation the breast tissue is felt to be firmer than normal, and to have a characteristically coarse or "knotty" feeling, which is best recognised by grasping the swelling between the fingers and thumb. If the breast be pressed against the chest wall the swelling becomes less evident. One or more of the small cysts may enlarge sufficiently to form a definite tumour or lump. The breast is freely movable on the pectoral fascia and the skin is not implicated. The axillary glands may be enlarged and tender.

The induration may disappear when the parenchyma atrophies at the menopause, but usually the enlargement of one or more cysts necessitates operative interference. In exceptional cases adeno-carcinoma supervenes.

Treatment.—As the patient is usually rendered anxious by the fear that the disease is cancerous, the first step in treatment is to reassure her as to its innocent character. The general health should be improved and any pelvic trouble attended to. In the early stages the application of a belladonna plaster and a supporting bandage is useful in soothing the part and in preventing the patient handling it. When a cyst enlarges sufficiently to form a palpable tumour, it should be removed by excising a wedge of the mammary tissue through an incision which radiates from the nipple. When several cysts are present, and particularly if on opening these they are found to contain intra-cystic growths, the whole breast should be excised, but it is not necessary to clear out the axillary lymphatics.

Tuberculosis of the Breast.—Tuberculous disease of the breast is rare. It is occasionally met with in the form of numerous caseating nodules scattered throughout the gland—the *disseminated form*—but more frequently as a single irregular abscess cavity, resulting from the coalescence of several of these caseating nodules—the *confluent form*. The bacilli may reach the breast in the blood-stream by metastasis from some tuberculous lesion elsewhere, for example, in the lungs or pleura; or the infection may take place by way of the milk ducts or lymphatics passing from the region of the nipple. In other

cases the mammary tissue becomes infected by direct spread of a tuberculous focus from the ribs, sternum, pleura, or axillary glands.

Clinical Features.—The disease is almost invariably met with in women between the ages of twenty-five and thirty-five. There is usually a history of injury or of a previous inflammation or abscess in the breast, and as a rule the patient suffers from some other tuberculous lesion. The condition is usually unilateral. Its onset is slow and insidious, and, not being attended with pain, the disease is usually well established ere it is recognised. In the early stages the breast is swollen, brawny and nodular; later, several small areas of softening appear, and run together, forming an irregular, ill-defined mass in the substance of the breast. Gradually the swelling reaches the subcutaneous tissue and invades the skin, which ultimately gives way at one or more points, forming sinuses with characteristically undermined edges. The axillary glands are almost always infected, in some cases even before the swelling in the breast is recognisable.

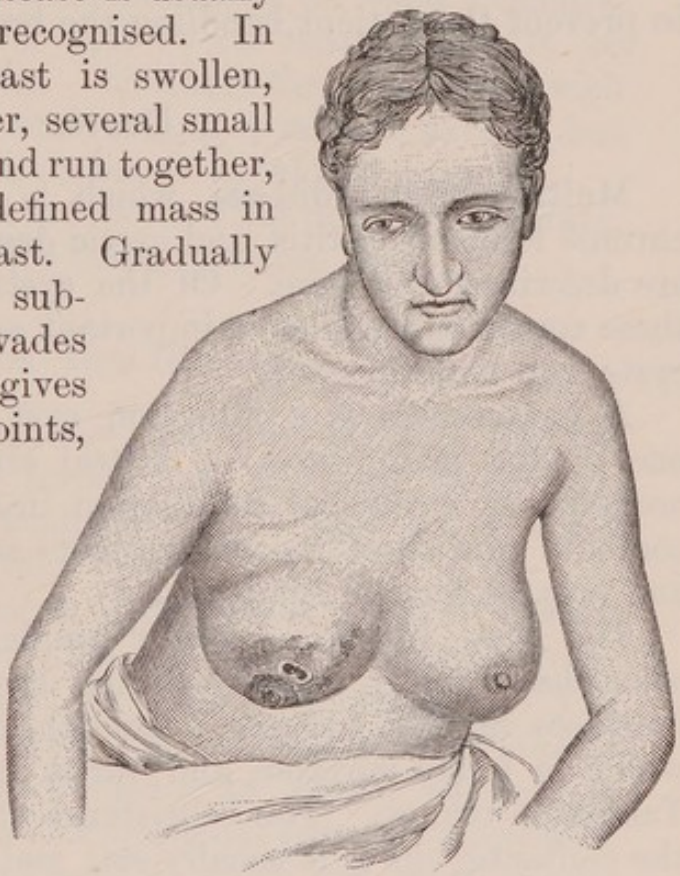

FIG. 60.—Tuberculous Disease of Right Breast with Cold Abscess and Sinus near Nipple.

The *treatment* consists in excising the breast and the affected glands.

Actinomycosis has occasionally been met with in the breast. Clinically it closely simulates tuberculous disease. The diagnosis is made by finding the ray fungus in the discharge. Excision of the whole mamma is the safest line of treatment.

Neuralgia of the breast or mastodynia is a condition usually met with in neurotic young women, who suffer at the same time from disturbances of the generative organs. The pain, which is usually worst during the menstrual period, is described by the patient as being very severe, and of a burning or shooting character. As a rule it affects only one breast, and this is excessively tender even to the gentlest touch. In the majority of cases no local cause for the pain can be discovered. In others,

however, it appears to be associated with the presence in the breast of an area of chronic mastitis, a small cyst, or a subcutaneous neuro-fibroma. When any such definite cause is discovered, it should be removed, by operation if necessary. When no local abnormality is present, the patient should be reassured that the condition is not cancerous—a point on which she is usually extremely anxious—and the general health should be improved by tonics and change of air and scene. Any pelvic disorder which may be present must also be corrected. Locally, a belladonna plaster and a supporting bandage should be applied to prevent the patient handling the breast.

Cysts.

Multiple cystic disease, which is so often associated with chronic lobular mastitis, and cystic degeneration of new growths are described elsewhere. Of the cysts which form apart from these conditions, the most important are galactoceles, involution cysts, and hydatid cysts.

A **galactocele** is a retention cyst formed by dilatation of one of the main ducts or lacteal sinuses, which has become occluded by cicatricial contraction in or around its walls. The contents consist of the constituents of milk variously altered, and may be fluid or semi-solid.

The cyst, which is usually single, forms near the areola somewhat rapidly, usually during lactation or pregnancy, and increases rapidly, forming a smooth, rounded or oval swelling, which is freely movable, and varies in size from a cherry to a Tangerine orange. The consistence of the swelling varies with the contents, but it is usually soft and elastic. When lactation ceases the swelling may disappear, but is liable to reform if the breast again becomes active. There is no retraction of the nipple, the axillary glands are not enlarged, and as a rule there is no pain.

During pregnancy or lactation it is not necessary to interfere with these cysts unless they are increasing rapidly and causing discomfort. Under these conditions the child should be weaned and the secretion of milk arrested. The cyst may then either be incised and drained, or excised.

Involution Cysts.—During the normal process of involution which occurs at the menopause, small cysts frequently develop as a result of obstruction of minute ducts or acini. They contain a clear, serous fluid or a dark brown, mucoid substance, and are known as "involution cysts." It is probable that in most cases

the so-called *serous or lymphatic cysts*—formerly believed to be due to dilatation of lymph spaces—are of the nature of involution cysts.

These cysts are frequently multiple, and are most abundant towards the periphery of the breast and on its deep surface. They form smooth, rounded or oval swellings, varying in size from a cherry to a Tangerine orange, are movable with the breast but not independently of it, and are not attached to the skin. When the contained fluid is under considerable tension, these cysts are liable to be mistaken for solid tumours, and it is not uncommon for their cystic nature only to be recognised on cutting into them. If single the cyst along with the breast tissue immediately surrounding it may be excised, but when they are multiple the whole breast should be removed.

Hydatid cysts of the breast are rare. They usually suppurate, and are seldom diagnosed before being operated upon.

Tumours of the Breast.

The most important of the *non-malignant* tumours are the fibro-adenoma, in its various forms, and the duct papilloma. Lipomata, chondromata, and angiomata are so rare that it is not necessary to refer to them further.

Fibro-adenoma.—This tumour is composed partly of fibrous and partly of glandular tissue. The glandular element consists of numerous branching tubes and irregular acinous spaces. The epithelium is arranged on the same plan as that of the normal gland tissue, and it shows no tendency to spread beyond its basement membrane. Between the epithelial masses is a variable quantity of fibrous connective tissue in which the blood-vessels ramify. The tumour is known as a *soft* or as a *hard fibro-adenoma*, according as the glandular or the fibrous element predominates.

In the substance of a soft fibro-adenoma cystic dilatations filled with mucoid fluid sometimes form—*cysto-adenoma*—and in some cases papilliform growths project into the interior of the cysts—*proliferous cysto-adenoma*. These tumours are not malignant, and the terms adeno-sarcoma and cysto-sarcoma sometimes applied to them are erroneous.

Clinical Features.—The *hard* fibro-adenoma is the variety most commonly met with, and it usually occurs in women between twenty and thirty years of age. It forms a rounded or oval swelling, usually about the size of a pigeon's egg, smooth or slightly nodular on the surface, and freely movable within

the breast substance. As it is completely encapsulated, it forms no attachments either to the skin or to the chest wall. The nipple is not retracted nor the axillary glands enlarged. Beyond an occasional shooting pain when the breast is handled or pressed upon, the patient suffers no discomfort.

The *soft* form presents very much the same characters save that it is less firm and may attain a greater size.

The *cystic* and *proliferous* forms usually occur in women

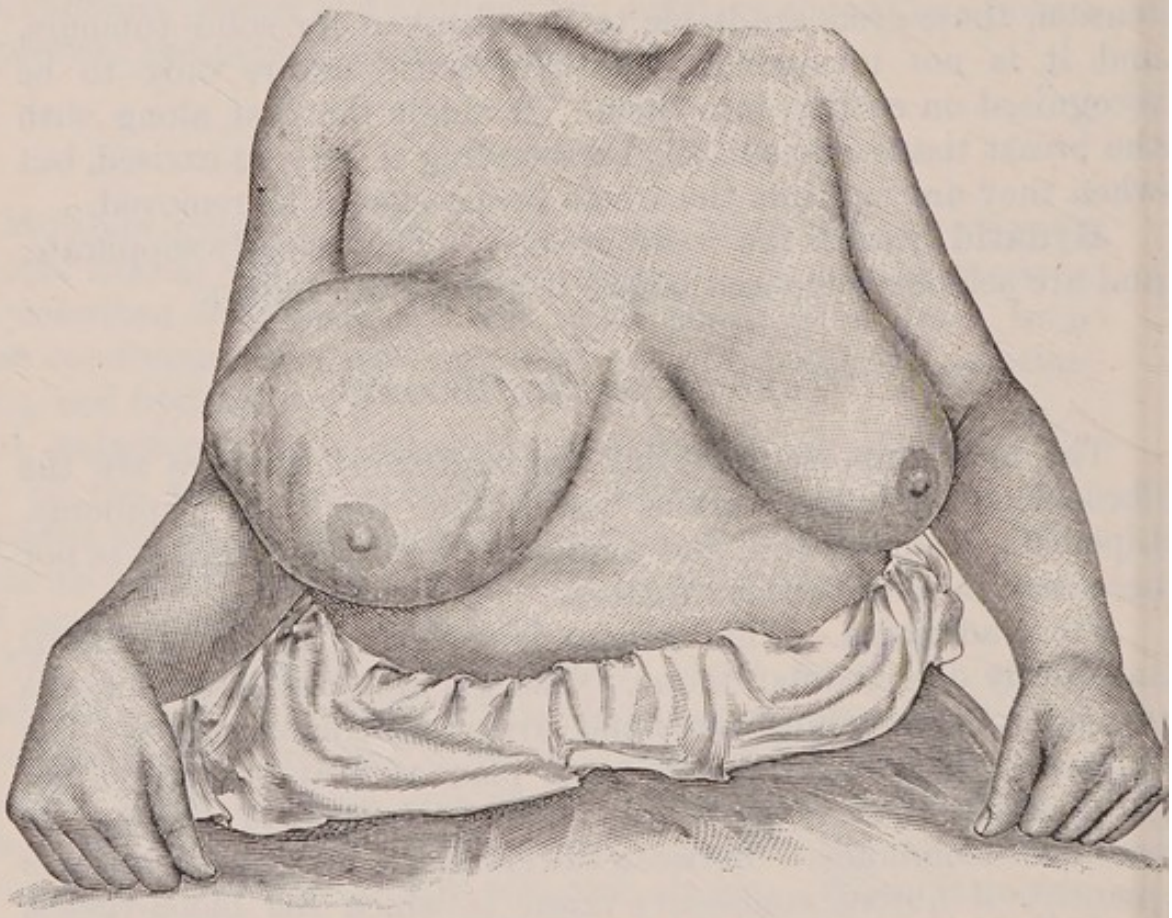

Fig. 61.—Cystic Adenoma of Right Breast in a woman, æt. 64.

(Mr. Annandale's case.)

between forty and fifty years of age. They may attain considerable size, and give to the breast a lobulated appearance (Fig. 61). They grow more rapidly than the ordinary fibro-adenoma, and in the cystic portions of the tumour fluctuation may be recognised. The skin over the cysts may be of a bluish colour, and is usually traversed by large dilated veins.

The *treatment* for all forms of fibro-adenoma is excision. The tumour is pinched up between the fingers and thumb, an incision radiating from the nipple is carried down to the growth, which can usually be readily shelled out of its capsule. After bleeding has been arrested the wound is completely closed.

When the tumour is deeply placed in the lower segment of the breast, the scar may be hidden by making the incision in the thoracico-mammary fold, and, after throwing up the breast, reaching the tumour from the posterior surface of the corpus mammæ (Gaillard Thomas). The cystic forms call for removal of the breast.

Duct Papilloma.—Pedunculated papillomata sometimes grow from the walls of the larger ducts and lacteal sinuses. They may be single or multiple, and are usually met with in multipara who have nursed their children for an unduly long period. They form a small, firm, elastic, lobulated tumour in the region of the areola. The escape of a clear or blood-stained fluid from the nipple serves to distinguish these tumours from fibro-adenomata. This discharge may be noticed for some months before any tumour is palpable. When the tumour is single and limited in size, the *treatment* consists in removing it along with the immediately adjacent breast tissue. When multiple, the whole breast should be removed.

Malignant Tumours.—**Sarcoma** of the breast is comparatively rare. It is met with at all ages, but generally before the age of forty. The tumour is usually of the spindle or round-celled variety, and is made up entirely of embryonic mesoblastic tissue. Any glandular elements which may be present are not of new formation, but merely represent portions of the original breast tissue which has been surrounded by the new growth. Cysts frequently develop in the substance of these tumours as a result of degeneration.

In the early stages a sarcoma is usually more or less completely surrounded by condensed fibrous tissue which forms an apparent capsule to the growth. The tumour cannot, however, be shelled out of this capsule, which is directly continuous on the one hand with the stroma of the breast, and on the other with that of the new growth.

Clinical Features.—The tumour appears as a rounded swelling in the substance of the breast. There is no retraction of the nipple, and at first the skin is not implicated nor the axillary glands enlarged. The tumour, which is comparatively soft, cannot be moved apart from the corpus mammæ. For some months the swelling may remain almost stationary and then begin to grow, rapidly infiltrating the whole organ. The skin over the breast becomes stretched, assumes a dusky red hue, and has large veins coursing through it. The axillary glands become enlarged and soft. There is often some general rise of temperature. Dissemination may take place through

the blood-stream to the lungs, liver, brain or other internal organs.

The *treatment* consists in excising the breast and the axillary glands on the same lines as for carcinoma, but in the rapidly growing varieties the prognosis is extremely unfavourable.

Carcinoma.—In the great majority of cases carcinoma of the breast originates in the epithelium of the acini, and the tumour is made up of masses of atypical epithelial cells surrounded by a varying amount of connective tissue. While it is convenient for clinical purposes to distinguish between different forms of cancer of the breast according to the relative amount of the epithelial and connective-tissue elements present, the disposition of these elements, the rate of growth of the tumour, and the extent to which it implicates the corpus mammæ, it is to be borne in mind that these forms are merely variations of one and the same disease.

Females suffer from cancer of the breast more frequently than males in the proportion of something like fifty to one. The age incidence varies in different forms. In a considerable proportion of cases the patient has previously suffered from puerperal mastitis and mammary abscess. In some instances there is a definite history of a blow or other injury preceding the appearance of the tumour. The importance of the rôle played by these antecedent conditions is difficult to determine. There is evidence in favour of the view that there is an hereditary proclivity to the disease.

Scirrhous Carcinoma.—This is by far the most common form of cancer of the breast. In it the connective-tissue elements predominate, while the masses of epithelial cells are comparatively few in number and small in size. Towards the centre of the tumour the epithelial clusters are compressed by contraction of the young fibrous tissue, and they undergo fatty degeneration. Towards the periphery the stroma is less dense and the epithelial masses are larger and more numerous. They fill the smaller acini, and, after bursting through the basement membrane, invade the lymph spaces of the stroma. The tissues immediately surrounding the tumour are usually infiltrated with leucocytes.

On a section being made through the tumour there is a characteristic creaking sensation as the knife divides the tissue, and the cut surfaces become slightly concave owing to contraction of the dense fibrous tissue in the centre of the growth. Towards the centre, the section presents a greyish-white, striated appearance, closely resembling that of an unripe pear, and there are

usually several yellow spots scattered over it. These are due to fatty degeneration of the epithelial elements. Towards the periphery the tissue is softer, of a bluish or pinkish colour, and shows numerous minute hæmorrhagic points.

Clinical Features.—This form of carcinoma is usually met with in women between the ages of forty and fifty, and it very often begins while the patient is still menstruating regularly. It sometimes occurs in patients below thirty. It is also occasionally met with in the male (Fig. 62). The pathological and clinical features of the disease are the same in both sexes.

The most common site is the upper and outer quadrant of the breast, but it may occur in any part of the gland. It is seldom multiple or bilateral.

In its early stages the condition is quite painless, and the existence of the tumour is usually discovered accidentally while the patient is bathing or handling the breast. In some cases indrawing of the nipple or dimpling of the skin over the breast first attracts the patient's attention. As the disease progresses, the patient experiences a dull, aching pain, with occasional sharp twinges shooting through towards the shoulder, up into the neck, or down the inner side of the arm. Still later the pain becomes severe and continuous, and by interfering with sleep wears out the patient's strength.

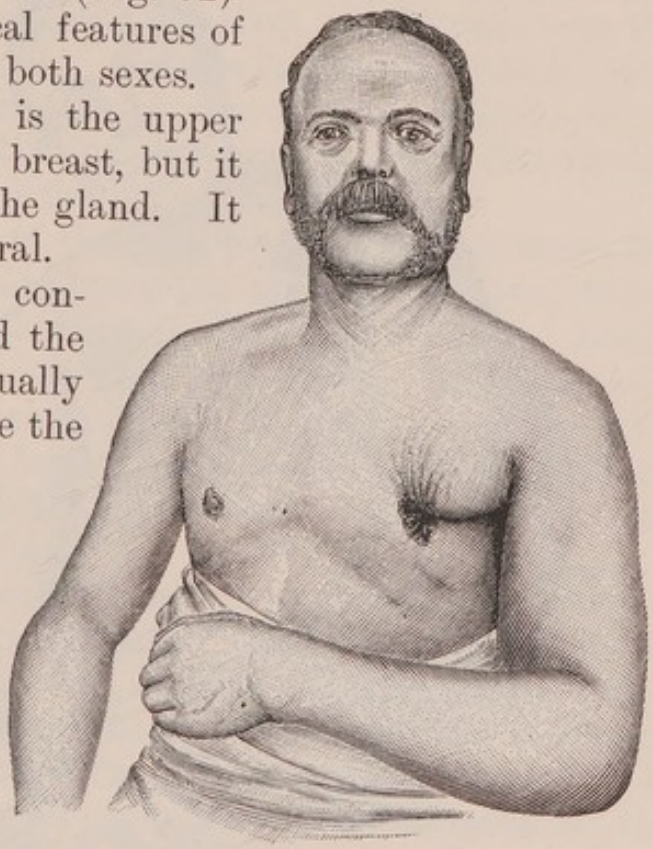

FIG. 62.—Scirrhous Cancer of the Breast in a man æt. 50, with œdema of upper extremity from enlarged axillary glands.

(Mr. Scot-Skirving's case.)

On palpation a more or less circumscribed and fairly well-defined tumour of stony hardness may be felt in the substance of the breast. Not being encapsulated, it cannot be moved apart from the breast. When firmly pressed against the chest wall with the flat of the hand, the tumour becomes more evident, and its stony hardness is fully appreciated. The skin over the growth may for a long time remain free, but, as the disease progresses, it becomes tacked down, and is later dimpled by contraction of the suspensory ligaments of Cooper. When the

skin becomes invaded by the tumour, it assumes a characteristically coarse and indurated appearance, aptly compared to that of the skin of an orange or to pig's skin. When the tumour is near the centre of the breast, it causes retraction of the nipple by dragging on the large ducts.

Glandular infection may take place at any time in the course of the disease. In many cases, and particularly in fat women, the glands cannot be palpated through the skin even although they are enlarged. Glandular enlargement is usually most marked in ulcerating cancers. The pectoral group are usually the first to become enlarged, later the axillary, the sub-clavicular and the supra-clavicular groups are infected. In course of time the enlargement and matting together of the axillary glands, by obstructing the lymph flow and pressing on the large veins, leads to great swelling of the upper extremity (Fig. 63). The nerve trunks also are pressed upon and severe pain results.

FIG. 63.—Advanced Ulcerating Cancer of Breast, with extensive involvement of the Lymphatics, causing elephantiasis of the arm.

(Mr. Annandale's case.)

Course and Terminations.—If left untreated, the tumour infiltrates the skin, and may ulcerate through it, forming an irregular, excavated ulcer with an indurated base and raised and everted edges—the *crateriform ulcer*. The discharge from such an ulcer is thin and watery, and may become fœtid and offensive. At the same time the tumour invades the retro-mammary fat and becomes adherent to the pectoral fascia and muscles of the chest wall, producing the characteristic fixation of the breast. Occasionally a tumour develops in the opposite

breast, probably as a result of cancer cells being carried across the middle line in the lymphatics. Occasionally numerous cancerous nodules appear in the skin, and spread till they form a hard, brawny patch, which may involve a large area of the chest wall, rendering it leathery and rigid—*cancer en cuirasse*. The disease may spread to the anterior mediastinum, either directly through the chest wall or by way of the lymphatics. Metastatic deposits may occur in different parts of the body, the spread taking place either through the lymphatic system or, as Goldmann has shown, by direct invasion of the veins in the neighbourhood of the tumour. Metastatic growths seldom occur within two years of the mammary tumour first being noticed. The organs most frequently invaded are the liver, the pleura, the lungs, the stomach, and the bones.

In the advanced stages of the disease the patient presents the so-called *cancerous cachexia*, becoming emaciated, worn, feeble and anxious, with dry, yellow or earthy-coloured skin. Death usually takes place from inanition and exhaustion, from pain and want of sleep. When the tumour has ulcerated, septic absorption occurs and may hasten the patient's end. Sometimes the fatal issue is determined by a metastatic growth occurring in a vital organ.

Atrophic Scirrhus.—This form of cancer is usually met with in patients beyond the age of sixty. It is characterised by its extreme hardness, the slowness of its growth, and the long course the disease may run—the patient in some cases living as long as fifteen or twenty years after the appearance of the tumour. It may occur as a single small nodule in the substance of the breast, or may affect the whole of the gland. The nipple is usually deeply retracted, and, in the diffuse variety, the breast forms a small, hard, projecting lump firmly fixed to the chest wall, and having the skin firmly adherent to it. The axillary glands may remain free of infection for several years, but eventually they become enlarged and hard, particularly if the growth ulcerates.

Colloid Cancer.—In rare cases carcinomatous tumours of the breast undergo colloid degeneration, the malignant epithelial elements becoming transformed into a clear, gelatinous material which distends the alveoli. The tumour, which is smooth and rounded, projects from the surface of the breast, and is characterised clinically by its slow growth and low degree of malignancy. The axillary glands are only implicated late in the disease, and metastases are seldom met with. The prognosis after operation is more favourable than in any other form of breast cancer.

Adeno-carcinoma.—Under this term Halsted has described a tumour of the breast which is made up of "large tubular spaces lined with many layers of epithelial cells." The condition is usually met with in women between fifty-five and sixty years of age. The tumour is larger, softer and more vascular than an ordinary scirrhus, and it tends to fungate through the skin, forming a pedunculated swelling. The axillary glands are seldom, if ever, implicated, and the tumour is much less malignant than the common forms of carcinoma.

Acute, Encephaloid, or Medullary Cancer.—In this form of carcinoma the epithelial elements predominate, while the stroma is scanty, soft and vascular. From the rapidity of growth of the tumour the condition is sometimes spoken of as "acute cancer." The terms "encephaloid" and "medullary" refer to the soft, homogeneous, brain-like appearance of the tumour on section, but as this appearance is also seen in sarcomata, and in other forms of tumours as a result of mucoid and hæmorrhagic degeneration, these terms are liable to lead to confusion.

Acute cancer is usually met with in women below the age of thirty, and in many cases appears during pregnancy or lactation. A hard, brawny swelling forms in the breast, and rapidly increases in size till the whole gland is implicated. The skin over the breast is invaded early and assumes a characteristically coarse "orange-peel like" appearance, and outlying nodules of cancer soon appear over the skin of the chest wall. Involvement of the axillary glands takes place soon after the tumour appears, and the disease usually proves fatal from metastatic growths within a few months of the onset. When the disease occurs during lactation, the skin is red and hot, and as there is a general rise of temperature, the condition is liable to be mistaken for mastitis or a mammary abscess. The prognosis is so unfavourable that operation is seldom to be recommended.

Treatment of Cancer of the Breast.—The only treatment is complete removal of the breast and of all the adjacent tissues to which the disease is liable to spread. The researches of Heidenhain and Stiles have shown that in order to prevent local recurrence of the disease it is necessary to remove (1) the tumour, together with the whole of the mammary gland, the skin over it, and the surrounding fat; (2) the fascia covering the pectoral and other muscles on which the breast lies; (3) the sternal fibres of the pectoralis major muscle; (4) the fat, lymphatic vessels and glands in the axilla and in relation to the pectoralis minor and costo-coracoid membrane.

Elliptical or angular incisions are carried from the edge of

the sternum to the axilla in such a way as to include all the skin overlying the mammary prominence, and to pass well beyond the tumour itself. The skin is then reflected from off the upper and lower portions of the breast, care being taken to include in the flaps as little of the supra-mammary fat as possible. The axillary fascia is then divided and the axillary vein exposed. The sternal fibres of the pectoralis major are next divided close to their insertion, and the muscle, together with the breast, dissected off the chest wall. The axillary fat and lymphatics are then cleared out and the fascia removed from off the pectoralis minor. The fat and glands beneath and behind the clavicle and the costo-coracoid membrane are then removed, access being gained by removing the pectoralis minor and the clavicular fibres of the pectoralis major. If the supra-clavicular glands are palpably enlarged, they should be removed through a separate incision. The nerve to the serratus magnus, the subscapular nerves, and the intercosto-humeral should, if possible, be preserved.

The flaps are brought together as completely as possible and sutured. A glass or rubber drainage tube may be inserted through a small opening made for the purpose in the posterior flap near the back of the axilla. This should always be done if the tumour has already ulcerated before operation. When the wound cannot be completely covered in by the flaps, the skin may be "undercut" for some distance around to enable it to be drawn over the open surface. If this is insufficient, skin grafts may be applied either at the time of the operation or later after granulations have formed.

The bandage which secures the dressing should be applied firmly to prevent oozing. The arm on the affected side should not be included in the bandage, but should be abducted to a right angle with the trunk and fixed on a pillow beside the patient. In this way the patient is rendered more comfortable, and the stiffness and impairment of movement which so often occur if the arm be bound to the side may be avoided.

Irremovable Tumours.—In cases in which the disease is so widespread that it is impossible to remove it completely, palliative measures must be adopted to alleviate the patient's suffering. For example, pain may be diminished and the patient's mind relieved by the removal of the main mass of the growth, particularly when ulceration, hæmorrhage and septic complications are present.

For cases otherwise inoperable, Beatson of Glasgow has suggested a method of treatment which consists in excising the

ovaries and Fallopian tubes. The idea underlying this procedure is that the removal of these organs interferes with the nutrition of the mammary tissue in such a way as to arrest the progress of the new growth. It is recommended that thyroid extract should be administered after the oöphorectomy, with the object of promoting the absorption of the degenerated cancer cells. In a considerable proportion of the cases in which this line of treatment has been tried some improvement has been observed, but it has usually only been temporary. Further experience of the method is required before an estimate of its real value can be formed. Meanwhile it should only be recommended in carefully selected cases, and those in which it seems to have been of most service are cases in which the disease is progressing slowly in women who have not reached the menopause, and in whom no secondary deposits have taken place.

The Röntgen rays have proved of service in bringing about the healing of cancerous ulcers, in causing the disappearance of secondary nodules in the skin, and in relieving pain; while in these ways they may retard the progress of the disease, they have not so far succeeded in bringing about a cure.

CHAPTER XXII.

THE ABDOMEN AND PELVIS.

Surgical anatomy—Injuries of the abdominal parietes: *Contusions; Rupture of abdominal muscles*—Injuries of the abdominal viscera: *Traumatic rupture of hollow and of solid viscera*—Wounds of the abdomen: *Punctured and Gunshot wounds*—Diseases of the abdominal wall: *Abscess and Cellulitis; Actinomycosis; Tumours*—Affections of the umbilicus: *Persistence of the vitelline duct; Persistence of the urachus; Urachal fistulæ and cysts; Inflammation; Umbilical fistulæ of other than congenital origin: biliary, urinary, fæcal; Tumours.*

Surgical Anatomy. — *Abdominal Parietes.* — The superficial fascia contains a variable quantity of fat, on the amount of which chiefly depends the thickness of the belly wall in different individuals. The muscles are arranged in three groups—anterior, posterior, and lateral. The anterior group comprises the recti and the pyramidales muscles; the recti are separated from one another in the middle line above the navel by a strong fibrous band—the linea alba—while below the navel they are practically in contact. The posterior group comprises the quadratus lumborum and erector spinæ. The muscles of the lateral group are arranged in three layers—the external oblique, the internal oblique, and the transversalis muscles—separated from one another by a small amount of loose areolar tissue. The internal oblique and transversalis muscles arise posteriorly by a tendon of origin called the lumbar fascia which is attached to the lumbar vertebræ; this fascia splits to ensheath the erector spinæ and quadratus lumborum. Anteriorly all three lateral muscles are inserted into a common tendon of insertion which splits to form a sheath for the rectus muscle.

Beneath the muscles is a layer of fascia known as the transversalis fascia, which may be said to line the entire abdominal cavity. Between the transversalis fascia and the parietal peritoneum is a layer of loose areolar tissue known as the extra-peritoneal fat.

The *peritoneum* lines the general cavity of the abdomen and pelvis, and is reflected from the parietes on to the viscera. The parietal and visceral layers are normally in contact, the space between them being only a potential one. The peritoneal cavity consists of two sacs, a greater and a lesser. The greater sac is that which is opened when the abdominal parietes are cut through in the operation of laparotomy. The lesser sac, or omental bursa of Continental writers, lies for the most

part behind the stomach. The communication between the two sacs is known as the foramen of Winslow, and lies just below and behind the portal fissure of the liver. Its margins are normally in contact with each other, and the foramen may easily become obliterated, and accumulations of fluid may thus be confined to the lesser sac, as, for example, in perforation of the posterior wall of the stomach, or as a result of injuries involving the pancreas.

In passing from one organ to another, and to the abdominal wall, the peritoneum forms numerous folds and fossæ, the number and extent of which interfere with the inspection of the whole of the peritoneal cavity through a limited incision in the abdominal wall, and render the cleansing of the cavity, when infected, a procedure of the greatest difficulty.

The largest of the peritoneal folds—the great omentum—forms an apron-like covering for the greater part of the intestines, and, by contracting adhesions with adjacent surfaces of peritoneum, it frequently serves to close perforations of the bowel and to limit infective processes in the peritoneal cavity. The mesentery, which conveys all the blood-vessels and nerves for the small intestine, is attached at its root along a line commencing above at the left side of the second lumbar vertebra, and inclining obliquely downwards to the right iliac fossa. It may be said to divide the peritoneal cavity into a right and a left compartment. Interference with its blood-vessels endangers the vitality of the intestine. The transverse meso-colon is attached to the posterior abdominal wall at the level of the second lumbar vertebra along the lower border of the pancreas; along with the great omentum it may be said to divide the peritoneal cavity into an upper and a lower compartment. The compartment above the transverse meso-colon is roofed in by the diaphragm, and contains the stomach and part of the duodenum, the liver with the gall-bladder and bile-ducts, and the pancreas. If pus forms in relation to any of these organs, it may extend upwards beneath the vault of the diaphragm and constitute a subphrenic abscess. This compartment may be shut off from the lower abdomen and pelvis by adhesions between the great omentum and the anterior abdominal wall. Purulent accumulations in this area may be drained through the anterior abdominal wall, through the loin below the last rib, or by the transpleural route. The space to the right of the mesentery and below the transverse meso-colon contains the cæcum, appendix and ascending colon, and is related to the right kidney and ureter and to the small intestine. If suppuration occur in relation to any of these organs, especially the appendix, the pus may accumulate in the right lumbar or iliac region, and may extend either upwards along the ascending colon to the subphrenic area, or downwards into the pelvis and pouch of Douglas. The compartment to the left of the mesentery is a very extensive one, being related to the greater part of the small intestine as well as to the transverse, descending and pelvic colon, and when suppuration occurs within its area the pus is liable to gravitate downwards into the pelvis and pouch of Douglas. Purulent collections in the iliac and lumbar regions are to be drained through an incision in the loin or anterior wall; those in the pelvis through an opening above the pubes, or by means of a drainage tube brought out through the vagina or rectum.

Properties of the Peritoneum.—In addition to allowing of free movement of the viscera, and supporting them in their proper relations, the peritoneum is capable of absorbing fluids, and it reacts very rapidly

to irritants. Its remarkable capacity of absorbing fluids may be beneficial by preventing such an accumulation as might serve as a culture medium for micro-organisms; but it may prove harmful if the fluid contain in solution a large amount of poisonous material, for the struggle between the infecting organisms and the individual is thus transferred from the peritoneum to the general circulation. The reaction of the peritoneum to irritants is usually manifested by the throwing out of an exudation on its surface, chiefly in the form of fibrinous lymph. If the irritant be of the nature of an aseptic foreign body, such as a portion of tissue which has been ligatured with silk, it is surrounded by the lymph, and as the latter becomes organised the foreign body is encapsulated or may be finally absorbed. Even infective material, if small in amount, may in this way be walled in and rendered innocuous or prevented from spreading. In this respect there is probably no tissue in the body more favourably disposed for resisting organismal influence than the peritoneum. If, however, the infective material is large in amount, exceptionally virulent, or introduced under conditions favourable to the lodgment and multiplication of bacteria, the properties of the peritoneum become harmful, inasmuch as the exudation affords an excellent medium for the growth of organisms, and the rapidity of absorption floods the circulation with their poisonous products. These considerations are of special importance in relation to peritonitis.

Sensibility of the Peritoneum and of the Abdominal Viscera.—Observations made in the course of operations performed without a general anæsthetic have revealed a number of interesting points bearing on this subject. The parietal peritoneum is sensitive to touch and pain, especially that portion of it lining the anterior abdominal wall and the iliac fossæ. It is most sensitive to stretching, as when the edges of a wound are drawn apart, or when one of the viscera connected with the parietal peritoneum is pulled upon. Traction on adhesions connected with the parietal peritoneum also causes pain. The painful impulses are transmitted by the spinal nerves. The visceral peritoneum, and to a great extent the viscera themselves, are insensitive, and, provided the parietal peritoneum is not put upon the stretch, may be handled or subjected to operative interference without the patient being aware of what is done. So long as the parietal peritoneum is not involved, gastric and intestinal ulcers may run their course without pain, and stones may lie in the gall-bladder without giving rise to symptoms. Adhesions between viscera rarely cause pain, while those involving the parietal peritoneum cause suffering by dragging on its nerves. It has hitherto been maintained that the visceral peritoneum becomes sensitive when it is inflamed, but Lenander, to whom we are indebted for the preceding observations, believes that it is insensitive, even in acute peritonitis, and that the pain in this affection is due to the involvement of the parietal peritoneum.

These observations explain the absence of pain in many grave visceral lesions, which is frequently a source of difficulty in diagnosis.

Subcutaneous Injuries of the Abdomen.

In the normal condition of the abdominal muscles the belly wall is so movable and elastic that it at once yields before any

force, and transmits the violence undiminished to the subjacent organs. If, on the other hand, the muscles are contracted, as for example, when the individual is prepared for a blow, the wall becomes rigid, and may itself suffer from the effects of the violence, while the subjacent organs escape.

Contusions of the Abdominal Wall without Visceral Injury.—These result from various forms of violence, and range in severity from a slight bruise to extensive tearing of tissue. In the more severe forms an accumulation of blood may occur between the muscles or in the extra-peritoneal fat, and although this is usually reabsorbed, it may persist as a hæmatoma. The clinical features are those common to bruises elsewhere, with, in addition, a variable amount of shock due to the impression made on the nerve plexuses within the abdomen. Chief interest attaches to the question whether or not the viscera have sustained injury, a point in diagnosis which will be considered presently. The treatment of a simple contusion consists in keeping the patient at rest in bed with the knees flexed over a pillow, and in the application of uniform pressure by means of cotton-wool and a bandage.

Rupture of Abdominal Muscles.—The abdominal muscles, and especially the recti, may be ruptured from their sudden contraction, or as a result of violence applied to the abdomen provided they are contracted at the moment of impact.

When the muscles are weakened by disease, as during convalescence from typhoid fever, they may rupture from comparatively slight violence or effort. Rupture of the rectus always occurs below the navel.

The clinical features are those of ruptured muscle in general. The ends of the muscle may be approximated by flexing the trunk, the shoulders being raised on pillows and the thighs flexed on the abdomen; failing this, if the muscle is healthy, the ends may be exposed by operation and sutured. When the patient reassumes the erect posture, he should wear a bandage or belt to prevent the formation of a ventral hernia.

Subcutaneous Injuries of the Abdominal Viscera.—Injury to the viscera most often results from violence inflicted with a blunt object applied at right angles to the abdominal wall, as by a kick, the passage of a wheel across the body, a crush between buffers, or a fall against a projecting object. The small intestine—and to a less extent the pancreas—is especially liable to suffer in such accidents through being nipped between the impinging object and the bodies of the vertebræ. Visceral injuries may also result from acute flexion of the trunk,

as when an individual is seated, and a heavy weight falls on his shoulders, compressing the contents of the abdomen. Those which result from falls from a height are chiefly of medico-legal interest.

Certain parts of the intestine are more exposed to injury than others, some in virtue of their situation, for example, the centrally placed coils of small intestine, others from their attachments, for example, the duodeno-jejunal junction. Distension of a hollow organ such as the bladder or stomach renders it more liable to rupture. Certain diseases also, for example, ulceration of the stomach or malarial enlargement of the spleen, predispose to rupture.

The viscus may be merely contused or it may be ruptured. Rupture of the liver, spleen, mesentery or omentum is dangerous chiefly because of the resulting hæmorrhage and possible death from loss of blood. Injuries in the epigastric region may lead to hæmorrhage in or around the pancreas and accumulation of blood-stained fluid in the lesser sac of the peritoneum. In the case of hollow organs such as the stomach, intestine or urinary bladder, the chief danger is from the escape of their contents into the peritoneal cavity setting up septic peritonitis. In hollow organs a distinction may be made between *complete* and *incomplete rupture;* in the former all the coats are torn through, and the contents escape at once unless the opening is blocked by omentum or protruded mucous membrane. In the case of incomplete ruptures one or other of the coats remains intact, and the escape of contents is thereby prevented. The rupture may, however, become complete as a result of infection and subsequent necrosis.

Clinical Features of Visceral Injuries.—These necessarily vary with the nature and severity of the violence, the extent of the injuries, and the viscus injured. As a rule there is no evidence of bruising of the abdominal wall. The degree of shock is especially liable to variation; it may be slight and evanescent, or it may be so great that death ensues within a few minutes. Vomiting when present usually continues after the stomach has emptied itself of food. There is persistent pain which radiates over the whole belly, and is increased by the least movement or manipulation. The abdominal muscles become contracted, immobilising the abdominal wall, and as the action of the diaphragm is restrained the respiration becomes almost entirely thoracic. The rigidity and flattening of the belly may give place to fulness and prominence, either as the result of the gaseous distension of the paralysed bowel, or from the escape of

gas into the peritoneal cavity, as in rupture of the stomach or intestine. Diminution or loss of the liver dulness may result from such escape of gas, but is not a reliable sign of this, as it may be produced by gaseous distension of the colon. As a result of the arrested peristalsis of the bowel the patient passes nothing per rectum, not even flatus.

In the case of rupture of a solid organ attended with hæmorrhage into the peritoneal cavity, the initial shock, instead of passing off, merges into the phenomena of the bloodless state: the pallor increases, the pulse becomes smaller and more frequent, the patient faints or becomes very restless, exhibiting the effects of "air-hunger," and the accumulation of blood within the belly may be recognised by increasing dulness in the loins. In rupture of hollow organs the symptoms of the initial shock gradually merge into those of septic peritonitis.

In an incomplete rupture of a hollow viscus, or when a perforation is so small that escape of contents is prevented, the initial shock is followed by an amelioration of the symptoms. There is here the possibility of natural cure, but as a rule, after an interval of comparative well-being, the features of a localised peritonitis appear, and this being limited by adhesions may terminate in the formation of a circumscribed abscess, or it may extend and cause general peritonitis.

Diagnosis.—It is often difficult to be absolutely certain of the existence of a visceral lesion, and especially when an accurate history of the injury is not obtainable in the case of persons found injured and in cases of alleged assault. The persistence of severe shock is strongly suggestive of visceral injury, although in some cases of rupture of the stomach or intestine the patient suffers little from shock, and may even be able to walk some distance. The diagnosis of visceral injury is rendered more certain by the persistence of vomiting after the stomach has emptied itself of food, the continuance of severe pain and rigidity of the abdominal muscles, or subsequent distension of the belly. Progressive bloodlessness with signs of accumulation of blood in the peritoneal cavity affords grounds for a definite diagnosis.

Rupture of the urinary bladder is so liable to be overlooked, especially in intoxicated individuals, that it is advisable to pass a catheter, as a routine practice, in all cases of known or alleged injury to the abdomen. So long as the diagnosis is in doubt the progress of the symptoms must be carefully watched, the patient being kept under observation, and examined at frequent intervals.

While it is not justifiable to operate indiscriminately in all cases of abdominal injury, or on patients with extensive injuries who are obviously dying, when the diagnosis is doubtful it is on the whole safer to perform an exploratory laparotomy than to wait until signs of peritonitis ensue. Except in the presence of severe shock an exploratory operation cannot be said to add to the danger of the patient, while the onset of peritonitis may place him beyond relief by surgical measures.

Treatment.—The operative treatment takes the form of a laparotomy, and the sooner this is carried out the better. It is not permissible to wait until the shock passes off, because in many cases this is kept up by bleeding or by the escape of visceral contents into the peritoneal cavity, and it is only after opening the belly that these can be arrested or eliminated. The chief indications to be fulfilled are, the closure of the rupture in the viscus, the arrest of hæmorrhage, and the cleansing of the peritoneal cavity.

The abdomen is opened, usually, by an incision over the seat of injury. If extravasated blood is found, the hæmorrhage must be traced to its source and arrested. If gas and other material have escaped from the alimentary canal, the perforation must be searched for and closed. If neither blood nor alimentary contents are discovered, a more detailed search is necessary, especially a methodical examination of the intestine. All escaped blood or alimentary contents must be removed, and the drainage of any inflammatory exudate provided for. The further details of the operation vary with the different organs, and will be considered later.

Wounds of the Abdominal Wall.—*Stab wounds*, produced by a knife, the spike of a railing or other pointed body, partake of the characters of punctured wounds, and the important point to determine is whether or not the wound has penetrated the peritoneal cavity, and if so, if it is complicated by visceral injury. There may or may not be symptoms of visceral injury, for example, rigidity of the belly wall, persistent pain, presence of blood in the vomit or in the stools. If the position and direction of the wound, its size, and the character of the instrument with which it was inflicted, give reason to suspect that the peritoneal cavity has been entered, the wound must be disinfected and enlarged, as the conditions found may justify. If the peritoneal cavity has been penetrated, the belly must be opened up sufficiently to admit of its interior being examined. If there is evidence of hæmorrhage or of escape of visceral contents, the lesion must be sought for and dealt with. The

possibility of multiple wounds of the intestine must be borne in mind.

In some cases the *protrusion of viscera*—usually the omentum, less commonly the small intestine—is the most striking feature. The prolapsed viscus is exposed to infection, and this may spread later to the peritoneal cavity. When the case is seen soon after infliction of the wound, the viscus should be cleansed with salt solution and returned into the abdomen. If the omentum is much soiled, the damaged portion should be removed. If the intestine is wounded, it should be stitched up or resected before being returned. If the prolapse is of long-standing, extensive alterations may have occurred in the protruded viscus as a result of septic infection, or, where the opening in the parietes is a small one, by strangulation.

The omentum or intestine may be gangrenous by the time the case first comes under observation, and the treatment for this is to be carried out on the same lines as in strangulated hernia.

Abdominal wounds should be closed by sutures wherever possible, and the patient kept recumbent as after a laparotomy.

Gunshot Wounds.—Those met with in civil practice are usually produced by pistol or rifle bullets discharged at close range, and they are to be dealt with on the same lines as stab wounds. In the case of gunshot wounds sustained in warfare the conditions vary so widely that no definite lines can be laid down regarding them. Recent experience has shown that when the abdomen of a fasting man has been traversed by a bullet of small calibre travelling at high velocity, it is better to abstain from operative interference The patient should be kept under morphin and nourished per rectum. Even when the abdominal cavity has been traversed by a bullet, and perforation of one or more viscera has almost certainly occurred, spontaneous recovery frequently takes place. If, however, in warfare the conditions both as regards the nature of the injury and the facilities for operating approximate those in civil practice, laparotomy should be performed, especially where there is evidence of internal hæmorrhage or of perforation of the stomach or intestine. Wounds of the liver, kidney and spleen usually heal well, and require no operative treatment, except for secondary complications, such as fistula or abscess.

Diseases of the Abdominal Wall.

Inflammation and Suppuration.—The subcutaneous cellular tissue may be the seat of circumscribed abscess or of diffuse

cellulitis. A good example of the latter is afforded by the cellulitis which spreads to the abdominal wall in cases of extravasation of urine.

The extra-peritoneal cellular tissue may likewise be the seat of abscess or of cellulitis. The situation and direction of spread of the suppurative process vary with the origin of the infection. That, for example, which originates in the urinary bladder may ascend from behind the pubes towards the umbilicus, forming a spherical swelling resembling the distended bladder; while that which originates from the uterus may spread outwards in the broad ligaments, and come to the surface in one or other iliac region. Among other forms of extra-peritoneal cellulitis and suppuration may be instanced that which arises in the loin from lesions of the kidney—perinephric abscess; those forming in the right iliac fossa from appendicitis and malignant disease of the cæcum; those which arise in connection with the elimination of biliary calculi and of foreign bodies in the stomach or intestine; and those resulting from osteomyelitis of the pubes or ilium.

The *clinical features* vary with the origin and seat of the cellulitis. The condition is seldom diagnosed until the inflammatory products form a definite swelling, and the presence of pus is uncertain until the abscess approaches the surface. Fortunately the pus tends to make its way towards the skin rather than into the peritoneal cavity. The pus in abscesses which form in the vicinity of the bowel is frequently fœtid from the presence of the colon bacillus.

The *treatment* consists in making an incision through the overlying skin and fascia, and then passing a director through the muscles and transversalis fascia until the purulent collection is reached. Additional openings may be required to establish free drainage. Treatment must also be directed to the lesion from which the cellulitis took origin.

Actinomycosis is met with in the abdominal wall chiefly as a result of extension from the intestine. It appears as an ill-defined, hard swelling which gradually softens and ruptures on the skin surface, discharging pus which contains the characteristic fungus. The affection is a very chronic one, and usually results in one or more sinuses which may lead down to the bowel.

Tumours of the Abdominal Wall.—The lipoma and fibroma are the most important of these. The *lipoma* may originate in the subcutaneous or in the extra-peritoneal areolar tissue. One variety of extra-peritoneal lipoma is represented by the small fatty hernia which occurs in the middle line in the epigastric

region and in the inguinal canal, and which will be described with hernia.

The *fibroma* grows from the fascial coverings of the muscles and from the aponeuroses of the abdominal wall. At first small, hard and insensitive, they may after a long period of slow growth become more active and attain a considerable size. They are met with chiefly in women who have borne children. Transitional forms between fibroma and sarcoma are not uncommon, and they may recur after removal—the "recurrent fibroid of Paget."

On examination it is found that the tumour moves with the wall and not with the contents of the abdomen, and that it does not change its position with alterations in the position of the patient.

Treatment.—The tumour should be freely excised, a zone of muscle fibres and aponeurosis in contact with its capsule being removed at the same time. If the parietal peritoneum is adherent to the growth, the adherent portion must also be resected. In order to prevent a ventral hernia, the gap in the abdominal wall is carefully sutured, the patient is kept recumbent for from four to six weeks, and must wear a belt or bandage on resuming the erect posture.

Affections of the Umbilicus.

Persistence of the Vitelline Duct. — *Patent Meckel's Diverticulum.*—The vitelline duct—the channel of communication between the intestine and the yolk sac—passes from the ileum a little above the ileo-cæcal valve to the umbilicus, and is usually obliterated at the eighth week of intra-uterine life. In its persistent tubular form it is known as a Meckel's diverticulum (Fig. 92). When the stump of the umbilical cord separates after birth the duct may come to open on the surface, constituting a fistula which discharges mucus, and in rare instances fæcal matter. The walls of the duct may be prolapsed through the umbilicus, and they are sometimes followed by protrusion of the intestine, which forms a projecting tumour, and by interfering with the passage of the intestinal contents may result in obstruction of the bowels.

If the intra-abdominal portion of the duct is obliterated while the portion in the umbilical cord remains patent, the separation of the stump of the cord may be followed by protrusion of the mucous membrane and the gradual formation of a raspberry-like tumour known as an entero-teratoma.

If the intra-abdominal portion of the duct is only obliterated at its two extremities, the intervening portion may become distended with fluid and form a cyst.

Treatment.—If the fistula at the umbilicus only discharges mucus there is no call for interference, but if it discharges fæcal matter it is better to open the abdomen, excise the diverticulum along with its termination at the umbilicus, and close the orifice of communication with the ileum. The entero-teratoma may be removed after ligaturing its base.

Persistence of the Urachus.—*Urachal Fistulæ and Cysts.*—The urachus or duct of communication between the urinary bladder and the allantois in the fœtus may remain patent and extend into the substance of the umbilical cord. In such cases, when the stump of the cord separates, a *urachal fistula* results and discharges a varying quantity of urine. If it does not close spontaneously, the patent urachus should be dissected out, and the opening at the summit of the bladder be closed by sutures.

In older children and in adults, a similar fistula may form as the result of the extension of inflammation from the bladder to the unobliterated urachus, in cases where there is a difficulty in voiding the urine by the normal channel. A painful swelling forms between the umbilicus and the pubes, and after rupturing at the navel discharges pus and urine.

The *treatment* consists in removing any obstruction to the escape of urine by the normal channel, getting rid of the inflammation of the bladder, and finally dissecting out the urachus from the navel to the bladder, and closing the opening in the latter.

Urachal cysts result if the urachus remain patent, while its vesical and umbilical openings are obliterated.

Inflammation of the umbilicus is usually the result of want of cleanliness, the epidermis and sebaceous secretion accumulating and undergoing decomposition. The umbilicus becomes inflamed and swollen, and a stinking discharge escapes on the surface. The treatment consists in cleansing the parts.

Umbilical Fistulæ of other than Congenital Origin.—Abscesses derived from any of the subjacent organs may point and rupture in the situation of the umbilical scar. The discharge is purulent in the first instance, but may become mixed with bile, fæces or urine, according to the origin of the abscess. *Biliary fistulæ* usually follow upon the inflammatory complications of gall-stones. *Urinary fistulæ* follow on prevesical cellulitis and abscess, and they resemble those which are associated

with a persistent urachus. *Fæcal fistulæ* result from various conditions, such as strangulated umbilical hernia, foreign bodies and ulcers of the intestine, and tuberculous peritonitis.

The prognosis and treatment depend on the condition which has preceded the fistula.

Tumours of the Umbilicus. — These include dermoids, papillomata, fibromata, sarcomata, and cancers. The primary cancer, usually a squamous epithelioma, results from long continued irritation, and appears as an indurated ulcer with offensive discharge. Secondary cancer appears as one or more hard nodules, and is a sequel to primary growths in the stomach, intestine or liver; its nature is revealed by microscopic examination showing columnar epithelium, the recognition of which will avoid a needless operation.

CHAPTER XXIII.

THE PERITONEUM.

PERITONITIS — Varieties: *"Aseptic peritonitis"; Septic peritonitis; Generalised peritonitis; Localised forms of septic peritonitis; Pneumococcal; Gonococcal; Chronic* — Peritoneal tuberculosis and tuberculous peritonitis: *Varieties*—Actinomycosis of peritoneum—Peritoneal adhesions and bands—Tumours of peritoneum and extra-peritoneal cellular tissue: *Mesenteric tumours; Omental tumours; Malignant disease of peritoneum; Mesenteric cysts; Hydatid cysts*—Affections of mesenteric glands—Subphrenic abscess.

PERITONITIS.

THE term peritonitis is applied to any inflammation of the serous membrane resulting from the presence of an irritant, and the changes observed in the membrane are to be regarded as representing the reaction of its tissue elements to the irritant.

"Aseptic Peritonitis."—When the irritant is of a mechanical or chemical nature, or is produced by attenuated organisms which are readily overcome by the tissues, the changes in the peritoneum are essentially reparative, and the resulting peritonitis may be considered a salutary process. Such changes constitute what has been termed "aseptic or reparative peritonitis," and consist in the exudation of fibrinous lymph which is either reabsorbed, or else leads to the formation of adhesions between opposing surfaces of peritoneum. For example, when blood is extravasated into the peritoneal cavity, it may be entirely reabsorbed, or its presence may cause a certain degree of irritation of the peritoneum which results in the encapsulation of the blood, and the formation of a blood-cyst. When normal bile escapes from a rupture of the gall-bladder it may be reabsorbed, or may cause a reaction on the part of the peritoneum which results in the formation of adhesions. Similar phenomena may follow upon the rupture of an ovarian cyst. Aseptic peritonitis may also be observed as a result of circulatory dis-

turbances, as from the rotation of the pedicle of a wandering spleen or of an ovarian cyst.

So long as organisms are excluded, the reactive changes take the form of a serous or fibrinous exudation, and are recovered from with or without the formation of adhesions. If, however, the disturbance of circulation and nutrition is so great as to permit of the passage of bacteria through the wall of the bowel, the characters of the lesion are altered and merge into those of septic peritonitis. When the peritoneum has been stimulated to reaction for some time—in other words, when it is chronically inflamed—it appears to be more tolerant of minor degrees of septic infection than it is in its normal state. It may be said that it has become immune, and is provided with the means of combating bacterial infection. Under these conditions it is found to tolerate operative interference better than in its normal state.

Septic Peritonitis.—When the peritoneum is infected with virulent organisms and these gain the upper hand, the condition of septic peritonitis ensues. If the infective material is abundant or exceptionally virulent, the patient may be poisoned and die before reactive changes have time to occur. This condition is termed *peritoneal intoxication or septicæmia.* It has hitherto been believed that the organisms chiefly concerned are the colon bacillus and the streptococcus pyogenes, but recent observations appear to show that anaërobic organisms of the pyogenic class are probably responsible for many cases of peritoneal infection. The gonococcus, the pneumococcus, and the organism of acute rheumatism are less frequently concerned in peritoneal infections. In a considerable proportion of cases there is a mixed infection. In some cases, especially those originating from lesions of the Fallopian tubes, the pus is found to be sterile.

In investigating the organisms in any given case of peritonitis it is better to make cultivations from the lymph than from the fluid exudation.

Etiology.—*Points of Origin of Septic Peritonitis.*—Infection may originate in any of the organs which are covered by, or are adjacent to the peritoneum, but the gastro-intestinal canal surpasses all the others in the frequency with which it is the starting-point of peritonitis.

Practically any lesion of the stomach or bowel which is attended with inflammation or ulceration is liable to be the starting-point of peritoneal infection. Lesions of the vermiform appendix rank first in order of frequency. Among other lesions may be instanced perforating ulcer of the stomach or duodenum,

intestinal ulcers, foreign bodies ulcerating through the gut, traumatic ruptures, various forms of enteritis, changes in the bowel associated with strictures and congenital diverticula of the intestine, circulatory disturbances resulting in damage to the wall of the gut and rendering it pervious to the passage of organisms, as for example in strangulation of the bowel, volvulus or intussusception, and in cases of obstruction of the mesenteric blood-vessels.

Organs intimately related to the intestinal canal, such as the gall-bladder, liver, and pancreas, may become the seat of infective inflammation which may extend to the peritoneum, as for example the inflammatory complications of gall-stones, suppurating hydatid cysts, abscess of the liver, or suppurative pancreatitis.

The female organs of generation, and especially the uterus and Fallopian tubes, frequently prove the starting-point of peritonitis, particularly by the spread of infections related to the puerperium and to abortion. Less frequently peritonitis takes origin from infective lesions of the spleen, the mesenteric glands, the urinary organs, adjacent serous cavities such as the pleura or pericardium, the umbilicus in newly-born children, and from infective conditions of the abdominal wall.

When infection occurs in relation to penetrating wounds or abdominal operations, the organisms are either introduced from without or are liberated from the alimentary tract. In the latter case it is not necessary that the lumen of the tract be opened; it is sufficient that the wall of the bowel be so damaged as to render it pervious to organisms.

In a small minority of cases it is not possible to discover any antecedent lesion to account for the peritonitis. It is possible that some of these so-called "idiopathic" cases result from infection through the blood-stream, as for example in peritonitis of pneumococcal origin.

The extent and characters of the peritonitis vary with the conditions which attend infection of the membrane. If the organisms have it all their own way the infection spreads widely, and a generalised or diffuse peritonitis ensues; if on the other hand the tissues are in a position to react, they may succeed in limiting the infection, and a localised or circumscribed peritonitis results.

Generalised or Diffuse Peritonitis.—This acute and frequently fatal disease is met with under conditions in which the infective agent is introduced in such quantity, or in such an active form, that the efforts of the tissues to combat it are ineffective.

The anatomical changes vary with the amount of reaction of the tissues and the stage and duration of the inflammation. In the most rapidly fatal forms—the so-called peritoneal septicæmia—the patient may die before any pronounced changes have had time to occur. More commonly the vessels of the membrane are markedly injected; the surface loses its lustre, and is covered with an exudation which may only amount to a stickiness, but more often consists of lymph which mats the intestines together and covers the solid organs. The lymph is usually thickest along the lines of contact between adjacent coils of bowel. It is at first fibrinous, but later becomes purulent and of a yellowish or greenish-yellow colour. The fibrinous exudation is usually accompanied by a fluid exudate which is at first serous, but tends to become turbid and to acquire the characters of pus. The inflammation may be diffused widely throughout the cavity of the abdomen, but as a result of the division of the cavity into pockets by the gumming together of adjacent surfaces, the exudation which accumulates in these pockets may vary in character at different parts of the belly. The inflammatory changes are always more marked in the visceral than in the parietal peritoneum, and are most advanced in the vicinity of the organ from which the infection took origin. The presence of fœtid gas in the peritoneal cavity may be due to decomposition of the inflammatory exudation, or the gas may have escaped through a perforation in the bowel or stomach. The coils of small intestine are usually greatly distended with gas, and their contents are in process of decomposition.

Clinical Features.—These vary with the nature of the primary lesion and the manner in which the peritoneum becomes infected, and according to whether the signs of inflammatory reaction on the part of the peritoneum, or the signs of absorption of poisonous products, predominate. Being in the majority of cases a secondary affection, the symptoms of peritonitis are usually preceded by those of the primary disease, and develop gradually or suddenly according to the rapidity with which the peritoneum becomes involved. With the onset of peritonitis the symptoms of the primary affection may be completely overshadowed.

In a typical or average case the patient feels extremely ill and is obliged to lie down. The facial expression is anxious. He lies on his back, often with the knees drawn up to relax the abdominal muscles, and he avoids any movement of the abdomen. The breathing is thoracic and is increased in frequency. The heart's action is depressed, and the pulse quick

and feeble, although in some cases the pulse does not alter till the disease is well advanced. If the peritonitis is part of a general septic infection, as in puerperal cases, the temperature may be elevated, but it is usually normal or subnormal, especially at the onset. The association of a subnormal temperature and rapid feeble pulse is characteristic of peritonitis.

Vomiting is one of the cardinal symptoms, and is rarely absent except in some cases resulting from perforating ulcer of the stomach. It is continuous and persistent; the stagnating decomposing contents of the upper coils of intestine regurgitate into the stomach, and are ejected from the mouth without effort and without preliminary retching. The vomited matter at first consists of sour-smelling, undigested food, later it is green from admixture with bile, and, finally, it is brownish from altered blood, and offensive as a result of decomposition. The patient only brings up a mouthful or two at a time, but the amount of fluid regurgitated from the stomach may be so great that the body is drained of its fluid, and the patient complains of a burning thirst. The urine is diminished in quantity, is concentrated, and often contains traces of albumin and indican. Abdominal pain is a prominent feature, and in cases of abrupt onset is severe enough to produce marked symptoms of shock. Pain and tenderness are usually most acute over the organ from which the peritonitis originated, for example in the right iliac fossa in appendicular lesions, and in the epigastrium in perforations of the stomach. The situation of the pain may thus afford evidence as to the seat of origin of the peritonitis. As the inflammation extends and becomes diffuse, the pain and tenderness become more widely distributed. The abdominal walls not only cease to move with respiration, but become rigid and board-like from reflex contraction of the muscles. In the later stages the abdomen tends to become distended and prominent from the formation of gas within the bowels. The inflammation of the serous coat leads to paralysis of the walls of the gut, the fluid contents stagnate and undergo decomposition, and this is attended with the formation of gas. The distension of the bowels bulges the anterior wall, and pushes up the diaphragm and liver, the latter organ being rotated so that its normal area of dulness may diminish or disappear. As a result of the intestinal paralysis nothing is passed by the rectum, not even flatus. In certain forms of peritonitis, in those for example which attend puerperal infections, there may be diarrhœa.

It is rarely possible by external examination to be certain of the presence of fluid exudation. An area of dulness in the

flanks or in other dependent parts of the abdomen may be due to an accumulation of fluid in the peritoneal cavity, but it may also be caused by coils of small intestine filled with fluid fæces. Fluid collections in the pouch of Douglas may be felt through the rectum or vagina. Fibrinous exudation may cause rough friction, especially over the liver.

As the disease progresses, the patient presents more and more the general features of septic poisoning; the face and extremities become cold and cyanosed from defective circulation and imperfect aëration of the blood; the intellect may become dulled by increasing toxæmia, but as a rule the patient remains conscious to the last, sometimes ceasing to complain or even expressing himself as feeling better.

In cases which recover, the general symptoms improve before the local, the pain and vomiting become less aggressive, and the bowel recovers its functions, and there is passage of flatus and later of fæces. The local phenomena gradually disappear, or may become localised to the region of the organ primarily affected, and terminate in the formation of a circumscribed abscess.

Diagnosis.—It is often difficult to differentiate between a localised and a diffuse peritonitis, as in the former the onset may be attended with symptoms of irritation of the peritoneum as a whole. This question is chiefly of importance in relation to peritonitis originating in the appendix, and will be considered with appendicitis.

It may also be difficult to differentiate between peritonitis and intestinal obstruction, especially if the patient only comes under observation in the stage in which there is regurgitant vomiting of foul-smelling fluid. In obstruction uncomplicated by peritonitis the pain is more spasmodic and griping in character, there are intervals during which the patient is free of pain, and tenderness is limited to the area of obstruction. The abdominal wall is more yielding, the distension is localised to one region, individual coils of intestine may be evident, and may show peristaltic movements, gurgling and other noises in the bowels are more noticeable, and it is often possible to give some relief to the patient by emptying the lower bowel by enemata. It must be remembered, however, that inasmuch as the damage to the wall of the gut resulting from obstruction renders it permeable to organisms and toxins within the bowel, intestinal obstruction tends sooner or later to become complicated by peritonitis.

Biliary and renal colic may simulate peritonitis, but there is

an absence of toxæmic symptoms, and the pain, tenderness and rigidity are confined to the area involved. Among other conditions to be diagnosed from general peritonitis are ruptured tubal pregnancy, acute pancreatitis, the onset of acute pleuro-pneumonia, and diaphragmatic pleurisy.

The *prognosis* varies with the nature and origin of the peritonitis. Diffuse peritonitis is always a grave disease. The more prominent the symptoms of general intoxication, the worse is the prognosis. Cases of peritoneal septicæmia are usually hopeless. When there is a decided reaction of the peritoneum the prospects are better, especially if the purulent exudate can be evacuated by operation.

Treatment.—To rest the abdomen the patient must lie on his back with the knees flexed over a pillow, and with a cage over the body to support the weight of the bed-clothes. As the stomach is incapable of absorbing nutriment, recourse should be had to rectal alimentation. In some cases the local application of an ice-bag or a cold coil affords relief, in others warm applications are more soothing. The administration of opium and belladonna relieves pain, rests the patient, and quiets the intestine, thus favouring the formation of adhesions which may localise the infection; it may, therefore, be of service in commencing peritonitis. At the same time it tends to mask the symptoms, and may thus establish a false idea of security on the part of the practitioner. In the later stages of peritonitis opium tends to increase the paralysis of the bowel. It is a good rule to withhold opium until a diagnosis has been made of the starting-point or cause of the peritonitis, in the event of this being one amenable to surgical interference.

The patient may be much relieved by washing out the stomach with hot water, and so getting rid of its decomposing contents. The washing is continued until the fluid returns clear, and some of the water may be left behind to relieve thirst. This procedure, however, is contra-indicated in cases of gastric ulcer.

The distension of the bowels may sometimes be relieved by rectal injections. The strength of the patient is to be supported by hypodermic injections of strychnin, strophanthus, or camphor, and by the repeated subcutaneous infusion of salt solution.

The exhibition of aperient medicines is not only useless, but harmful, in generalised peritonitis. In peritonitis of streptococcal origin recourse may be had to the use of anti-streptococcic serum.

Operative Treatment.—The rational treatment of diffuse septic

peritonitis is to open and cleanse the peritoneal cavity, and to deal with the lesion from which the peritonitis originated. In practice, however, this is not always practicable. In the first place the patient may have already absorbed a lethal dose of toxin, in which case an operation will only precipitate the fatal termination. It is therefore better to abstain from interference in cases in which the symptoms of septic poisoning predominate, and especially in cases coming under the category of peritoneal septicæmia. Further, the efficient cleansing of the cavity of the peritoneum, especially when the intestines are ballooned with gas and the opposing serous surfaces are gummed together by lymph, is often a mechanical impossibility. In addition, the lesion from which the peritonitis originated may not lend itself to surgical treatment.

There remain, however, a number of cases in which it is our duty to give the patient such chance of cure as an operation may offer.

The preliminaries of the operation include the hypodermic injection of strychnin, washing out the stomach, and emptying the bladder. A local anæsthetic may suffice, but if it is necessary to carry out manipulations within the abdomen a general anæsthetic must be employed. Unless there are reasons to the contrary, an incision three or four inches long is made near the middle line to one or other side of the umbilicus, and is extended as may be required. If it is found that the bowels are blown up with gas and gummed together with purulent lymph, it may be wiser to abandon the operation and close the abdomen, or at most to introduce large drainage tubes into the loins and pouch of Douglas, and to wash through these. In other cases an attempt should be made to cleanse the cavity, and to discover and remove the source of the peritonitis. The cleansing of the peritoneal cavity is effected by soaking up the exudation with pads of gauze wrung out of saline solution. Irrigation is called for in the more generalised forms of peritonitis—for example, in perforated gastric ulcer. Two large tubes are pushed in—alongside each other—to successive regions, and a steady stream of saline solution, at a temperature of about 105° F., is sent along one of them until it returns quite clear. Coarse handling of the viscera must be avoided; adherent lymph should not be removed. It may be necessary to make additional openings, especially one above the pubes to drain the pouch of Douglas. With the object of more thoroughly cleansing the peritoneum it has been proposed to eventrate the bowels through a large incision. Partial eventration may be necessary to obtain access to the

primary lesion; the extruded coils must then be enveloped in compresses wrung out of hot salt solution and surrounded by hot towels. It may be advisable to incise and empty one or more of the distended coils of bowel, especially if the distension is an obstacle to some essential step in the operation, as for example when a distended cæcum prevents access to a diseased appendix, or when it is found impossible to return distended coils to the abdomen. The bowel being paralysed, it is only possible to empty a limited length of intestine through each incision. The opening is closed again by a purse-string suture carried through all the coats of the bowel, and a serous suture at right angles to the long axis of the bowel. The methods of dealing with the individual sources of the peritonitis will be considered under the respective organs. The operation is concluded by closing the abdominal wound, leaving room for the various drainage tubes. A wick of iodoform gauze or worsted should be passed to the bottom of each tube, or they may be sucked dry at frequent intervals by means of a syringe. The head of the bed may with advantage be raised to direct the fluid into the pelvis. If an area of infection has been left behind which it is impossible to remove, it should be packed with a large strand of iodoform gauze or wool, the end of which is brought out at the wound.

The *after-treatment* consists in combating shock, relieving symptoms, and securing the action of the bowels. M'Cosh's procedure of injecting a solution of sulphate of magnesia into the lumen of the bowel—preferably the jejunum—before closing the abdomen is an attempt to fulfil the last indication. The alternative plan is to give calomel in repeated small doses followed by a saline. Flatulent distension may be relieved by an enema containing turpentine.

Localised Forms of Septic Peritonitis.—In virtue of the capacity of the peritoneum to form adhesions, septic infections frequently remain localised to the vicinity of the organ in which they originate. This is most frequently observed in relation to the appendix, the female pelvic organs, and the gall-bladder. At any stage of the process resolution may occur; the organisms die out, the exudation is reabsorbed, and recovery ensues. If the inflammatory exudate become purulent, the condition approaches that of a circumscribed abscess in other parts of the body, the wall of the abscess consisting of inflamed serous surfaces gummed together by lymph.

The *clinical features* are at first similar to those of diffuse peritonitis, but as the infection becomes localised the general symptoms subside, while the inflammatory signs become more

marked in the region of the organ primarily affected. The local pain and tenderness increase. The rigidity of the abdominal wall is most marked in the area involved. A more or less defined swelling forms, and is sometimes palpable through the anterior abdominal wall, sometimes through the rectum or vagina. The general condition of the patient improves as the localisation becomes more complete, and the pulse affords the most useful guide to its occurrence. The clinical features and progress naturally vary with the seat and extent of the infection. If pus forms, it may rupture into the general cavity, into one of the adjacent hollow organs, or into the extra-peritoneal cellular tissue. As a rule the pus approaches the surface, and the skin becomes œdematous and pits on pressure.

The *treatment* is essentially operative. It is best studied with the individual organs.

Pneumococcal Peritonitis.—This may occur in association with pneumonia, pleurisy, or meningitis, and is then part of a general infection, and is of little surgical importance. The organisms reach the peritoneum through the blood-stream, or by extension from the pleura through the diaphragm. Pneumococcal peritonitis is met with chiefly in female children, and it runs its course without any starting-point being discoverable. After an acute onset characterised by pain in the lower part of the belly, vomiting and fever, the symptoms may moderate for a time and then become more aggressive. The abdomen becomes distended, especially in the lower umbilical region, and there may be the physical signs of fluid exudation. Sometimes there are several distinct encapsulated collections of fluid within the belly, mostly situated below the umbilicus. In suppurative cases the abscess has been known to point and rupture at the umbilicus. The pus is of a greenish colour, without odour, and is mixed with a large amount of fibrin. It may contain pneumococci alone or along with other pus organisms.

The diagnosis from appendicital or tuberculous peritonitis may be difficult.

The *prognosis* is more favourable than in most other forms of septic peritonitis. Although spontaneous recovery is possible, the treatment is to open and irrigate the abdomen and establish drainage.

Gonococcal Peritonitis.—This is met with chiefly in females, and occurs both in adults and in children. The peritoneum is infected by way of the Fallopian tubes, either through the ostium or by the rupture of a pyosalpinx. In the male the infection may spread from the seminal vesicles. The peritonitis follows

upon a gonorrhœa, sometimes of long standing, and in either sex it may be limited to the pelvis—pelvic peritonitis—or may become generalised. A characteristic feature is that the onset is very acute, and is followed by an abatement of the urgent symptoms; and that, in spite of the apparent gravity of the illness, the patient may gradually recover with or without the formation of extensive pelvic adhesions. The diagnosis of the gonorrhœal origin of a given case of peritonitis may be difficult, unless gonococci are discovered in the discharge from the cervix, vagina or urethra. The question of operative interference is still an open one, chiefly because recovery is known to be possible without having recourse to it. At the same time, incision and drainage have yielded excellent results even when the outlook seemed grave in the extreme, and the removal of a quantity of purulent exudate, and of a pyosalpinx when this is present, affords the patient a better prospect of rapid and complete recovery than when the condition is left to nature.

Chronic Peritonitis.—It appears inadvisable to apply this term to the reparative changes in the peritoneum which attend upon almost every form of intra-abdominal disease. A primary and progressive chronic peritonitis can scarcely be said to exist apart from such chronic infections as tubercle, syphilis, or actinomycosis.

Peritoneal Tuberculosis and Tuberculous Peritonitis.—This affection is specially common in children and young adults, although it may be met with at any period of life. It rarely exists as an independent disease, being usually secondary to some other tuberculous lesion. This may involve the intestines, the Fallopian tubes, or the abdominal lymphatic glands, the peritoneum being infected by direct extension. Tuberculous disease of the lung or pleura may spread to the peritoneum by way of the lymphatics, while tubercle of the bronchial glands, the bones, and joints, or the genito-urinary organs, may travel by way of the blood stream.

Acute miliary tuberculosis usually affects the peritoneum and pleuræ simultaneously, and is met with chiefly as part of a general tuberculosis. The general symptoms may overshadow the local signs to such an extent that the condition may be mistaken for typhoid fever. The disease is not amenable to surgical interference, and is usually fatal within a few months of the onset.

The *chronic forms* of peritoneal tuberculosis are much more important. For descriptive purposes they may be divided into

two main types, according to whether the exudation of fluid or the formation of adhesions is the predominant feature.

Tuberculosis with Fluid Exudation—Tuberculous Ascites.—In the common diffuse form the peritoneal cavity gradually fills up with fluid which yields a dull note on percussion, the dulness varying in position with the attitude of the patient. In advanced cases the abdomen is prominent, the skin tense and shiny, with distended veins running in it. The large belly presents a striking contrast to the emaciated condition of other parts of the body. In male children, if the processus vaginalis is patent, it also becomes filled with fluid. The condition often yields to medical measures—the internal administration of iodoform and salol, of cod-liver oil and arsenic, and the local use of gentle massage in the shape of inunction with ichthyol, mercury, or cod-liver oil—in combination with open-air treatment. In the absence of improvement within from three to six months recourse should be had to laparotomy. A small incision is made below the umbilicus, and the fluid—a clear, straw-coloured serum which is usually sterile—is allowed to drain away. If the finger be inserted, the peritoneum is found to be studded with firm tuberculous nodules varying in size from a pin's head to a hazel-nut, and the mesenteric glands may be felt to be enlarged. The wound is sutured except where the tube emerges, and the usual dressings are applied, and must be changed frequently within the first twenty-four hours until all the fluid has drained away; the tube is then removed. The improvement which follows simple laparotomy is often remarkable, and is probably due to reactive changes in the peritoneum increasing its bactericidal properties. If the fluid re-accumulates, the laparotomy may require to be repeated.

A more radical operative treatment is to open the abdomen by an incision long enough to permit of exploration, and, if feasible, to remove any primary tuberculous focus, such as the Fallopian tubes or caseous mesenteric glands.

The *encysted form of tuberculous ascites* is much rarer, and is usually met with in adults, especially of the female sex. The infected area is enclosed by adhesions which may become condensed so as to form a wall of considerable thickness and strength. The clinical features may closely resemble those of an ovarian or other cystic tumour, for which the affection has been mistaken by experienced clinicians.

This form seldom yields to medical treatment, and should therefore be subjected to operation. The incision is made over the cystic swelling, wherever it may be, and the fluid evacuated.

The wound may then be closed with sutures or the cavity may be packed and drained; in the latter case a discharging sinus results and may persist indefinitely.

If the peritoneal cavity be opened outside the limits of the tuberculous collection, it is necessary to differentiate this from a cystic ovarian tumour. In the former there are extensive adhesions to adjacent structures, while in the latter some part of the wall will present the smooth, shining surface of a cyst. In doubtful cases the diagnosis is to be cleared up by microscopical examination.

The *purulent form of tuberculous peritonitis—or cold abscess of the belly*—is rare, and is met with chiefly in female children. The illness runs a somewhat rapid course, emaciation is very pronounced, there is tenderness of the belly, and the temperature curve is of the hectic type. If left to nature, the abscess may reach the surface and rupture at the umbilicus. There should be no delay in performing laparotomy. The fluid resembles green pea-soup, and escapes in enormous quantity. No tubercles are felt on introducing the finger; the viscera are covered over by a uniform layer of gelatinous exudation. Although the prognosis is less favourable in purulent than in ascitic cases, we have observed remarkably rapid improvement and complete recovery.

In the *dry forms of peritoneal tuberculosis associated with the formation of adhesions and matting of viscera* the abdomen is only moderately distended, and pain and tenderness are but little marked. In percussion there are irregular areas of dulness and resonance; and on palpation there is either a general feeling of increased resistance, amounting to doughiness, or else hard, irregular and nodular masses, or atypical thickenings are felt. In some cases a sausage-shaped mass—the thickened and crumpled omentum—may be palpated running transversely across the abdomen about the level of the umbilicus. Fluid may collect in the spaces between adhesions, but it is small in quantity and does not yield fluctuation, nor does it change its position with the movements of the patient. On rectal examination it may be possible to feel scattered nodules in the peritoneum, or a prominent swelling occupying the pouch of Douglas consisting of adherent coils of bowel. The *prognosis* is grave in this form of peritoneal tuberculosis, not only because there is little tendency to spontaneous recovery, but also because it is liable to be attended with various complications, such as abscess formation with rupture at the umbilicus or in the ileo-cæcal region, sometimes followed by a fæcal fistula, or by the sudden or gradual development of intestinal obstruction. These graver cases are frequently

associated with tuberculous ulceration of the bowel and with pulmonary phthisis.

The *treatment* in this group of cases is not hopeful, and is surrounded with difficulties. The operation of laparotomy may prove very difficult on account of the dense matting of the intestines to each other and to the abdominal wall, and misguided attempts to unravel the coils may result in tearing the fragile intestine and may bring about a fæcal fistula. In more favourable cases the tuberculous infection is limited to the neighbourhood of the primary focus—an intestinal ulcer, a tuberculous appendix or Fallopian tube—which primary focus should be removed.

After any laparotomy for peritoneal tuberculosis there is a risk of tuberculous infection of the scar, resulting in its breaking down into an ulcer, sometimes followed by a fæcal fistula, or after healing by a ventral hernia.

Actinomycosis of the peritoneum usually arises from pre-existing disease in the intestine, especially in the cæcum. Large insensitive masses, consisting of coils of intestine, omentum and inflammatory exudation, form in the belly. The mass, which is at first hard, gradually softens, forming a chronic abscess, which bursts externally leading to the formation of tortuous discharging sinuses. The pus contains the characteristic fungous bodies. The disease tends to progress and to prove fatal. Treatment consists in the internal administration of iodides and the removal of the infected tissues with a sharp spoon.

Peritoneal Adhesions and Bands.—Adhesions between apposed surfaces of peritoneum may result from any form of lesion within the abdomen. They result not only from affections which give rise to acute peritonitis, but also from those which pursue a chronic or latent course, such as gastric and intestinal ulcers, gall-stones, disease in the mesenteric glands, or tuberculous peritonitis. They also occur in relation to external hernia and after abdominal operations, especially those in which the peritoneum has been roughly handled, or in which surfaces have been denuded of their serous covering.

Adhesions are frequently reabsorbed. If they persist, they are liable to become elongated from being constantly dragged upon by the movement of the viscus to which they are attached, and to be moulded into a cord-like structure or "band" by the rolling movements of the intestines. A portion of adherent great omentum may be similarly elongated and moulded into a band. Bands consist of fibrous connective tissue invested by peritoneum, and they vary in thickness from that of thick catgut to that of the little finger. They vary also in

length, the longest recorded measuring seventeen and a half inches.

Adhesions and bands may exist without giving rise to any symptoms, or they may, by fixing or dragging upon structures to which they are connected, cause suffering and bring about conditions dangerous to life. Abdominal pain and discomfort may result from traction on the parietal peritoneum; the functions of the stomach may be disturbed from the pylorus being dragged upon or narrowed; the intestine may become kinked, twisted or strangulated, causing colicky pain, constipation or even obstruction of the bowels. The formation of adhesions after abdominal operations may be prevented by taking care to avoid irritating the peritoneum by rough handling or prolonged exposure to the air, by removing all blood-clots from the peritoneal cavity, and by suturing the peritoneum over raw surfaces and pedicle stumps. The bowels and omentum should be replaced in their proper relations, and this is best accomplished by filling the cavity with hot saline solution so as to float the intestines and allow them to adjust themselves.

Tumours of the Peritoneum and Extra-Peritoneal Cellular Tissue.

Mesenteric tumours originate in the extra-peritoneal tissue at the root of the mesentery, and as they increase in size they insinuate themselves between the layers of the mesentery and project towards the abdominal cavity. They are also known as *retro-peritoneal tumours* because of this relation to the posterior layer of the peritoneum. They are usually innocent in character, and consist almost exclusively of fat, hence the terms *mesenteric* or *retro-peritoneal lipomata*. They rarely cause symptoms until they attain a large size, and then by their bulk they may exert pressure on adjacent viscera. They form rounded or oval, lobulated, soft or semi-fluctuating tumours which occupy the central area of the abdomen, and are slightly movable from side to side. One or more coils of intestine may run obliquely across the tumour. The possibility of removing the tumour can only be determined after opening the abdomen. Apart from adhesions the chief difficulty consists in avoiding injuring the large mesenteric blood-vessels; should these be damaged, it may be necessary to resect extensive segments of the intestine in relation to the tumour. The peritoneal investment is divided, and an attempt made to shell the tumour from out the mesentery. The malignant form of mesenteric tumour—*the retro-peritoneal sar-*

coma—closely resembles the lipoma clinically, but is of more rapid growth and of firmer consistence; its removal should not be attempted.

Omental tumours lie in the umbilical region, near the anterior abdominal wall, and are freely movable. The innocent forms may lend themselves to extirpation, but special care must be taken not to damage the blood-vessels supplying the transverse colon.

Malignant Disease of the Peritoneum.—This may be a primary affection in the form of colloid cancer or endothelioma; more often it is secondary to cancer of the stomach, liver, intestine or ovary. The clinical features are those of an insidious ascites, not unlike that resulting from tuberculosis, with nodular tumours in different parts of the abdomen. If the belly is opened there escapes an abundant serous exudate, frequently turbid from the presence of degenerated cancer cells, and sometimes blood-stained from hæmorrhage. The peritoneum may be seen and felt to be studded with cancer nodules, which in the omentum are collected into larger masses. In the secondary forms it may be possible to recognise malignant disease in the organ from which the peritoneal metastases originated.

Mesenteric Cysts.—These appear to originate in relation to the lymphatics of the mesentery, and may be described as *serous*, *chylous*, or *hæmorrhagic* according to the nature of their contents. They form very insidiously, and may attain a considerable size before attention is directed to them by the enlargement and prominence of the abdomen, by the sudden onset of colicky pains, or by symptoms of intestinal obstruction. They occupy the middle line of the abdomen at or below the umbilicus, are rounded, tense and elastic, and are freely movable from side to side. There is often a zone of resonance across the cyst corresponding to a coil of intestine, and there is usually an area of resonance between the cyst and the pubes. Although these points are characteristic, mesenteric cysts have frequently been mistaken for ovarian and pancreatic cysts and for other forms of movable abdominal tumour. Puncture for diagnostic purposes is not recommended.

The *treatment* consists in opening the abdomen and investigating the relations of the cyst. If the conditions are favourable it is best to shell out the cyst after incising the investing peritoneum; otherwise the cyst is stitched to the parietal wound and drained.

Hydatid cysts of the peritoneum are usually secondary to hydatid disease in the liver or other viscus.

The Mesenteric Glands.

These glands lie between the layers of the mesentery, and receive lacteals from the small intestine and the colon as far as the sigmoid flexure. Along with the retro-peritoneal glands which lie beside the aorta they transmit lymph and chyle to the thoracic duct. Infective agents may pass from the mucous membrane of the intestine to the glands by the lymph-stream.

Tuberculous disease is extremely common. A diffuse caseating form, associated with tuberculosis of the peritoneum and intestine, is almost exclusively met with in children, and is known as *tabes mesenterica.* It is not amenable to surgical interference. Localised disease in the mesenteric glands may give rise to various complications which call for operative treatment. That most frequently met with is the condition in which the tuberculous disease, having erupted through the capsule of the gland, causes a localised adhesive peritonitis, followed by the formation of a band which may bring about intestinal obstruction. Obstruction may also be brought about by tuberculous infiltration and contraction of the mesentery, or by adhesion and kinking of the intestine over a tuberculous gland. A rarer complication is that in which the gland, having become the seat of acute inflammatory softening, ruptures and discharges its purulent contents into the peritoneal cavity, setting up acute peritonitis. A group of tuberculous glands, usually those of the lower ileum, may become inflamed and give rise to a palpable mass in the right iliac fossa, which, when associated with severe pain and high fever, may lead to the condition being mistaken for a lesion of the appendix. Enucleation of the inflamed glands should be performed if practicable.

Suppuration in the mesenteric glands is one of the recognised complications of typhoid fever; when met with in the form of a circumscribed abscess this should be opened and drained.

In lymphadenoma, lymphatic leucocythæmia, and in various forms of malignant disease, the mesenteric and retro-peritoneal glands are often extensively involved, and may form multiple tumour-like swellings within the abdomen.

Subphrenic Abscess.

The term subphrenic abscess is applied to a collection of pus beneath the vault of the diaphragm. This potential space is divided into two compartments by the suspensory ligament of the liver, and the abscess may be located on the right or on the

left side. In a certain proportion of cases the pus accumulates in the cellular tissue behind the peritoneum, but in the majority it is intra-peritoneal, the general peritoneal cavity having been previously shut off by adhesions. The abscess is usually situated on the same side of the body as the organ from which the original infection proceeded. Abscess on the right side (Fig. 64), for example, most often originates from lesions of the liver, bile-ducts, vermiform appendix, or right kidney, or from infective

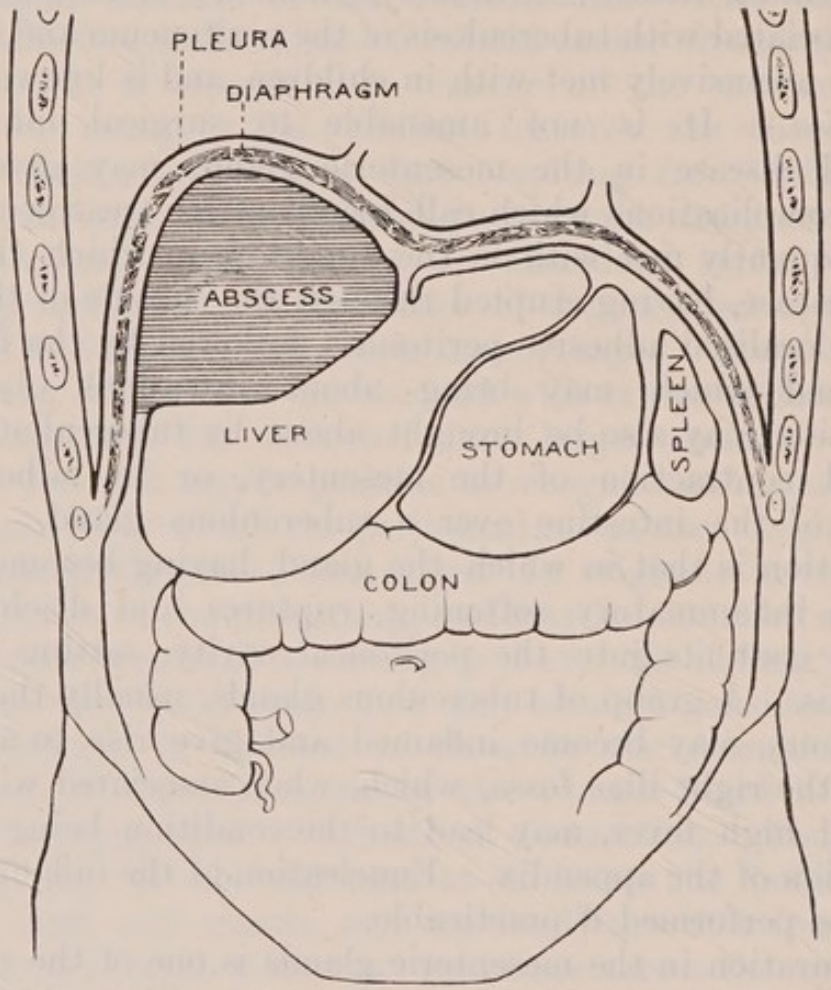

FIG. 64.—Diagram of Subphrenic Abscess on right side, displacing the diaphragm and liver.

conditions of the right pleural cavity or thoracic wall; while abscess on the left side (Fig. 65) results from lesions of the stomach, left pleura, or left thoracic wall. The abscess may contain pus only, or a combination of pus and gas; the gas may be derived from the perforation of a hollow organ, such as the stomach, or, as is more frequently the case, it is formed within the abscess itself as a result of bacterial decomposition.

The subphrenic abscess which follows upon lesions of the vermiform appendix is practically always right-sided, and it may be extra- or intra-peritoneal. The extra-peritoneal abscess

is due to an infection spreading upwards from the ileo-cæcal region in the cellular tissue behind the ascending colon, or between the layers of the ascending meso-colon. The intra-peritoneal abscess results from the shutting off of what was originally a general peritonitis, or it forms around an appendix which was abnormally situated.

The subphrenic abscess which follows upon lesions of the stomach is intra-peritoneal, and is nearly always located beneath

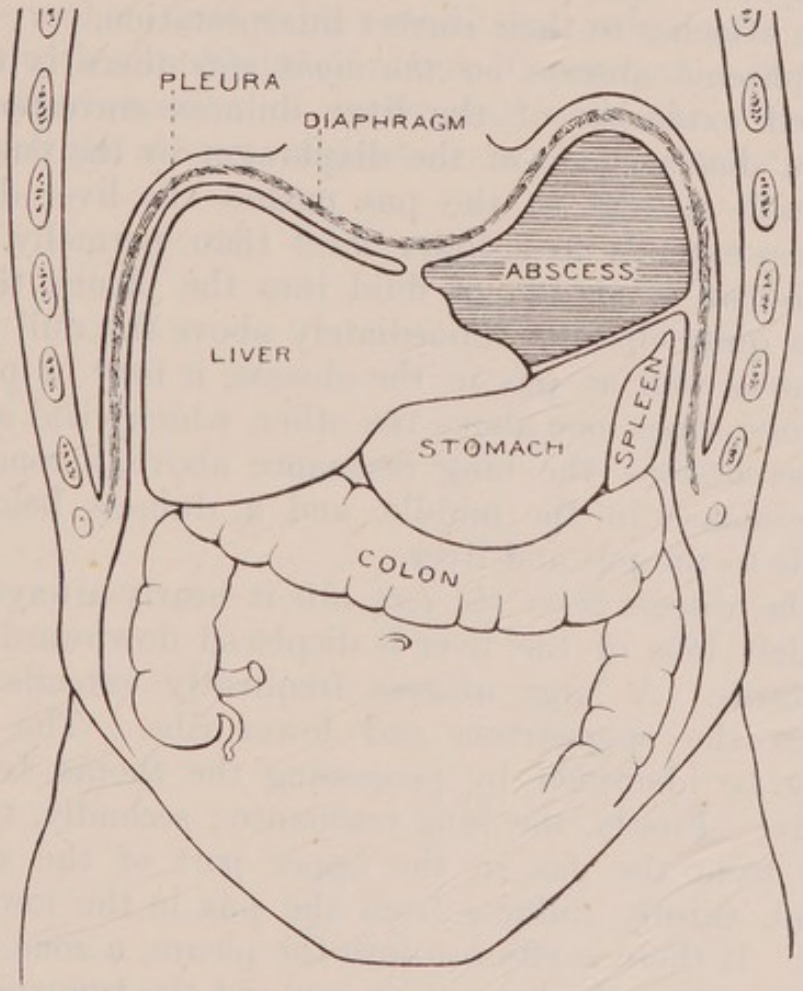

FIG. 65.—Diagram of Subphrenic Abscess on left side, displacing the diaphragm, left lobe of liver, stomach and spleen.

the left vault of the diaphragm. It usually originates in an ulcer which has perforated on the posterior wall of the stomach or in the vicinity of the lesser curvature, the perforation having been preceded by adhesions which confine the extravasated septic contents to the subphrenic space on the left side. It may perforate the diaphragm and burst into the pleura, giving rise to one form of empyema.

The *clinical features* vary widely in different cases. There is usually a history of antecedent disease in one or other of the abdominal viscera. The prominent symptoms are those common

to all forms of circumscribed intra-abdominal abscess, namely, pain, remittent fever, vomiting, progressive illness, with loss of appetite and strength. There is an increasing leucocytosis. The proximity of the abscess to the diaphragm may be indicated by a feeling of oppression and difficulty in taking a deep breath, and by pain over the lower ribs on one side radiating to the shoulder. There may also be tenderness and a degree of fulness over the lower intercostal spaces.

The physical signs are somewhat complicated, and great importance attaches to their correct interpretation.

In subphrenic abscess *on the right side* there is usually a dome-shaped extension of the liver dulness corresponding to the upward displacement of the diaphragm by the pus accumulated beneath it, and as the pus pushes the liver down, the liver dulness extends to a lower level than normally. Unless there is also an exudation of fluid into the pleura, the breath sounds are quite distinct immediately above the dull area. If there is gas as well as pus in the abscess, it may be possible to identify three zones, one above the other, which yield a different note on percussion—the lung resonance above, a zone of tympanitic resonance in the middle, and a dulness below which corresponds to the pus and liver.

When the abscess is *on the left side* it nearly always contains gas; the left lobe of the liver is displaced downwards and the heart upwards. A large abscess frequently extends forwards and bulges the epigastrium and lower ribs. The following zones may be identified by percussing the thorax from above downwards:—Firstly, the lung resonance; secondly, tympanitic resonance from the gas in the upper part of the subphrenic space; and, thirdly, dulness from the pus in the lower part of the space. If there is effusion into the pleura, a zone of dulness intervenes between the lung resonance and the tympanitic zone.

Exploratory puncture is carried out by means of a fairly long needle connected with the aspirator. The needle is inserted where the tenderness and dulness are most marked; its passage through the diaphragm may be recognised by the transmission of respiratory movements. Commonly enough serum is aspirated from the pleura, and, when the needle is pushed in further, pus is obtained. If a single puncture is negative, the needle may be reinserted at different points. It is essential that the presence of pus be demonstrated before proceeding to incision and drainage, and this procedure should follow immediately on the exploratory puncture. The incision is planned so as to afford the most direct access to the cavity of

the abscess. If the abscess project below the costal margin anteriorly, it is opened from the front; in the majority of cases the trans-pleural route, similar to that employed for hepatic abscess, must be employed, and it yields the most efficient drainage. In isolated cases the abscess is behind the liver, for example, where it has originated from the appendix or right kidney, and it may be possible to reach it by making an incision below the twelfth rib, and then working upwards between the liver and the diaphragm.

Even under favourable conditions subphrenic abscess is attended with a mortality of about 40 per cent. If the patient recover, the question of interfering with the diseased organ from which the abscess originated may require to be considered.

CHAPTER XXIV.

APPENDICITIS.

Surgical anatomy—Pathological anatomy: *Catarrhal changes: Erosions; Strictures; Concretions; Necrosis; Perforation; Bacteria concerned; Adhesive peritonitis; Circumscribed suppurative peritonitis or peri-appendicular abscess; Diffuse peritonitis;* Clinical features; *Phenomena dependent on inflammation of the appendix itself; Peri-appendicular peritonitis with swelling or abscess formation; Diffuse peritonitis and peritoneal septicæmia;* Diagnosis; Prognosis; Treatment; *Expectant measures; Indications for operation;* Recurrent appendicitis.

Surgical Anatomy.—The vermiform appendix is a short, narrow, blind tube arising from the inner and back part of the cæcum about three-quarters of an inch below the ileo-cæcal junction. Its length varies, the average being about two and a half to three inches. Its origin from the cæcum is indicated approximately on the surface of the abdomen by a point about two inches from the anterior superior iliac spine on a line between this and the umbilicus—the so-called M'Burney's point. The lie or direction of the appendix is subject to considerable variation. It has been found in every possible situation which its length would allow it to attain. The commonest directions in which it points are—(1) Upwards and inwards, being overlapped by the lower end of the ileum and its mesentery. This is the situation in which it is most frequently found in operating for the removal of the organ, and is that associated with the classical signs of appendicitis. (2) Downwards over the brim of the pelvis, when it is liable to be associated with what has been aptly termed pelvic appendicitis, the inflammatory swelling being best observed by rectal or vaginal examination. (3) Upwards behind the cæcum, in which position it is associated with retro-cæcal appendicitis, in which the infection frequently spreads to the retro-peritoneal cellular tissue, and is more likely to be shut off from the general peritoneal cavity than in any of its other situations.

The anterior longitudinal muscular band of the cæcum affords the surest guide to the appendix, the base of which can be located with certainty by following this band to its lower termination.

The appendix is completely covered by peritoneum, and has a well-formed mesentery which connects the process to the under surface of the mesentery belonging to the lower end of the ileum. The meso-appendix varies in length, in some cases extending to the tip of the organ, in others terminating about its middle.

The artery of the appendix runs in the mesentery near its free border, and is liable to be compressed or kinked when the mesentery is pulled upon or twisted. The lymphatics pass in the mesentery to one or two small glands near its base, and from them the efferent vessels pass to the meso-colic glands behind the ascending colon.

The minute structure of the appendix is remarkable chiefly on account of the large amount of lymphoid tissue in the submucous coat, suggesting an analogy with the tonsil, which it also resembles in its susceptibility to bacterial infection.

Pathological Anatomy.—The inflammatory lesions included under the term appendicitis are primarily due to bacterial infection of the mucous membrane of the appendix, and especially of the lymphoid tissue situated beneath the epithelial lining. The organisms chiefly concerned are colon bacilli and streptococci, together with certain anaërobic bacteria which impart to the pus its fœtid odour, and are mainly responsible for the occurrence of gangrene and the severe forms of general intoxication.

The anatomical changes range from those which attend a simple catarrh to a necrosis or gangrene of a portion of the wall of the appendix or of the whole organ. The importance of the catarrhal changes is that the swelling of the mucous membrane tends to narrow or even to block the lumen and the communication with the cæcum, so that the contents of the tube are retained and afford a favourable nidus for organisms. The erosions which form on the epithelial surface enable the organisms to invade the submucous tissue, from which they may spread to the muscular and peritoneal coats. The cicatricial changes which follow upon catarrh may result in the formation of one or more annular constrictions of the tube which, by causing retention of the contents, may determine fresh outbreaks of inflammation from time to time. Chronic retention and catarrh, together with decomposition changes in the contents of the tube, are the chief agents in the production of what are known as *appendicular concretions*. These are rounded or oval calculi consisting of a variable mixture of lime salts, bacteria, and materials derived from the fæces; they are usually so soft that they can be crushed between the fingers. They are commonly grasped by the wall of the appendix either near the apex or towards the middle of the tube between two annular constrictions. Once formed, a concretion may increase in size by further deposit on its exterior, and in all probability it tends to keep up the catarrhal process to which it owed its origin, and by its mechanical pressure to damage that part of the wall with which it lies in contact. These concretions often bear a striking resemblance to date-stones, plum-stones or orange-pips, but it is

extremely seldom that any foreign body is met with in the appendix either free or forming the nucleus of a concretion. In one instance, however, we have found an ordinary pin in the lumen of the tube.

The bacterial infection, which is the essential factor in appendicitis, is liable to spread from the mucous membrane to the other coats of the tube, and finally to involve the peritoneum. The anatomical changes in the tube are analogous to those observed in a strangulated loop of bowel, and vary with the virulence of the invading organism from a simple adhesive inflammation to one attended with necrosis and sloughing. The gangrene usually affects one or more circumscribed areas, and the necrotic patches are sharply defined from the living tissue around (Fig. 66). Sometimes the entire organ undergoes necrosis, and appears as a blackish-green, flaccid structure completely separated from its connections, and scarcely to be recognised as an appendix. The gangrenous process may even spread to the wall of the cæcum. Perforation of the appendix is most frequently the result of necrosis and subsequent separation of the slough. This may take place at the apex, particularly when the meso-appendix does not extend to the tip; or on the convex border, usually opposite the point at which the mesentery stops; or it may occur at the junction with the cæcum. Perforation frequently takes place over a concretion, and the resulting aperture may be large enough to allow the concretion as well as the infective material pent up in the lumen to escape.

FIG. 66.—Gangrene of Distal Portion of Appendix—concretion in proximal portion.

The serous coat is involved in all but the mildest forms of inflammation of the appendix, and the gravity of the disease depends on the manner in which the surrounding peritoneum is able to contend with the infection.

The formation of fibrinous adhesions represents a successful attempt on the part of the peritoneum to circumscribe and encapsulate the infection. The adhesions involve the great

omentum and the adjacent parts of the small and large intestine and their mesenteries, and they play a considerable part in the formation of the swelling in the right iliac fossa, which is one of the clinical signs of the disease. If the process be arrested at this stage, complete recovery may take place, the inflammatory products disappear, and the parts return to their normal condition.

Peri-appendicular abscess, or *circumscribed suppurative peritonitis* represents a less successful attempt on the part of the peritoneum to overcome the infection. It may follow on the adhesive form, the sero-fibrinous exudation undergoing a purulent transformation, but more commonly it results from a perforation of the appendix which has been preceded, or is immediately followed, by the formation of limiting adhesions. At first the abscess is confined to the immediate vicinity of the appendix itself, and contains a small quantity of thick greenish pus having a fæcal odour. The disease may be arrested at this stage and recovery take place. More frequently the abscess increases in size, or several small collections of pus coalesce and form a large abscess. The abscess is walled in by the peritoneum of the iliac fossa, the cæcum, the lower coils of the ileum, and the great omentum matted together by adhesions. If the abscess extend forwards, its anterior wall comes to be formed by the parietal peritoneum. The appendix may hang free in the abscess cavity; more frequently it is buried in the purulent lymph forming the wall of the abscess; and in rare cases it sloughs off from the cæcum and lies loose in the pus. The situation of the abscess varies with the position of the appendix. It is most often situated in the right iliac fossa to the inner side of the cæcum, but not infrequently it is found to the outer side of or behind the cæcum, or in the pelvis. Sometimes it lies nearer the umbilicus, and, in the case of a very long appendix, or an unduly movable cæcum, may actually be found in the left iliac fossa. The abscess may extend in an irregular manner, the original limiting adhesions melting away, while fresh adhesions form beyond the spreading margin. It is possible to have several distinct purulent collections separated from one another by adhesions. The abscess may spread to a considerable distance from its seat of origin, for example, upwards along the ascending colon to the diaphragm, where it constitutes one form of subphrenic abscess, or downwards into the true pelvis, the pus collecting between the rectum and bladder in the pouch of Douglas. The pus may open into one of the hollow organs—cæcum, rectum, or bladder. It is by no means uncommon to find a collection of pus in the pouch of Douglas completely shut

off by adhesions from the abscess around the appendix—a point of importance in connection with treatment, as the deeper collection may escape detection and not be drained by the tube introduced into the appendicular abscess.

Diffuse Peritonitis.—In the absence of a sufficient reaction on the part of the surrounding peritoneum the infection rapidly spreads, and becomes diffuse, or even generalised. In the gravest cases of all—such as give rise to the condition of peritoneal septicæmia—there is no reaction, and only a small quantity of odourless, blood-stained serum is found in the peritoneal cavity. In other cases there is diffuse suppuration, with accumulations of pus in the pelvis and flanks and between the lower coils of intestine, while in the upper part of the abdomen the exudation is serous or sero-purulent. In a third group of cases, although the suppuration is not confined to the appendicular region, certain areas of the peritoneal cavity are shut off by adhesions so that the larger collections of pus are separate from one another.

The cellular tissue in the iliac fossa may be infected either directly or by way of the lymphatics. A suppuration, originally intra-peritoneal, may spread to the cellular tissue if prevented by firm adhesions from extending within the abdomen. The suppuration may spread along the iliac fossa between the peritoneum and the iliac fascia as far as Poupart's ligament, being prevented from entering the thigh by the attachment of the fascia to Poupart's ligament, or it may spread upwards behind the ascending colon towards the kidney, or backwards into the loin.

Conditions of Occurrence.—Although appendicitis is chiefly a disease of youth, and occurs with greatest frequency between the ages of twenty and thirty, it may be met with at any period of life. It is approximately three times more common in the male than in the female—a fact of which there is no satisfactory explanation, unless the additional blood-supply from the ovarian artery be so regarded. The infective process usually occurs in individuals who are apparently in good health, although in some cases it may follow upon an antecedent catarrh of the bowel, or on some general blood infection, such as influenza. The influence of cold, injury, excessive exertion, especially that entailing use of the psoas muscle, sometimes assigned as causes of appendicitis, are rather to be regarded as factors which may light up an acute inflammation in an appendix which is already diseased. Whatever be the explanation, there is no doubt of the fact that the disease has increased in frequency within recent years.

Clinical Features.—It should be stated at the outset that it is not always possible to identify clinically the different anatomical lesions above described, or, before opening the abdomen, to distinguish between the catarrhal, the perforative, and the gangrenous forms of appendicitis. For purposes of description we may differentiate the following clinical types:—(1) those cases in which the phenomena depend chiefly on inflammation of the appendix itself; (2) those in which there is peri-appendicular peritonitis with swelling or abscess formation; and (3) those complicated by diffuse peritonitis.

Cases in which the Clinical Phenomena are dependent on Inflammation of the Appendix itself.—These include the mild forms in which the symptoms are referable rather to the reflex phenomena of peritonism than to actual peritonitis. The patient is seized with abdominal pain, which is usually referred to the umbilicus, followed by nausea and vomiting, and sometimes by diarrhœa; and the temperature rises two or three degrees. On examination of the abdomen there may be some general tenderness, but the pain and tenderness soon become localised to the right iliac fossa, and are most marked in the region of M'Burney's point. The tenderness prevents palpation, but even under an anæsthetic nothing abnormal can be felt. In the course of from twenty-four to thirty-six hours these symptoms subside, and the patient becomes quite well, except for a little tenderness in the region of the appendix. Such attacks are very liable to recur at irregular intervals, constituting what is known as recurrent appendicitis.

Appendicitis associated with Peri-Appendicular Peritonitis and Inflammatory Swelling.—The onset of the illness is attended with symptoms similar to those above described. There is, however, more decided general illness with a definite rigor, considerable fever, rapid pulse, and vomiting. The bowels are constipated and no flatus is passed. The abdominal wall in the region of the right iliac fossa does not move with respiration, and is rigid and excessively tender to touch, both on superficial and on deep palpation.

It is at first impossible to infer the nature or extent of what is obviously a peritonitis, but in the course of a day or two the severity of the illness abates, the signs of peritoneal reaction become localised, and, if the rigidity of the abdominal wall has yielded sufficiently to allow of palpation, a swelling can be recognised in the right iliac fossa. This swelling, which is roughly discoid in shape, and varies in diameter from two to four inches, is not movable, and is tender to the touch. If

resolution take place, the general symptoms still further subside, the evening rise of temperature is less, flatus is passed or the bowels may move, and from the fifth to the seventh day onwards the swelling diminishes from the periphery towards the centre. The abdominal wall recovers its pliability, and the phlegmon comes to be represented by a deeply placed, rounded lump or mass fixed in the iliac fossa. The swelling usually disappears altogether in from fifteen to twenty days, but traces of it may remain as long as six or eight weeks.

Peri-appendicular Peritonitis followed by the Formation of an Abscess.—It is seldom possible to say whether or not suppuration is going to take place. If an abscess is forming, the symptoms of localised peritonitis persist, the temperature remains elevated, or if it has fallen, rises again, often reaching a higher point than before. The pulse is quickened, and sweating is often a marked feature. Examination of the blood usually reveals a marked leucocytosis. At the same time the local features change. The swelling increases in area, and may form a salient bulging in the right iliac fossa; it may be observed to alter in consistence, becoming softer and more doughy, and it becomes more tender. Œdema of the abdominal wall, dilatation of the surface veins, and fluctuation are later developments, and occur as the pus increases in amount and approaches the surface.

The situation of the abscess and the associated physical signs vary with the anatomical position of the appendix. The foregoing description refers to the condition when the appendix is in its usual position at the inner side of cæcum and overlapped by coils of small intestine.

In the retro-cæcal situation of the appendix the pus accumulates behind or to the outer side of the cæcum, and is more or less extra-peritoneal; hence the symptoms of peritonitis are less marked or may be absent, the vomiting is less, and the constipation not so pronounced; the abdominal wall is less rigid, and on palpation no definite swelling is to be felt, but merely an ill-defined, deeply-situated resistance. The right leg is frequently flexed, there may be marked tenderness on pressing in the loin, where at a later stage there may be evidence of pus approaching the surface.

In the pelvic form of appendicitis most information is gained by a rectal examination; a soft, tender swelling is felt in the pouch of Douglas, especially towards the right side. The patient complains of trouble with the bladder in the form of frequency of micturition, difficulty in starting the act, and pain

while the bladder is contracting, and especially at the end of micturition. There may also be rectal tenesmus, and pain shooting down the right leg. In addition to these pelvic symptoms a phlegmonous swelling may be felt in the iliac fossa.

Rupture of an appendicular abscess on the skin surface is only observed in neglected cases, and is usually followed by persistent sinuses and sometimes by a fæcal fistula. Rupture into the bowel is usually followed by marked improvement in the general and local symptoms, and, in the case of a large abscess, by the appearance of pus in the stools. If an abscess bursts into the bladder, pus appears in the urine.

Complications, such as parotitis, pleurisy, hepatic or subphrenic abscess and general pyæmia, are occasionally met with, sometimes in cases in which the original appendicital lesion has not been recognised. Thrombosis of the iliac veins may ensue and cause a persistent œdema of the lower extremity.

Appendicitis complicated by diffuse Peritonitis and Peritoneal Septicæmia.—The cases included under this head constitute the gravest forms of appendicitis, sometimes spoken of as fulminating or *foudroyant* appendicitis, and are the chief source of the mortality from this affection. At the onset the symptoms are those common to all forms of acute appendicitis, and it is rarely possible to recognise the gravity of the case until after the lapse of twelve, eighteen or twenty-four hours. The symptoms of general infection progress without any evidence of local reaction. The symptoms of most value as indicating the gravity of the case are collapse, subnormal temperature, and a rapid, feeble pulse. The appearance of the face is altered, the features becoming drawn and pinched, and the expression anxious. Vomiting is usually persistent, and is not preceded by retching. The abdominal walls are rigid, and in the later stages the abdomen becomes distended. There may be nothing to indicate the appendicular origin of the disease, although pain and tenderness are usually more marked in the right iliac fossa than elsewhere. As these cases are not attended with any reaction on the part of the tissues, the leucocyte count is seldom of any value. The patient may die within thirty-six hours of the onset of the condition, and he is often to the end remarkably calm and free from suffering, and fails to realise the gravity of his condition.

In less severe cases there is some swelling in the iliac fossa, and other evidence of peritoneal reaction. The patient may live for several days, the final symptoms often being those of intestinal obstruction due to paralysis of the bowel.

Diagnosis.—While it is true that in the majority of cases of acute appendicitis there is little difficulty in recognising the condition, in a considerable number the clinical features so closely simulate those of other acute abdominal affections that it is extremely difficult to arrive at a diagnosis. In the absence of definite local signs in the iliac fossa, for example, confusion may arise in relation to such conditions as renal or biliary colic, perforated gastric or duodenal ulcer, intestinal obstruction, acute poisonings, typhoid fever, ruptured pyosalpinx or suppurative cholecystitis, the onset of acute pneumonia or diaphragmatic pleurisy on the right side.

In the case of children appendicitis may be simulated by latent tuberculous peritonitis with an acute exacerbation, softening tuberculous glands in the right iliac fossa, pneumococcal peritonitis, and inflammatory conditions at the base of the right lung and pleura. Before proceeding to operation a bimanual examination should be made under chloroform.

In the presence of a swelling in the iliac fossa confusion may occur in regard to extra-uterine pregnancy, ileo-cæcal intussusception, or osteomyelitis of the ileum. Peri-appendicital swellings of some standing may be mistaken for malignant or tuberculous disease at the ileo-cæcal junction.

Prognosis.—This should always be guarded in view of the treacherous character of the disease, and of its capacity of endangering life even in cases with a comparatively mild onset. The most favourable cases are those which begin to improve within twenty-four hours of the onset, and which continue to progress favourably. In a considerable number of cases, however, serious symptoms suddenly supervene on the fourth or fifth day, after the patient has apparently been making satisfactory progress. Acceleration and weakening of the pulse, persistent constipation and continuous vomiting, progressive distension of the abdomen, and an alteration in the general appearance of the patient, are characteristic of the dangerous forms of the disease, and indicate a grave prognosis.

Treatment.—*Expectant measures* are indicated in cases of appendicitis seen within a few hours of the onset. These consist in absolute rest in bed with the knees flexed over a pillow, and the application of cold-water tubes or ice to the right iliac fossa. The patient is allowed nothing but sips of hot saline solution, and, if necessary, a single dose of opium or morphin to subdue the pain. The bowels must not be disturbed either by medicine or enema, and palpation of the abdomen should be restricted to a minimum. The patient must be visited at frequent intervals,

as there is no condition which requires more careful watching. The patient is confined to bed until all the symptoms disappear, and is carefully nursed till the health is completely restored, when the question of removing the appendix may be considered.

Operative Treatment. — One of the greatest practical difficulties with regard to the treatment of acute appendicitis is to determine the moment at which operative interference is called for. The indications vary so widely in individual cases that it is only possible here to suggest certain general rules by which we are guided.

Operation is indicated *within the first twelve hours* if from the outset the symptoms assume a grave character, as, for example, in cases of so-called fulminating appendicitis. Early or immediate operation is nearly always called for in appendicitis of acute onset in children, because of the frequency with which the affection terminates in suppuration and in gangrene.

The abdominal cavity is opened by an incision in the line of the fibres of the external oblique, over the usual situation of the appendix. The diffuse nature of the lesion is evidenced by the presence of turbid serum or pus amongst the intestines and omentum. Although the infection is diffuse, it must not be inferred that it is generalised throughout the peritoneal cavity, and it is therefore safer not to irrigate at this stage for fear of spreading the infection. The exudation should be mopped up with gauze, and the extent of the infected area ascertained by careful exploration. The appendix is sought for and removed. Drainage is provided for by one or more tubes surrounded by iodoform worsted. A second incision may be required in the middle line for cleansing purposes and to drain the pelvis. The tubes may usually be removed at the end of twenty-four hours, and the worsted after two or three days. A smaller amount of packing is introduced, and renewed at intervals until the wound is healed. At first the patient is stimulated and nourished by the rectum. After twenty-four hours the bowels should be encouraged to move by means of repeated small doses of calomel, or sulphate or phosphate of soda. In operating as above for acute appendicital peritonitis, difficulty may arise from paralytic distension of the bowel. We have seen cases where the cæcum was so greatly distended that it was necessary to open and empty it before access could be obtained to the appendix. In other cases the risk of obstruction has been so great, that before closing the abdomen we have inserted a drainage tube into the cæcum, or into one

of the coils of the lower ileum, to allow of the escape of gas and liquid fæces.

If *within twenty-four hours* there is a decided improvement, especially in the facies and pulse, operation may be deferred; but the patient should be kept under continuous observation, the condition of the pulse and temperature, and the number of leucocytes, being specially noted, and attention paid to any changes taking place in the region of the appendix. Nourishment in the form of meat extracts, beef tea, cream, and aërated or barley water, by the mouth, is now permitted, and the action of the bowel is solicited, on or after the third day, by repeated doses of sulphate of soda or by enemata. Hot fomentations may replace the cold local applications. The question of operative interference is now dependent on the occurrence of suppuration within the area which has been shut off by adhesions, or on extension of the septic process to parts beyond the adhesions.

If, on the other hand, the symptoms show no signs of improvement *at the end of twenty-four or thirty-six hours*, and if the pulse, the facies, and the absence of abdominal movements indicate a progressive infection within the belly, it may be assumed that localisation is defective, and whatever the precise anatomical condition of the appendix, the best chance for the patient is to operate on the lines above indicated. The persistence of any one of the symptoms of onset is to be regarded as an indication for operative interference.

Operative interference for circumscribed suppuration is most often called for from the fifth to the tenth day, when the mass in the iliac fossa, instead of subsiding, becomes larger and more tender, the temperature begins to rise again, the pulse increases in frequency, and the number of leucocytes steadily rises. The operation varies with the situation of the abscess, as determined by careful palpation after the patient is completely anæsthetised. It is a safe rule to cut down upon the abscess where it has been located by physical examination, rather than over the supposed position of the appendix.

The simplest condition is that in which an abscess in the iliac fossa has spread towards the surface and become adherent to the *anterior abdominal wall*. The parietes are incised over the centre of the swelling down to the peritoneum, and the peritoneum cautiously perforated with a blunt instrument such as a dissector. When the pus begins to ooze out, the opening is carefully enlarged with dressing forceps, and after all the pus has been soaked up the abscess cavity is explored. The appendix is

searched for, and should be removed along with any concretion which may be found loose in the cavity. In these cases it is quite sufficient to ligature and cauterise the stump of the appendix. Drainage is then provided for by rubber tubes and gauze or worsted. This is spoken of as the "complete operation." If the appendix cannot be identified, its removal may be undertaken after an interval of a few days, by which time an intra-peritoneal operation can be carried out with safety.

When the abscess is not adherent to the anterior abdominal wall, the general peritoneal cavity is necessarily opened, and must be shut off by packing with gauze, before the adhesions which limit the abscess are separated. This should be done gently, and the pus must be soaked up as it oozes out until the abscess cavity is emptied. The appendix is searched for and, if possible, removed, and drainage is provided for by tubes and worsted, the rest of the wound being closed with sutures. The tubes and worsted are removed in forty-eight hours, and replaced by a smaller and smaller amount of drain material until the cavity fills up from the bottom.

When the abscess is in the pelvis, better access may be obtained by an incision in the middle line, and in some cases both a lateral and a median incision may be required. The appendix may be removed at the same time or after an interval of a few days. When the abscess is located in the pouch of Douglas, it is most efficiently drained by a tube brought out through the vagina or rectum.

If the abscess approach the surface *on the outer side of the cæcum or in the loin*, it may be opened and drained by means of an incision placed close to the crest of the ileum, keeping outside the peritoneal cavity.

Sinus or Fæcal Fistula after Operation.—If a sinus or fæcal fistula form, it usually heals during the ordinary period of convalescence. If, however, the appendix has not been removed, or a concretion has been left behind, the opening persists, and the removal of the appendix should be recommended unless there is good reason to the contrary. The abdomen is opened by a fresh incision in the immediate vicinity of the sinus after the latter has been disinfected and packed, the cæcum is identified, and the anterior longitudinal band followed down until the root of the appendix is exposed. This is divided and ligatured, and the stump invaginated into the cæcum, after which the rest of the appendix is removed. If the adhesions are firm the muco-muscular tube may be shelled out from its peritoneal investment.

A *ventral hernia* results in a certain proportion of suppurative

cases, owing to the defect in the muscular layers in the track of the drainage-tube. It is to be treated by means of a belt, or by an operation, which essentially consists in reuniting the different layers of the abdominal wall by several tiers of sutures.

Recurrent Appendicitis.—Recovery from a first attack of appendicitis without operation is followed by recurrence in a proportion of cases which has been estimated at about 20 per cent. Recurrence usually takes place within a year of the original attack, and is said to be more liable to occur if this has been of a mild character. The suppurative forms are less likely to relapse owing to the destructive changes which take place in the appendix, rendering it less liable to infection, and less capable of transmitting infection to adjacent tissues. The anatomical changes met with in and around the appendix in recurrent cases vary widely. In some cases the appendix is to all appearance normal, and but for the fact that the attacks cease after it has been removed, it would be difficult to believe that it was the cause of the symptoms.

In most cases, however, changes are found in the appendix or its vicinity which are obviously responsible for the recurrent attacks. The appendix, for example, may present one or more strictures, may contain a concretion, or may be bent on itself. Sometimes its lumen is entirely obliterated at one point, and the part beyond is dilated and club-shaped. Kinking or torsion of the organ frequently results from contraction of its mesentery, from an adhesion to an adjacent surface, or from strangulation by a band. Less commonly the appendix is bound to the cæcum or buried in adhesions, so that it is only to be discovered with considerable difficulty, or it is attached to the ovary, the Fallopian tube, the bladder, the rectum, or even to some more distant organ, such as the gall-bladder.

The *clinical features* vary widely both as to the frequency and severity of the attacks. After the original attack the patient may remain well for weeks, months, or even years before being troubled again, or the attacks may recur at short intervals, so that the patient is never really well, and is unable to continue his occupation. In some cases the attacks are slight from the first, the patient never suffering acutely. The history frequently is that each attack commences with a feeling of discomfort in the abdomen, which the patient from his previous experience recognises as indicating the advent of another seizure. This discomfort is succeeded after a variable period by pain, which is at first slight, but gradually becomes more and more severe, and may be attended with vomiting.

The pain is referred all over the abdomen, and after lasting for some hours disappears, leaving a general tenderness and a specially tender point in the right iliac fossa corresponding to the position of the root of the appendix. The tenderness lasts for two or three days, and gradually passes off. On the other hand, each recurrence may partake of the character of an ordinary acute appendicitis, and may at any time culminate in suppuration. A cure may ultimately occur by a gradual process of obliteration. The recurrent attacks are usually attributed by the patient to such causes as strain, chill, indiscretions in diet, or inattention to the bowels, factors which would probably be inoperative unless the appendix were already the seat of pathological changes.

The *diagnosis* is easy when the patient's sufferings date from a primary acute attack, and when there are recognisable physical signs of a diseased appendix in the form of induration and tenderness in the right iliac fossa. In a small proportion of cases it is possible to feel the enlarged or thickened appendix. In the absence, however, of these factors, and especially in cases of recurrent colic without physical signs, confusion may arise between painful attacks of appendicular origin and those proceeding from the intestine, kidney, ureter, ovary or Fallopian tube. Cases are also met with in which obscure gastro-intestinal attacks with pain, indigestion and vomiting—sometimes diagnosed as nervous dyspepsia—are really of appendicular origin, and disappear after removal of the appendix.

Treatment.—While not prepared to advise removal of the appendix after a first attack in all cases, we should recommend it (1) if swelling or tenderness is still present one month after the onset of the attack; (2) if the patient wishes to insure his life; (3) if he proposes to enter one of the public services; (4) if he intends to reside where he will be out of reach of surgical assistance; and (5) in children, because, if recurrence takes place, it is often of a grave type.

After a second attack, the removal of the appendix is recommended unless in the presence of such contra-indications as Bright's disease or diabetes.

The operation, although sometimes difficult on account of adhesions, is attended with a very small mortality, averaging about 1 per cent. The incision is made in the line of the fibres of the external oblique, with its centre at M'Burney's point; the external oblique and its aponeurosis are divided in the same line and the edges drawn aside; the internal oblique and transversalis are divided in the line of their fibres, and their

edges are drawn aside; the transversalis fascia and peritoneum are divided in the line of the external oblique, and these edges are drawn aside. This method of opening the belly was suggested by M'Burney, with the object of preventing ventral hernia, and is known as the "gridiron method." The cæcum is identified and partially pulled out at the wound; the anterior longitudinal band is traced down to the root of the appendix, and the latter is divided close to the cæcum between two pressure forceps. The exposed mucous membrane is destroyed with pure carbolic acid or with the cautery. The stump of the appendix is ligatured, and invaginated into the cæcum by means of a purse-string suture. The cæcum is then replaced. The appendix, still held at its root by the pressure forceps, is enucleated from its mesenteric and adventitious attachments, each segment of tissue containing blood-vessels being seized before division and subsequently ligatured. The meso-appendix is ligatured with the help of an aneurysm needle before being cut. If the appendix is firmly adherent to a coil of intestine much care must be exercised, and in some cases it will be safer to leave a thin layer of the serous coat of the appendix attached to the intestine than to run any risk of injuring the wall of the gut. The abdominal wall is then reconstituted by suturing in layers. The patient may be allowed up at the end of a fortnight or three weeks.

CHAPTER XXV.

HERNIA.

Definition — Constituent parts — Richter's hernia — Littré's hernia — Etiology of hernia—Clinical conditions: *Reducible; Irreducible; Inflamed; Obstructed or Incarcerated; Strangulated* — Inguinal hernia: *Anatomy; Varieties; Oblique; Direct; Inguinal hernia in children; Interstitial hernia* — Femoral hernia — Umbilical—Ventral—Lumbar—Obturator—Diaphragmatic—Sciatic and other special forms of hernia—Hernia of individual viscera.

THE protrusion, either externally or towards the thorax, of any of the abdominal contents from the cavity of the abdomen is spoken of as a *hernia*. When the protruded organ is bowel or omentum, the term hernia is applied without qualification, but when any other viscus is present in the protrusion, such terms as "hernia of the liver," "hernia of the bladder," "hernia of the stomach," and so on, are employed. The popular term *rupture* is misleading, as a hernia is nearly always of slow formation, and is not attended with tearing of tissue.

In describing a hernia it is customary to refer to its sac, its contents, and its coverings. The *sac* is derived from the parietal peritoneum, and in acquired hernia is at first represented by a mere laxity or bulging of the peritoneum. Later, at one point a dimple is formed, which gradually deepens and becomes elongated into a tube-like process which lies between the layers of the abdominal wall. As this tube-like structure becomes elongated it gradually reaches the subcutaneous tissue, and there, relieved of pressure, expands and becomes spherical or pyriform in shape. To some extent the increase in length of the sac may be due to a gliding or displacement of the peritoneum, but it is chiefly the result of gradual stretching of the serous membrane. The upper end or narrow portion of the sac is known as the *neck*, the expanded lower end as the *fundus*. The sac may present an hour-glass shape, or may be multilocular from the forma-

tion of diverticula. In course of time the sac becomes fixed by adhesions to the surrounding tissues, so that it cannot be returned within the abdomen. In congenital hernia the sac is represented by a tubular process of peritoneum—the processus vaginalis—which ought to have been obliterated before birth. The neck of the sac varies in length and calibre in different herniæ. If it become obliterated by adhesion of its walls or by a plug of omentum, it is cut off from the peritoneal cavity, and may become filled with fluid and constitute a *hydrocele of the hernial sac.*

The *contents* of a hernia may be represented by any of the structures within the abdomen. The small intestine and great omentum are those most commonly present. When intestine alone is protruded the hernia is termed an *enterocele;* when omentum only, an *epiplocele.* The term *Richter's hernia* is applied when only a part of the circumference of the intestine is protruded (Fig. 67). A *Littré's hernia* is one containing a Meckel's diverticulum. Fluid derived from the peritoneal cavity may be present in the sac, particularly in cases of tuberculous and other forms of ascites. The friction and pressure of the structures within the hernial sac may result in their becoming adherent to one another or to the inner surface of the sac. The omentum is especially liable to become fixed by adhesions, while the intestine, in virtue of its greater range of movement, more often remains free. The omentum may undergo a considerable increase in bulk from deposit of fat in its substance, and, when pressed upon by a truss, may become tough and fibrous.

FIG. 67.—Richter's Hernia—from a strangulated femoral hernia.

The *coverings* of a hernia are derived from the layers of the abdominal wall traversed by the hernia, variously altered by stretching and pressure.

Etiology of Hernia.—The factors favouring the development of hernia may be considered as predisposing and exciting. The chief *predisposing* factor is an error or defect in development.

Certain herniæ, particularly in the inguinal and umbilical regions, are *congenital,* and are due to imperfect closure of the openings in the abdominal wall as a result of incomplete or delayed developmental processes.

The weakness of the abdominal wall at the umbilicus, or at

any point where its normal constituents have been replaced by scar tissue, also favours the formation of a hernia. The structural arrangements at the inguinal and femoral canals act in the same direction.

Males are more liable to hernia than females because of the frequency of errors of development in relation to the processus vaginalis, and of the weakness of the abdominal wall at the site of passage of the spermatic cord, and because of the more laborious nature of their occupations.

The frequency with which hernia is met with varies at different periods of life. Those forms due to congenital defects are common in infancy and childhood. During adolescence and early adult life the condition is comparatively rare, but as age advances it becomes more common.

In old age the attachment of the mesentery to the posterior abdominal wall may descend to a lower level than normal, and thus increase the tendency to hernia; this "prolapse of the mesentery" (Lockwood) is often associated with an alteration in the configuration of the abdomen—a flattening or recession above, and a bulging below the umbilicus.

Among the *exciting causes* most importance attaches to those conditions which increase the intra-abdominal pressure, such as the muscular effort required in laborious occupations, especially the lifting of heavy weights in the stooping posture. In infants excessive crying, in adults coughing and straining at defecation or micturition, act in a similar manner.

Clinical Conditions of Hernia.

A hernia may be reducible, irreducible, inflamed, obstructed, or strangulated.

A **reducible hernia** is one in which the contents of the sac can be returned within the abdomen. As a rule the sac is fixed to the surrounding tissues and cannot be replaced. The reduction may take place spontaneously when the patient lies down, or may be effected by manipulation on the part of the patient or surgeon, this manipulation being known as *taxis*. A reducible hernia forms a soft, rounded swelling, which on straining or coughing presents an expansile impulse known as the "impulse on coughing." When the sac contains intestine the swelling is elastic, uniform, and resonant on percussion; during reduction of the hernia there is a characteristic gurgle, and the last portion is most easily reduced. When there is omentum in the sac the swelling is less uniform in consistence, is uneven, knotted or

lumpy, and is dull on percussion; there is no gurgle on reduction, and the last part is the most difficult to reduce.

The *symptoms* of reducible hernia vary greatly in different individuals. Many are unaware that they are the subjects of hernia, and go about for years without inconvenience or anxiety. Others, and especially strong, young adult males, suffer a great deal from the first, and may, even before there is any swelling visible externally, complain of severe colicky pain in the region of the hernia, and reflected along the nerves connected with it, and of inability to lift weights, or to take part in any form of exercise calling for muscular exertion.

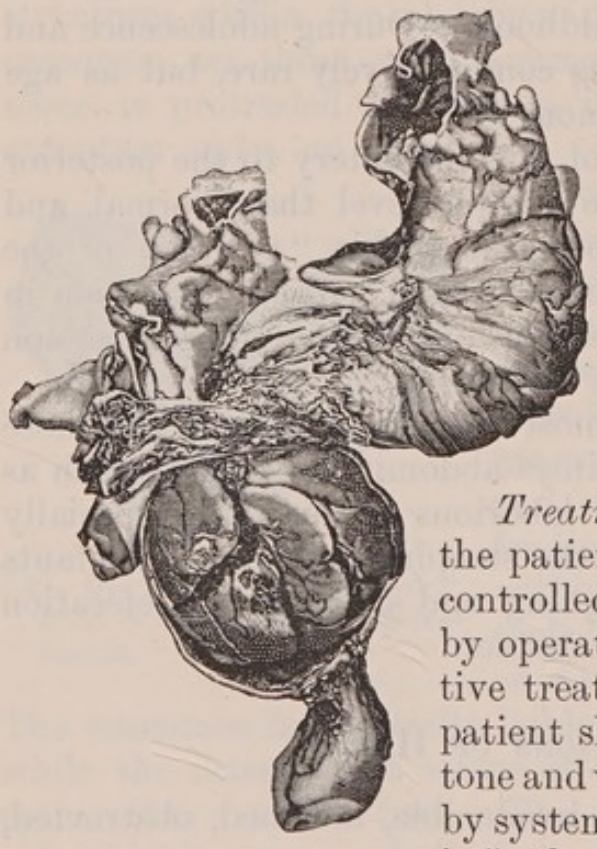

FIG. 68.—Irreducible Inguinal Hernia.

Prognosis. — Unless the hernia is controlled by a truss, or is cured by operation, it tends to become larger and more unmanageable, and at any time may become strangulated. An individual with a rupture which is not controlled by a truss is not accepted for life insurance.

Treatment.—The alternatives before the patient are either to have the hernia controlled by a truss, or to have it cured by operation. In addition to the palliative treatment by means of a truss, the patient should endeavour to improve the tone and vigour of the abdominal muscles by systematic exercises, such as "pulling in" the abdominal wall, or stooping forward with the knees stiff. Any cause of straining, such as the lifting of heavy weights or constipation, should be avoided.

Irreducible Hernia.—An irreducible hernia is one in which the contents of the sac cannot be completely returned within the abdomen. The commonest cause of irreducibility is the presence of adhesions between the contents and the sac, especially adhesions implicating the omentum. Less frequently it is due to increase in bulk of the prolapsed omentum from continued deposition of fat in it, or to the mere bulk of the hernial contents, so that there is no longer accommodation for them within the abdomen.

The *symptoms and signs* are similar to those of a reducible

hernia, with the exception that the whole or some portion of the hernial protrusion cannot be returned within the abdomen. The impulse on coughing is present although it may not be distinct. There is often complaint of a sense of weight, of dragging, or of colicky pains, and of digestive disturbances. Irreducibility is a constant source of danger to life, as by keeping open the hernial aperture it tends to favour the descent of further portions of bowel or omentum, and thus paves the way for the occurrence of strangulation.

Treatment.—In a small proportion of cases it is possible to render the hernia reducible by confining the patient to bed with the foot of the bed raised, by restricting the diet and regulating the bowels, and by applying steady pressure with a pad of wool and an elastic bandage. If this succeed, the hernia may then be controlled by means of a truss. If it fail, recourse must be had to operation. In those who are not fit subjects for operation, the symptoms may be relieved, and the danger of strangulation lessened, by wearing some form of apparatus, such as an excavated pad or bag, which will support the protrusion.

Inflamed Hernia.—This condition depends upon a localised peritonitis affecting the hernial sac or its contents, and is of importance chiefly because it leads to the formation of adhesions. It usually results from traumatic influences, such as the pressure of an ill-fitting truss or unskilful attempts to reduce the hernia. There is localised pain and tenderness which readily yield to rest and hot fomentations. The bacterial inflammation which attends strangulation of a hernia will be considered with that condition.

Obstructed or Incarcerated Hernia.—This condition is chiefly met with in the irreducible umbilical hernia of fat women, who have allowed the bowels to become constipated. There is an impediment to the passage of the fæces along the loop of bowel involved in the protrusion. The hernia becomes swollen, tender, and firm or doughy in consistence, and the patient complains of colicky pains, constipation and vomiting. The condition is often looked upon as a bilious attack, and therefore as of little importance, whereas it is really a grave condition, and may merge insensibly into strangulation. The *treatment* consists in confining the patient to bed, the foot of which is raised, and emptying the colon by means of copious enemata, succeeded by gentle kneading and taxis. If the symptoms are not relieved, recourse must be had to operation.

Strangulated Hernia.—A hernia is said to be strangulated when the circulation of the blood through the contents of the

sac is seriously impeded. The passage of the intestinal contents along the loop of bowel contained in the sac is also obstructed. It may occur on the first occasion on which the intestine is protruded from the abdomen, or it may occur in herniæ of many years' standing. It is, on the whole, less likely to occur in large herniæ in which the canal is widely dilated than in small ones. The occurrence of strangulation involves serious risk to life, because of the associated obstruction of the bowels and the risk of septic complications.

Mechanism of Strangulation.—Strangulation may be said to ensue when there is such a disproportion between the calibre of the neck of the sac and the bulk of the structures passing through it that the blood-supply of the contents is impeded. This may be brought about by an addition being made to the contents of the hernia, for example, by a sudden exertion on the part of the patient forcing down an extra loop of intestine through the hernial aperture. Of the structures passing through the neck of the sac the bowel and the veins of the mesentery suffer most.

The *pathological changes* vary according to the tightness and duration of the strangulation. The initial changes in the bowel are the result of mechanical interference with the circulation, while the later and more serious effects depend upon bacterial invasion of its coats.

The usual effects of *venous congestion* are well marked: the bowel becomes turgid, swollen and firm in consistence; its colour varies from a livid blue to a claret or even black colour. The dark colour is due chiefly to extravasation of blood into the coats of the bowel. The strangulated loop becomes distended with gas. Fluid exudes into the sac and soon becomes blood-stained. The peritoneum of the sac and of its contents for a time retains its shining lustre. When the strangulated loop is liberated from the neck of the sac it commonly presents at one or at both ends a deep groove—*the constriction groove.* If an opening is made into the bowel, the contents are found to be stained with blood as a result of hæmorrhage from the congested mucous membrane.

The further changes are due to *bacterial infection of the coats of the bowel*, and partake of the characters of inflammation or of gangrene, or of a combination of these. When inflammation predominates, the usual phenomena of peritonitis are present: the serous surface of the bowel and sac becomes opaque and covered with fibrinous lymph, while the fluid in the sac becomes turbid. When gangrene ensues, the bowel loses its natural lustre and firm consistence; it becomes flaccid and sodden like wet blotting-

paper, and its colour changes to an ashen grey, yellow, or green. The fluid in the sac acquires a putrefactive, sometimes almost cadaveric odour, the result of bacterial decomposition. The organisms concerned — the colon bacillus and less frequently staphylococci, streptococci, or pneumococci — are derived from the lumen of the bowel.

The *sites of gangrene* are of great importance in regard to its treatment by operation. It may affect the entire loop involved in the sac or only its convexity, or it may be confined to the ring of bowel subjected to direct pressure at the neck of the sac in the situation of the constriction grooves. It is of great importance, therefore, in operating for strangulated hernia, after dividing the constriction, to pull down and examine the bowel from the neck of the sac. In exceptional cases the sac also may be the seat of gangrene.

If the *omentum* alone is strangulated, it merely exhibits the effects of venous congestion and of hæmorrhages into its substance, and such a degree of inflammation as may result in adhesions. If intestine is present as well as omentum, the latter may participate in the septic process, the bacterial infection being derived from the bowel.

The *changes in the bowel above and below the hernia* closely resemble those which take place in other forms of intestinal obstruction. The bowel above becomes distended with gas and fluid, its wall is the seat of minute hæmorrhages, and the superficial layers of the mucous membrane are shed, giving rise to shallow ulcers. Bacterial decomposition of the contents of the bowel results in the formation of poisonous products, which are readily absorbed through the devitalised mucous membrane, giving rise to general intoxication which may prove fatal. The bowel below the hernia is usually contracted and empty.

Natural Terminations.—The gangrenous bowel gives way, and the sac and its contents are converted into a foul-smelling, fæcal abscess containing gas. The sac and its coverings slough as the abscess points and ruptures, and a fæcal fistula results. More commonly the condition proves fatal from septic absorption before these changes have time to occur.

Clinical Features.—As the symptoms of strangulated hernia are essentially those of intestinal obstruction, they resemble very closely those of obstruction resulting from other causes. They vary according to the severity of strangulation and the nervous constitution of the patient. There is often a history of a previous threatening of strangulation which has been tided over. On the occurrence of strangulation the patient is often aware of

a change in the hernia; he may, for example, after a sudden effort experience the forcible descent of a larger mass of hernial contents, and observe a decided increase in the size of the hernia. There is an immediate difficulty in effecting reduction, and the hernia becomes tense, hard and painful. It is usually dull on percussion, as the result of exudation of fluid into the sac, and the expansile impulse on coughing is diminished or lost. Simultaneously with these changes there is complaint of pain in the abdomen, usually referred to the region of the umbilicus. In some cases pain is the first symptom. The pain is very acute, with exacerbations of a colicky nature, causing the patient to stoop forward or compelling him to lie down. It is attended with sweating, with a feeling of coldness and collapse, and is nearly always followed by nausea and vomiting. The cessation of pain is usually an indication that gangrene has occurred. Shock is most pronounced in the small recent hernia of young adults. Sometimes it is entirely absent. The severity of the symptoms does not necessarily correspond with the gravity of the changes in the hernial contents, and the patient may be able to walk about although the bowel is already gangrenous.

Vomiting is one of the most constant symptoms. At first the vomited matter merely consists of undigested food from the stomach. Later it is composed of the contents of the upper part of the small intestine, bile being a prominent constituent, and, finally, of the decomposing and fœtid contents of the bowel above the loop engaged in the hernia. This dark brown or black, foul-smelling fluid is often described as "fæcal" or "stercoraceous," under the impression that it contains fæcal matter, but this is rarely, if ever, the case. As in other forms of intestinal obstruction, it is characteristic that the vomited matter is ejected without retching or appreciable effort. As a rule nothing is passed by the rectum, although an enema may bring away fæcal matter from below the seat of obstruction. In a Richter's hernia, and in a hernia in which only omentum is in the sac, the bowels may move. Unless the loop of bowel concerned is high up in the jejunum, the abdomen tends to become distended and rigid, and it may be tender on pressure. Peristaltic movements of individual coils of bowel are rarely observed unless the strangulation is not very tight and has lasted for several days.

The temperature is usually subnormal, the pulse small and rapid, the face pale and drawn, and the expression anxious. There is great complaint of thirst, and the tongue is dry and brown. The urine, which usually contains albumen, is dark in colour and small in quantity.

If the condition is not relieved, the patient sinks with symptoms of progressive toxæmia added to those of intestinal obstruction or of septic peritonitis.

The only chance of natural recovery lies in the formation of a *fæcal fistula*. The hernial swelling becomes livid or dusky-red in colour, and it may crepitate from the presence of gas. Finally the skin sloughs, the putrid contents of the sac are discharged externally, and the discharge gradually becomes fæcal.

When omentum is strangulated alone the symptoms are similar, but are less urgent, and there is not the same risk to life.

Diagnosis.—The patient himself may be ignorant of the fact that he suffers from hernia, and in stout people a small hernia is liable to be overlooked even when sought for. An irreducible hernia may be present, and yet the symptoms of obstruction be due to an independent affection of the bowel, such as gall-stone ileus. The vomiting may be due to torsion of the testicle, to appendicitis, or to biliary or renal colic. If there is any possibility that the hernia is the cause of the symptoms, it is wiser to subject it to operation in the first instance.

Prognosis.—It is rarely possible to infer the amount of damage to the bowel from the duration of the symptoms alone. Gangrene may take place within a few hours, while on the other hand the bowel may be found viable after strangulation of several days' duration.

Treatment.—The strangulation must be relieved and the contents of the hernia returned within the belly with the least possible delay. The reduction may be effected by means of taxis or by operation.

Taxis.—By this is meant the reduction of a hernia by external manipulation. The foot of the bed must be raised considerably, and the patient placed in such an attitude as to relax the parts in the region of the hernial opening. If there is much pain morphin may be administered hypodermically. A rubber bottle filled with hot water, or an ice bag, is applied over the hernia; the use of ice, however, is to be avoided if there is any element of shock present, or if the vitality of the bowel is believed to be already endangered. The taxis is applied by steadying the neck of the sac with one hand, while the tumour is compressed by the other. The compression is carried out steadily and gently, and must not be persevered with unless there is a gradual diminution in the size of the tumour, or other indication of gradual and safe reduction. Any time limit for its application is misleading. A general anæsthetic should not be administered unless, in the event of failure, one is prepared to proceed to

operation. The disappearance of the hernial contents should be complete, and should be tested for by passing the finger into the hernial canal. A pad and spica bandage are applied over the hernial orifice, and the patient should be kept in bed until the treatment of the hernia by truss or operation has been decided upon.

Dangers from Taxis.—The bowel may sustain further damage, favouring the occurrence of gangrene, or it may be actually ruptured; if the contents of the sac are septic, they may be returned within the peritoneal cavity and give rise to peritonitis. The most frequent accident, however, is that known as *apparent or false reduction*, of which there are three principal forms:—(1) *Rupture of the sac* in the region of its neck, and escape of the contents into the extra-peritoneal cellular tissue; when this occurs, the surgeon recognises that the reduction is obviously incomplete. (2) *Reduction into another sac.* This is most likely to occur where there are two sacs with a common neck, at which the bowel is strangulated. The bowel is forced by the taxis from one sac into the other, the strangulation at the neck of the sac being still unrelieved. This accident is met with chiefly in interstitial hernia. (3) *Reduction en bloc or en masse.* This is usually the result of long-continued and ill-regulated taxis, the whole sac being forced within the abdominal wall, although still outside the peritoneum, the relations of sac and contents to one another being unaltered, and the strangulation at the neck still persisting.

In all of these forms of false reduction the symptoms of strangulation continue, and a fulness and sense of resistance may still be felt in the region in which the displacement has occurred. The manipulator, moreover, is usually conscious that although he has changed the position of the hernia he has not relieved the obstruction. When this accident occurs, an operation should immediately be performed for the relief of the strangulated bowel.

Taxis should not be had recourse to when the hernia, previous to the onset of strangulation, had been irreducible, when the symptoms are very acute, with profound constitutional depression, when the strangulation is of considerable duration,—twenty-four hours or more,—or when the coverings of the hernia are inflamed.

Operative Treatment.—Failing reduction by taxis, there should be no delay in having recourse to the operation of herniotomy, which in itself is not a serious one: the danger to the patient consists in it being performed too late. In aged

and weakly patients it may be advisable to operate under local anæsthesia ; in others a general anæsthetic is to be preferred.

When there is regurgitation of foul fluid from the stomach, this viscus should be washed out before beginning the operation.

Herniotomy.—An incision is made over the neck and upper part of the sac, the coverings are divided, and the sac exposed and opened. If the fluid is turbid and foul smelling, the viability of the bowel is doubtful. At this stage the sac and its contents should be irrigated with hot saline solution to minimise the risk of infection of the peritoneal cavity. The next step consists in dividing the constricting agent, which is usually found at or about the neck. In inguinal hernia this should be done by cutting down upon it, not only because the tissues to be divided are seen before they are cut, but because the integrity of the sac at the neck is preserved, and this is an advantage in carrying out the radical cure. In femoral hernia the division is nearly always carried out from within outwards by means of a probe-pointed hernia knife, guided to the constriction by the finger or a broad hernia director.

The constriction having been divided, the affected loop of bowel is drawn down into the wound, and the region of the constriction grooves examined. After the bowel has been freed and washed with warm lotion the colour often improves to a marked degree. The viability of the bowel is pretty certain if a peristaltic wave can be sent across the affected loop by flicking it with the finger. If the bowel is merely compressed and exhibits changes resulting from venous congestion, it should be emptied of its contents by pressure and returned within the abdomen. If it is inflamed and covered with lymph, it should be irrigated with saline solution before being returned. If in addition there is any alteration in the colour and consistence of the bowel which indicates incipient or actual gangrene, the damaged bowel must be invaginated or removed. Invagination is to be preferred provided the gangrenous area is small enough to allow of this being done without unduly narrowing the lumen, and it is best effected by a series of Lembert sutures after the method of F. M. Caird. More commonly the gangrenous area is too extensive to admit of invagination, and the entire loop of bowel must be resected along with the mesentery in immediate relation to it. The resection should extend well beyond the possible limits of damage to the bowel, in order to have perfectly healthy tissues for end-to-end junction by suture. Where the condition of the patient is so critical as not to permit of this being carried out,

the usual practice is to incise the bowel freely, and thus allow of the escape of the intestinal contents.

The omentum, if healthy, is returned within the abdomen; if damaged or infected, it is removed, the divided vessels being carefully ligatured.

The operation is completed by performing the radical cure, which consists in obliterating the neck of the sac and closing the hernial canal.

After-Treatment.—The patient may continue to vomit foul-smelling fluid for some hours after the operation. This may be controlled by washing out the stomach. There is some difference of opinion as to the use of opening medicine; our own practice is to give an enema the following morning, and a Seidlitz powder or other mild laxative by the mouth on the second day. The appearance of blood in the stools is occasionally observed after herniotomy, but is not a cause of anxiety. The patient should be kept recumbent for at least four weeks, preferably with the foot of the bed elevated. If the radical operation has been performed, the use of a truss is not recommended unless the patient's occupation entails severe exertion.

Sequelæ of Strangulation.—Stenosis and Stricture of the Intestine.—The symptoms of obstruction may continue after herniotomy as a result of the loop of bowel which was returned failing to transmit its contents. This may be due to paralysis of its muscular coats, to the occurrence of gangrene, to the persistence of the constriction grooves at either end of the loop, or to kinking of the bowel as a result of adhesions. A combination of these conditions may be present.

If the symptoms do not yield to washing out of the stomach and irrigation of the lower bowel, the abdomen must be opened just above the hernial opening, the damaged loop drawn out of the wound, and an artificial anus established above the seat of obstruction. If the patient's general condition is favourable, immediate resection and end-to-end suture may be performed.

Symptoms of obstruction coming on towards the second or third week after herniotomy, the patient meanwhile having progressed favourably, are usually due to the development of a fibrous stricture in the situation of the original constriction groove. The clinical features are those of chronic, incomplete obstruction, with occasional vomiting of large quantities of fluid, and gurgling noises in the abdomen. Distended coils of bowel showing active peristalsis, which is readily induced by manipulation of the abdomen, may be visible. The treatment consists in opening the abdomen above the hernial canal, and

either drawing out the loop of intestine and resecting the strictured segment, or establishing an artificial anus, according to the condition of the patient. The stenosed segment can be resected after the obstructive symptoms have passed off.

The Varieties of Hernia—Inguinal Hernia.

This is by far the commonest form of hernia, and includes all herniæ which traverse the inguinal canal. If it leaves the abdomen through the internal abdominal ring to the outer side of the deep epigastric artery, and traverses the entire length of the inguinal canal, it is called an *oblique*, or, from its relation to the deep epigastric, an *external inguinal hernia*. If it escape in the interval between the deep epigastric artery and the outer border of the rectus muscle, that is, to the inner side of the deep epigastric, it is called a *direct or internal inguinal hernia*. If the protrusion does not extend beyond the external abdominal ring it is spoken of as a *bubonocele;* if it descends into the scrotum or labium it is called a *scrotal or a labial hernia*.

Surgical Anatomy.—The inguinal canal extends from the internal abdominal ring, which is situated half an inch above Poupart's ligament midway between the anterior superior iliac spine and the symphysis pubis, to the external ring, situated immediately above the crest of the pubes. In the adult it is about an inch and a half long, and has a direction almost directly inwards, with a slight inclination downwards and forwards.

The anterior wall is formed by the aponeurosis of the external oblique, and in the outer third by those fibres of the internal oblique which take origin from Poupart's ligament. The posterior wall is formed by the transversalis fascia, together with the conjoined tendon at its inner part, and a distinct layer of tendinous fibres derived from the transversalis muscle at its outer part. The conjoined tendon is often thin and weak, and blends internally with the sheath of the rectus. The floor of the canal is formed by Poupart's ligament, and its reflection on to the body of the pubes—Gimbernat's ligament; and the roof, by the arching fibres of the internal oblique and transversalis muscles.

Action of the Inguinal Canal.—"In a healthy individual the anterior and posterior walls are in close apposition. When the arched fibres of the internal oblique contract, they become straight and descend towards Poupart's ligament, compressing the spermatic cord against that structure. While so descended

they are gripped and fixed by the pressure of the anterior and posterior walls, which by the contraction of the external oblique and the transversalis are made tense and are approximated. The canal, therefore, acts as a sphincter, and would with greater accuracy be described as the inguinal valve" (Moynihan).

The *coverings* of an oblique inguinal hernia, from without inwards, are: the integument, the intercolumnar fascia derived from the aponeurosis of the external oblique, the cremasteric fascia and cremaster muscle continuous with the internal oblique, the infundibuliform fascia representing the fascia transversalis, the extra-peritoneal tissue, and the peritoneum.

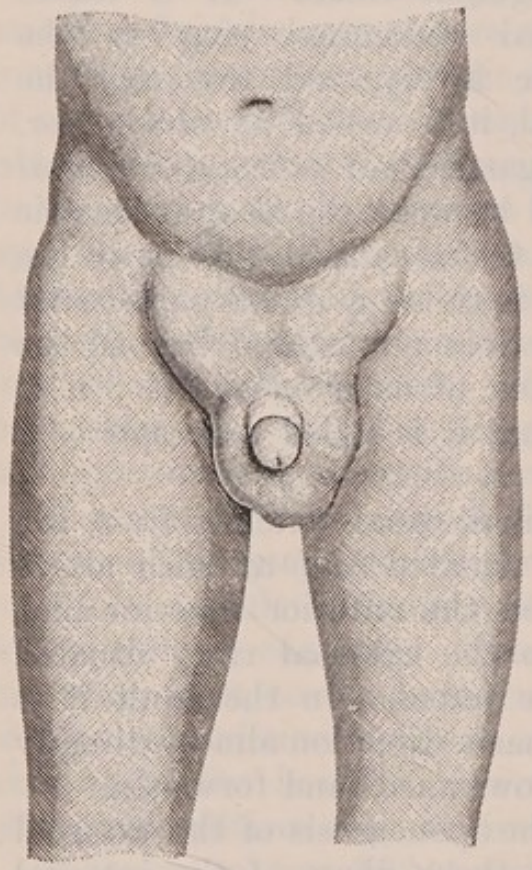

FIG. 69.—Double Oblique Inguinal Hernia.

Oblique Inguinal Hernia.—In the *acquired* form the sac is derived from the parietal peritoneum. In the earliest stage a mere bulging at the internal ring may be observed during expulsive efforts. By degrees the canal is filled up by the protruded peritoneum until the external ring is reached, and then the hernia increases more rapidly and becomes pyriform in shape, the neck or narrow portion of the swelling lying in the inguinal canal. In its further progress the hernia descends into the scrotum, where it lies above or in front of the testis with the structures of the cord behind it. As a result of the stretching of the inguinal canal, the internal and external abdominal rings become approximated until they lie directly behind one another, and the neck of the sac and the canal which it occupies become progressively shorter. This is best appreciated clinically by reducing the hernia and invaginating the scrotum by passing the finger along the cord until it is engaged in the external ring. In herniæ of long standing the canal may be so short that the finger traverses the whole length of it, and may even enter the abdomen through the internal ring. Acquired hernia, although at first unilateral, ultimately becomes bilateral in fully one-third of the cases.

Diagnosis.—While the hernia is still in the stage of bubono-

cele, it is to be distinguished from an undescended testis, an encysted hydrocele of the cord, enlarged lymphatic glands, the softer forms of connective-tissue tumours, and a chronic abscess. When the hernia has emerged from the external ring, it is to be differentiated from a femoral hernia. When it has descended into the scrotum, it is to be diagnosed from varicocele, hydrocele, hæmatocele, and pathological enlargements of the testicle.

In the female an acquired inguinal hernia escapes from the external abdominal ring and enters the labium, having the same relations to the round ligament of the uterus as to the spermatic cord in the male. Labial hernia is to be differentiated from hydrocele of the canal of Nuck, labial cysts, abscesses, and tumours.

Inguinal Hernia depending upon Congenital Anomalies in the Processus Vaginalis.—As the testis descends into the scrotum in the course of normal development it is accompanied by a pouch of peritoneum called the processus vaginalis, the lowest portion of which becomes the tunica vaginalis, while the upper portion becomes obliterated at or before birth. Should the processus vaginalis remain patent throughout, it forms a ready-made hernial sac into which the abdominal contents may descend, and in the sac the contents of the hernia are in contact with the testis and entirely surround it. This is known as a *congenital hernia.* Such a hernia frequently appears quite suddenly, the condition of the sac allowing the contents to pass at once into the scrotum. Congenital hernia is more common on the right side, because the right testis descends later than the left. In young adults it not infrequently becomes strangulated at its first emergence, and when strangulated is more difficult to reduce than the acquired variety. Constrictions, the result of attempted closure at certain points, may give rise to an hour-glass sac. The constituents of the cord are found on the posterior aspect of the patent processus, and are more adherent to it than to the sac of an acquired hernia. It is rarely possible by external examination alone to differentiate between an acquired and a congenital scrotal hernia.

Hernia into the Funicular Process.—When the processus vaginalis has become shut off at the upper end of the testicle and remains open above, an abdominal viscus may descend into the unobliterated portion, constituting a "hernia into the funicular process." It resembles the congenital hernia, but more often appears at a later period of life; the testis is below the fundus of the sac, quite separate and distinct from it; the hernia is seldom so large, and is cylindrical rather than globular

in shape. This is probably the most common form of inguinal hernia.

Infantile Hernia.—This comparatively rare variety of hernia is not well named. The term "infantile" has no reference to the age at which the hernial tumour appears, for the majority of cases have been met with in adults. A second peritoneal process is pulled down into the scrotum behind a persistent processus vaginalis by an aberrant attachment of the gubernaculum testis. Infantile hernia does not present any distinctive clinical features; the new sac descends behind the processus and bulges into it, so that on cutting down to the protruded gut from the front three layers of peritoneum are met with, the first two belonging to the processus vaginalis, and the third representing the newly formed hernial sac. It is not identified until exposed by operation.

Closely allied to infantile hernia is that known as *encysted hernia*, in which the newly formed sac descends into and invaginates the processus vaginalis, which is obliterated only at the internal abdominal ring, and which entirely envelops the hernia instead of lying in front of it as in the infantile variety. It may be associated with retention of the testis in the inguinal canal.

Hernia with Retention of the Testis.—This association is not uncommon, especially in children. The testis may be retained within the abdomen, or, as is more usual, may occupy some part of the inguinal canal. The testis is frequently arrested in its development, and may be exceedingly sensitive. In the majority of cases the hernia comes down before the testicle, next in frequency the hernia and testis descend simultaneously, exceptionally the testis descends first, and is followed after a variable interval by the hernia. In the treatment of this condition, the attempt may be made by means of a truss provided with a horseshoe-shaped pad to retain the hernia while allowing the testicle to descend, but this is seldom practicable. The operative treatment is more satisfactory; the testis and cord are freed from their coverings, and the former is brought down to and fixed in the scrotum. The process of peritoneum is then divided and closed at the internal ring, and the walls of the inguinal canal brought together.

Congenital Hernia in the Female.—A process of peritoneum —the canal of Nuck—accompanies the round ligament in the fœtus, and is usually obliterated at birth. If it remain patent and a hernia descend into it, this is known as a "hernia into the canal of Nuck." The canal may remain patent, however, without leading to the development of a hernia.

Direct Inguinal Hernia.—This variety of hernia is always acquired, and it protrudes at the semilunar line between the epigastric artery and the outer edge of the rectus muscle. It enters at the lower part of the inguinal canal, splitting or carrying in front of it the conjoined tendon, and emerges at the external abdominal ring. The spermatic cord usually lies at the outer side of the sac. There is no obliquity of the neck.

It is met with chiefly in adult males between the ages of forty and fifty. It is usually small, forming a bubonocele, and rarely reaches the scrotum. When the hernia is being reduced it appears to pass directly backwards, and relatively to the protrusion the abdominal opening is large, and appears as a simple gap in the belly-wall. The hernia is slightly more common on the right than on the left side, and it may be bilateral. It is usually reducible. It is less liable to strangulation than the oblique hernia, and when strangulated the bowel is less frequently damaged seriously.

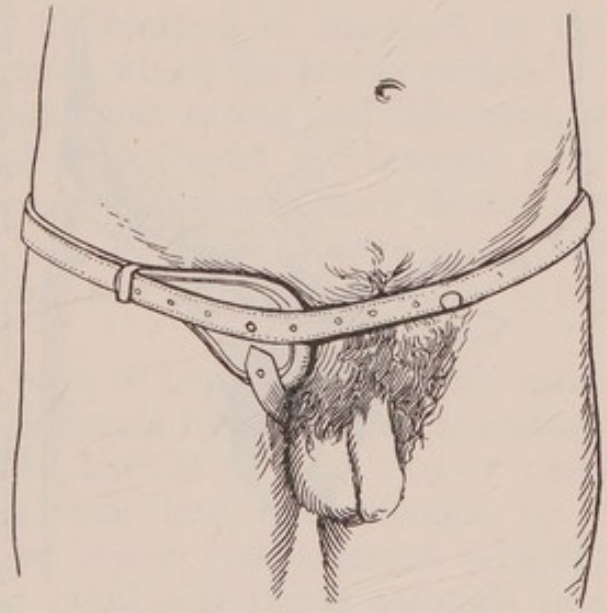

FIG. 70.—Single Spiral Truss for Right Oblique Inguinal Hernia.

Treatment of Inguinal Hernia in the Adult.—*Palliative treatment* consists in the wearing of a mechanical appliance known as a *truss*. A truss is a belt containing a stout spring which encircles the body, and is fitted with a pad, by means of which the force of the spring is applied to the hernial orifice. The pad is made of cork covered with chamois leather or other soft material. In being measured for a truss the patient should be lying down, and the tape crosses the base of the sacrum, comes forwards between the iliac crest and the upper border of the great trochanter, and reaches the middle line just above the symphysis pubis. The number of inches recorded will express the size of the truss. A truss should fulfil two essential conditions—it should retain the hernia completely under all circumstances, and it should be perfectly comfortable. A good truss should be light and yet strong, should fit the body accurately, and the pad should maintain its position in all movements of the wearer. If the spring presses too lightly, the truss fails to retain the hernia; if on the other hand it presses too heavily, it causes discomfort, and tends to bring about atrophy of the

abdominal wall, and even to enlarge the existing opening. In every case the truss should be applied and tested by the surgeon. It is put on while the patient is recumbent, and the pad should cover the internal ring and inguinal canal, and should exert pressure in an upward and backward direction. It must not rest on the pubic bone, as it is liable to chafe and may fail to control the hernia. The truss should be constantly worn when the patient is in the erect position, but may be discarded when he is recumbent, unless there is some condition, such as cough or frequent straining at micturition, which necessitates its being worn at night. A vulcanite or other waterproof truss may be worn in the bath. Whether a single or double truss should be worn for a unilateral hernia is largely a matter of personal opinion. Some object to the wearing of a pad on the side on which there is no hernia because it is believed to weaken the abdominal wall. If the pad is large enough to distribute the pressure, and does not dimple the wall at any one point, no such weakening results. A double truss sits more comfortably, and can often be worn without understraps. A single truss with an understrap is that most commonly employed in congenital hernia. When the pad is not sufficient to control the hernia, it must be made fuller and more bulky, and of such a shape that the surface next the skin looks rather more upwards. The soft part of the pad may be prolonged downwards into a tail or understrap—the "rat-tailed truss." This truss may be employed also in cases of direct hernia. In some cases the "forked tongue truss" may prove more efficient.

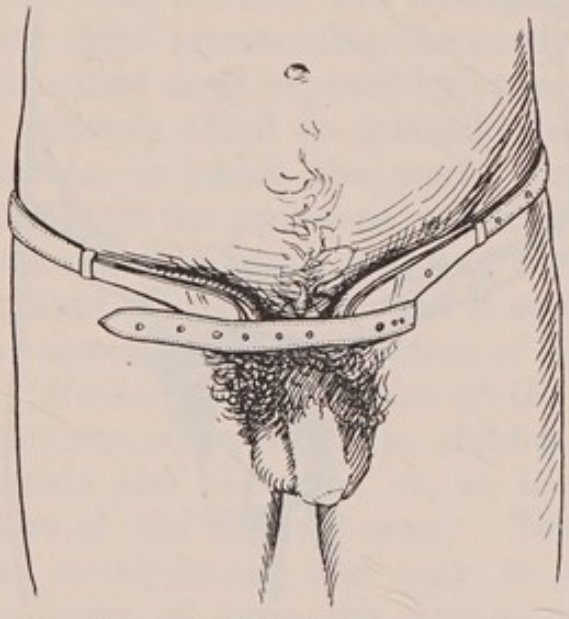

FIG. 71.—Double Spiral Truss for Inguinal Hernia.

Operative Treatment.—In many cases this is the more satisfactory method of treatment, for example, when the hernia cannot be efficiently controlled by a truss; when it is irreducible; when there has been a threatened or actual strangulation. In cases which are congenital, and in cases complicated by imperfect descent of the testis, also, operation is indicated. Operation should also be performed in young men who intend entering one of the public services, or who are going abroad where they

may be out of reach of surgical assistance; and in cases in which, from the nature of the patient's occupations and habits, the use of a truss is liable to be interfered with. It may be added that, in many cases, the question of operative interference remains a matter of the personal choice of the patient.

Herniæ which are of such enormous size that the abdomen is unlikely to be able to accommodate the protruded viscera; cases in which the abdominal walls are flaccid and bulging, and in which the conditions which have led to the acquisition of the hernia are likely to continue, for example, persistent cough from lung disease, or straining on micturition from enlargement of the prostate, are unsuited for operation.

The "*radical cure*" aims at obliteration of the neck of the sac and closure of the canal through which the hernia protruded. The neck of the sac may be simply cut across and ligatured, it may be displaced from its usual situation at the internal ring, or it may be twisted on itself so as to obliterate more thoroughly its lumen. The inguinal canal is to be closed so as to strengthen the abdominal wall at this point, and at the same time avoid any constriction of the cord.

Interstitial Hernia.—This form of hernia receives its name from the fact that the sac of the hernia forms in the interstices of the abdominal parietes. The hernial sac has two or more loculi or compartments which open into the abdomen by a common mouth. The outer or lower compartment occupies the upper part of the inguinal canal, and rarely descends into the scrotum. The upper and inner loculus extends between the layers of the abdominal wall in one of three situations:—

(1) Between the peritoneum and the fascia transversalis, constituting what is known as a *pro-peritoneal or intra-parietal* hernia; (2) between the internal and external oblique muscles, the *inter-parietal* variety—the most common of the three; and (3), between the external oblique muscle and the skin—the *extra-parietal* variety. The pro-peritoneal loculus of the sac may pass upwards and outwards towards the anterior superior spine; or directly backwards so that it occupies the inner part of the iliac fossa; or it may pass downwards and inwards into the true pelvis, and lie by the side of the bladder. This form of hernia, although rare, is of clinical importance, because from the absence of an external swelling the diagnosis is rarely made until strangulation occurs and the hernia is exposed by operation. In the second and third varieties the interstitial sac is capable of being recognised, as it is visibly distended with the usual hernial contents. Strangulation is infrequent.

In males the development of the interstitial sac probably depends upon imperfect descent of the testis, which bars the way to the extension of the hernia downwards towards the scrotum, and causes the sac to spread in the direction of least resistance. In both sexes it is more common on the right side. As these herniæ cannot be controlled by a truss, they are best treated by operation.

Inguinal Hernia in Children. — Inguinal hernia is very common in children of both sexes. The commonest form is that in which the funicular process, although shut off from the tunica vaginalis, remains patent, closely resembling an acquired sac. In male children it is more frequently met with on the right side, because of the later closure of the funicular process on that side. While the predisposing cause is the incomplete closure of the processus vaginalis, various exciting causes may be present, such as diarrhœa and gaseous distension of the bowels, excessive crying or vomiting, whooping-cough, straining on micturition as a result of phimosis, and rectal irritation by worms. Hence the importance of the medical treatment in cases of hernia in children, and especially in infants. If these exciting factors are got rid of, there is a strong tendency for the slighter forms of hernia to be recovered from. Irreducibility and strangulation are unusual.

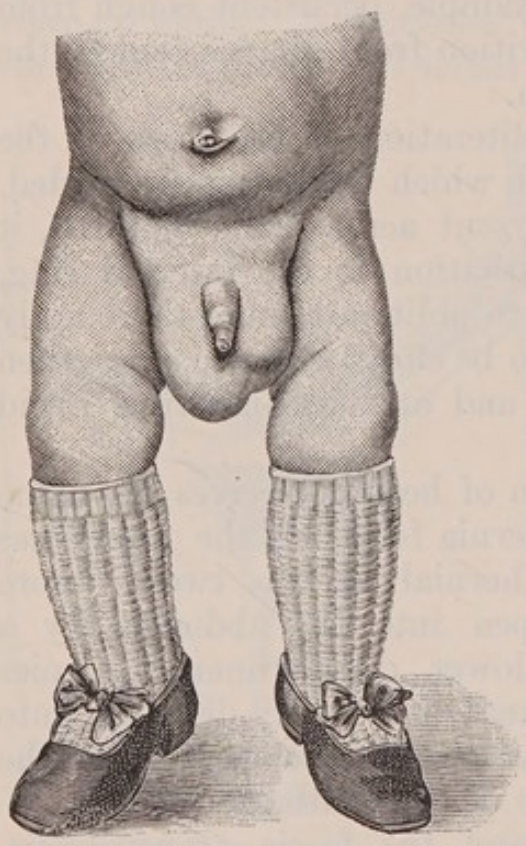

FIG. 72—Double Congenital Inguinal Hernia in boy, æt. 1 year. (First noticed on right side when two weeks old. Left hernia noticed four weeks later. Could not be controlled by truss. Treated by radical operation.)

Hernia of the cæcum is comparatively common in right scrotal hernia, and is characterised by its large size, the width of the neck, and the difficulty of retaining it with a truss. In some cases the vermiform appendix may be palpated through the tissues of the scrotum.

In examining children for hernia it is important to make out whether or not the testes have descended into the scrotum, and to avoid mistaking the various forms of congenital hydrocele for hernia.

Treatment.—When the child is under a year old, the mother or nurse is shown how to reduce the hernia, and is directed to do so whenever she notices it down. In children over a year the hernia must either be controlled by means of a spring truss covered by india-rubber, or cured by operation. If there is any difficulty in the use of the truss, or if the hernia continues to come down whenever the truss is left off, operation should be had recourse to.

The essential step of the operation consists in the isolation and removal of the patent funicular process, its neck being ligatured at the level of the internal ring. According to the patency of the canal, one or more sutures may be passed through the internal pillar and conjoined tendon on the inner side, and Poupart's ligament on the outer side, so as to approximate these structures.

In children strangulation is usually a gradual process, and there is little risk of the rapid occurrence of gangrene. There is therefore less urgency for operation than in adults. The foot of the bed should be well raised, and a pad of wool and spica bandage applied over the swelling in order to facilitate reduction.

It is a remarkable fact that in children herniotomy for strangulation is more frequently called for during the early months of childhood, the greatest number of operations having been performed during the first three months of life.

Tuberculosis of the hernial sac is not uncommonly met with in children in association with tuberculous ascites.

Femoral Hernia.

A femoral or crural hernia escapes from the abdomen at the crural ring, passes down the crural canal, and emerges through the saphenous opening in the thigh. Next to inguinal, it is the commonest form of hernia. It is more often met with in the female, probably because the pelvis is wider, the crural ring larger, and Gimbernat's ligament less strongly developed than in the male. Femoral hernia is almost invariably acquired, and is rarely met with under the age of twenty, because there is practically no crural ring or canal until the pelvis is fully developed. It is most common in women who have borne children. It is probable that in some cases a rapid loss of fat may tend to the production of a femoral protrusion, owing to the removal of some of the material which helps to support the abdominal aspect of the crural ring.

Surgical Anatomy.—The crural ring is represented on the

abdominal aspect by a slight depression, and is closed by a specialised portion of the extra-peritoneal tissue containing a lymphatic gland, and known as the *septum crurale*. The ring is bounded in front by the superficial and deep crural arches; behind by the pubic bone covered by the pectineus muscle and fascia; to the outer side by the partition of the crural sheath which separates the ring from the common femoral vein; and to the inner side by Gimbernat's ligament. The deep epigastric artery, in its course inwards from the external iliac, passes close to the upper and outer angle of the crural ring, and gives off its pubic branch, which runs transversely inwards to Gimbernat's ligament to anastomose with the pubic branch of the obturator. An enlargement of this anastomosis constitutes an "aberrant obturator," the obturator arising by a common trunk with the epigastric. When it curves round the inner side of the ring along the free margin of Gimbernat's ligament, it is liable to be wounded in the operation of herniotomy. The crural canal is about half an inch in length. In front of it the upper margin of the saphenous opening arches inwards to join Poupart's and Gimbernat's ligaments.

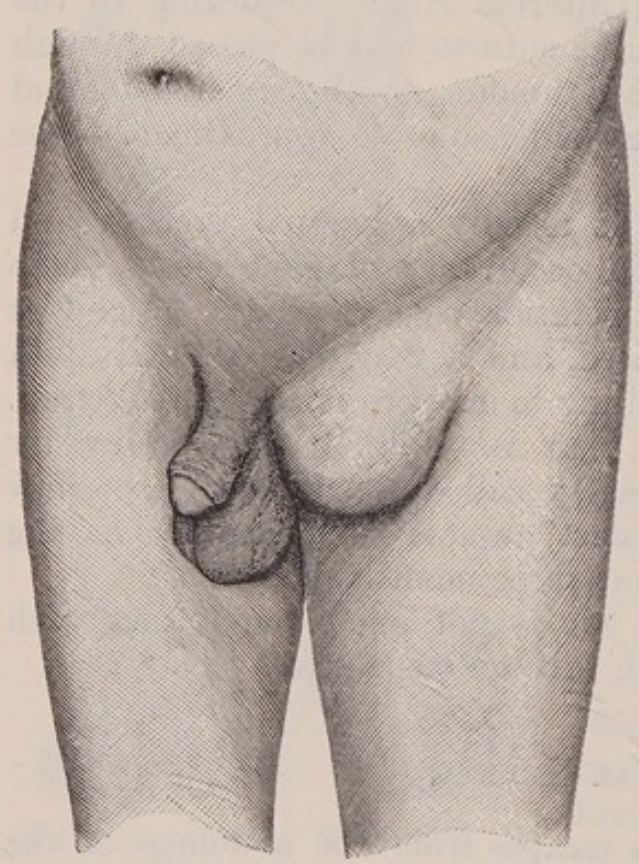

FIG. 73.—Femoral Hernia in man, æt. 46.

That portion of the upper edge lying internal to the femoral vein is known as the femoral, or Hey's, ligament. The upper part of the pectineal fascia is strengthened by a tough band of fibrous tissue, known as Cooper's ligament. A hernia passing along the canal at first descends vertically, but on reaching the saphenous opening it bulges forwards, and tends to enlarge in an upward and outward direction, working upwards over Poupart's ligament. Large herniæ may extend down the thigh. The coverings of a femoral hernia, from without inwards, are: the integument, including the cribriform fascia, the femoral sheath representing the transversalis fascia, the extra-peritoneal tissue and septum crurale, and the peritoneum. In the case of

small femoral herniæ the sac is usually loosely attached, and may be accidentally reduced with the contents. In very large herniæ the sac may present several diverticula, and so exhibit a lobulated appearance.

A femoral hernia forms gradually, and very often painlessly, and it may pass unnoticed by the patient for years, especially in stout women. The hernia is often as small as a cherry or a pigeon's egg, and may contain only a small tag of omentum which is irreducible, or only a portion of the circumference of the bowel—Richter's hernia (Fig. 67). Large herniæ containing several feet of small intestine are, however, sometimes met with.

Femoral herniæ are more often strangulated than inguinal, and are in any case more difficult to reduce. Gangrene may take place rapidly, and is often localised to the constriction ring at the neck of the sac opposite the sharp edge of Gimbernat's ligament, hence the necessity in herniotomy of pulling down this portion of the bowel for inspection.

Diagnosis.—It may be repeated that strangulated femoral hernia is often overlooked because of its small size, and the fact that its existence is unknown to the patient, hence the necessity of carefully examining the femoral canal in all cases where there are symptoms of acute intestinal obstruction.

It is often difficult to distinguish between femoral and inguinal hernia in fat women on account of the indefinite landmarks. The neck of an inguinal hernia lies above and internal to the spine of the pubes, that of a femoral hernia below and external to the spine. If the hernia be reducible, it may be noticed that in the one case it disappears at the inguinal canal, and in the other at the crural canal. In irreducible hernia an attempt should be made to introduce the finger into each of the hernial canals—the one will be found empty, the other occupied.

Varicose pouching of the saphena vein closely resembles a hernia, but the swelling reappears after reduction in spite of pressure on the crural canal, and it is associated with varix of other parts of the limb.

Enlarged inguinal glands when matted together and prolonged into the crural canal, as in tuberculosis, may be difficult to differentiate from a femoral hernia. Among other conditions which may simulate a femoral hernia may be mentioned psoas abscess, enlargement of the bursa underneath the ilio-psoas, a fatty tumour which may be a downgrowth from the hypertrophied extra-peritoneal fat, and consolidated aneurysm.

Treatment.—Palliative treatment by trusses is carried out on the same line as in inguinal hernia, and the method of measuring

for the truss is the same in both. For unilateral hernia a single truss is sufficient. The pad is usually a little smaller than that of an inguinal truss, and is elongated from above downwards to cover the femoral canal. It should press in a direction directly backwards, and the pad should not rest against the spine of the pubes. The understrap should be placed a little farther forward than in an inguinal truss. The metal spring may encircle the pelvis on the same or on the opposite side; in the latter case the appliance is known as an "opposite-sided truss." Where there is difficulty in controlling the hernia, the pressure of the pad is rendered more efficient by incorporating it in a belt which encircles the upper part of the thigh. If, as occasionally happens, an inguinal hernia is present on the same side, the femoral pad may be prolonged upwards and inwards to cover the inguinal canal.

The majority of irreducible femoral protrusions should be submitted to operation; this procedure is carried out on the same lines as in inguinal hernia.

When operation is contra-indicated, the slighter forms of femoral hernia with irreducible omentum may be treated by an ordinary truss, the pad of which is concave instead of convex.

Umbilical Hernia.

Three varieties of umbilical hernia are described: (1) congenital hernia of the umbilical cord, (2) umbilical hernia of infants, and (3) umbilical hernia of adults.

Congenital hernia of the umbilical cord is due to a defective coalescence of the lateral halves of the abdominal wall, and has been aptly compared to a spina bifida. The contents of the hernia probably never at any time occupied the abdomen. When the gap at the umbilicus is small, the condition is described as a *hernia at the root of the cord*, and it may be controlled by means of a pad and bandage. When the gap is moderate in size, the hernia is sacculated, and over it are expanded the structures of the cord, which may be so thin as to be transparent. As this variety nearly always terminates fatally if left to itself, it should be subjected to operation if the condition of the child permits. The sac is opened, the contents returned within the abdomen, and the gap in the wall closed by sutures. The extreme varieties in which the abdomen is open throughout its entire length are practically eventrations, and are merely of pathological interest.

Umbilical Hernia of Infants.—This form develops subse-

quently to the closure of the abdominal wall, and is due to yielding of the umbilical cicatrix. It appears some weeks or months after birth, and is equally frequent in the two sexes. It forms a small, rounded or cylindrical projection which is easily reducible, and which almost without exception disappears before puberty. The *treatment* consists in reducing the hernia, and approximating or overlapping the edges of the opening by a broad strip of plaster applied circularly round the abdomen from behind forwards.

The Umbilical hernia of adults is met with chiefly in corpulent women over thirty-five, and especially in those who have borne children. The protrusion of peritoneum may occur at any part of the umbilical scar, or in its vicinity, in the latter case the hernia being, strictly speaking, of the ventral type. The opening in the abdominal wall is usually circular, and is bounded by the fused aponeuroses of the abdominal muscles. The muscles are weak and flabby, and the recti widely separated. The contents usually consist of omentum, while the larger varieties contain the transverse colon, and less frequently small intestine. The omentum always lies in front, and may form a complete lining to the peritoneal sac. Sometimes there are two separate openings leading into a common hernial sac, which is not infrequently divided into loculi, a fact which it is important to remember, since intestine may be strangulated in one of these loculi, and be perfectly free in another.

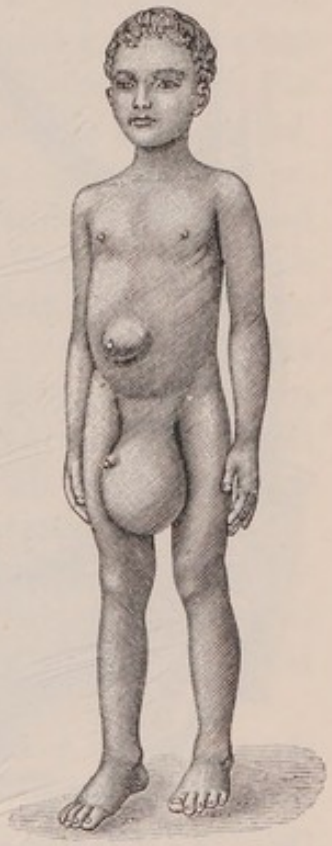

FIG. 74. — Umbilical and Inguinal Hernia in boy, æt 8.

As regards the causation of the hernia it is undoubtedly associated with progressive adiposity. It may be that the deposition of fat in the abdominal wall, taking place uniformly except in the umbilical cicatrix, causes stretching of this structure, so that it yields more readily to increased intra-abdominal pressure; or it may be that the fat deposited in the omentum tends to send out protrusions of its substance through weak points in the cicatrix, especially in the situation formerly occupied by the umbilical vein.

The hernia develops gradually, and forms a smooth, globular, painless swelling. With increasing size it may become lobulated, as a result of adhesions between the contents and the wall of

the sac. The umbilical scar, stretched and bulging, is usually seen on the lower half of the swelling. Large herniæ become pendulous, and hang down over the pubes (Fig. 75). The expansile impulse on coughing is very decided. Over the convexity of the tumour the coverings of the sac are usually very thin, and the skin may become the seat of eczema or of ulceration. Umbilical herniæ, when they have attained any considerable size, are nearly always irreducible because of adhesions between the sac and its contents, and also because of the mere bulk of the protrusion and the accumulation of fat in the herniated omentum. The patient complains of a sense of heaviness and dragging in the swelling, and there may be pain and tenderness as a result of local peritonitis. Obstruction of the prolapsed loop of bowel is more often met with than in any other form of hernia; it is characterised by attacks of flatulence, vomiting and constipation, and may insidiously merge into a condition of strangulation. These attacks are erroneously interpreted by the patient as "bilious attacks," and as having nothing to do with the hernia, and in this way they often escape medical observation.

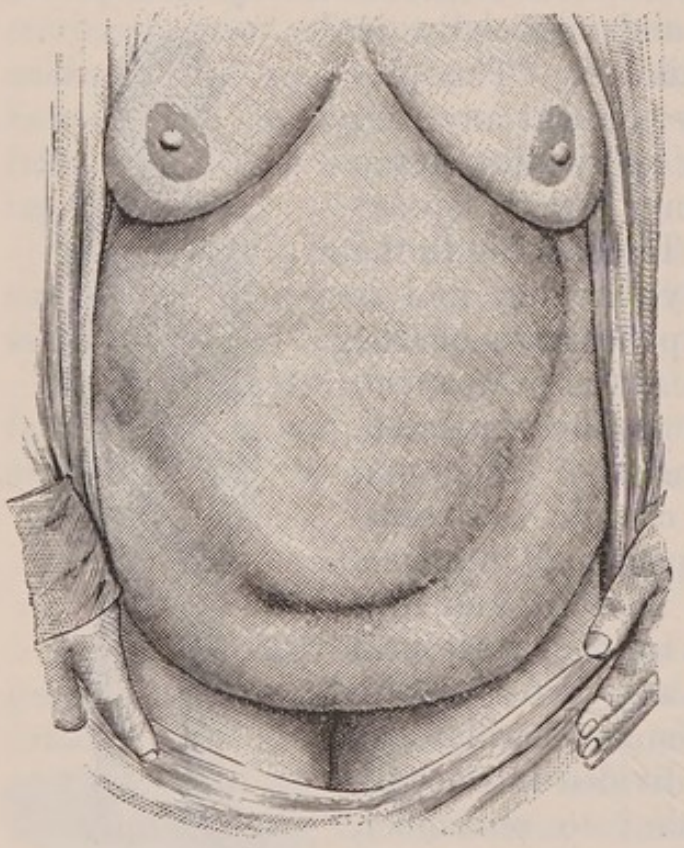

FIG. 75.—Irreducible Umbilical Hernia in woman, æt. 43.

Treatment.—When the hernia is small and reducible, the best support is obtained from a well-made abdominal belt provided with a large, round vulcanite shield to cover the umbilical area. In addition, careful attention is paid to the diet and the bowels, and to any cause of increased abdominal pressure. An endeavour should be made to reduce the amount of adipose tissue. If the hernia is irreducible, the patient should be confined to bed, the foot of which is elevated, and the bowels should be thoroughly emptied by enemata. Should the irreducibility persist, the alternative lies between supporting the hernia by means of an

abdominal belt and subjecting it to operation. It must be pointed out in this connection, that patients suffering from irreducible umbilical hernia are not favourable subjects for operative interference; their corpulence and excessive weight are alone a source of difficulty both at the operation and in the after treatment, and in the case of large protrusions there may be no room in the abdomen for the contents of the hernia. Any slight error in technique is apt to be followed by cellulitis and other septic complications.

Operation.—In large herniæ the tumour is outlined by two horizontal elliptical incisions. The sac is exposed and opened, not over its convexity where the coverings are thinnest and adhesions are most likely to be met with, but close to the margin of the aperture in the abdominal wall. The omentum is unravelled, adhesions separated, and the protruded portions ligatured and removed. The intestine is then reduced and retained by a large pad of gauze. The wall of the sac is then dissected free and removed. The opening in the peritoneum is closed by sutures. In order satisfactorily to close the opening in the parietes the different layers of the abdominal wall should be stitched to each other in succession; it is especially important to approximate the recti muscles and their sheaths. An abdominal belt should afterwards be worn to diminish the tendency to recurrence.

Ventral Hernia.—Under the term *ventral hernia* are included all such protrusions through the anterior abdominal parietes as do not appear at the inguinal, femoral, or umbilical apertures. Several varieties are recognised.

In young children *divarication or separation of the recti muscles* is sometimes met with above the umbilicus, so that on straining a cylindrical protrusion appears in the interval between the umbilicus and ensiform cartilage. The condition disappears spontaneously, and is of no clinical importance.

In adults, and especially in multiparous women, the separation of the recti usually occurs below the umbilicus, and a vertical swelling appears between the muscles on the least exertion. The fingers can readily be introduced between the recti, and the margins of these muscles can be distinctly felt. The condition is merely troublesome, inasmuch as a belt must be worn to support the abdominal wall. Where there is pain and inconvenience in spite of the belt, an operation should be performed similar to that described for umbilical hernia.

Hernia in the linea alba, although it may occur below the umbilicus, is met with chiefly above this point, and is then known as an *epigastric hernia* (Fig. 76). The linea alba above

the umbilicus is represented chiefly by transverse fibres, and, when these are coarse in texture, irregular apertures or spaces may exist between them. Through such an aperture, the long axis of which is placed transversely, a protrusion of extra-peritoneal fat may occur, forming a small, rounded, irreducible tumour beneath the integument, and only to be distinguished from an ordinary lipoma by the fact that it is free from the skin. Such a hernia may rapidly increase in size by dragging outwards a peritoneal pouch, and so forming a hernial sac into which omentum and intestine may be protruded. These herniæ are met with chiefly in male adults above the age of thirty, midway between the umbilicus and ensiform cartilage. The long axis of the tumour is usually horizontal. They often escape notice till abdominal symptoms—griping pains, flatulence and vomiting—ensue. In such a hernia we have twice observed strangulation with gangrene of the loop of bowel engaged in the sharp-edged ring in the linea alba.

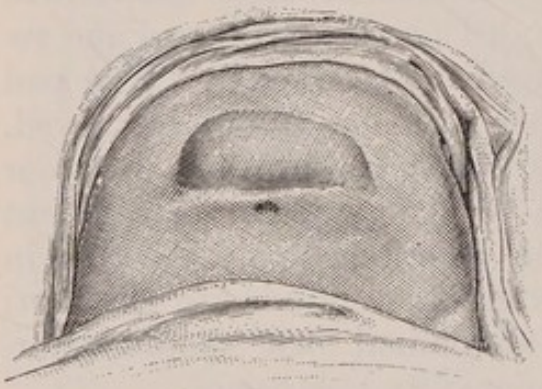

Fig. 76.—Strangulated Epigastric Hernia, of many years' duration, in an old man. The hernia was reducible till three days before admission, when it became strangulated.

If causing no inconvenience the hernia may be controlled by a belt, otherwise, and in our opinion as a routine procedure, it should be subjected to operation on similar lines to that performed for umbilical hernia.

Hernia in the linea semilunaris is rarer than hernia in the middle line. It is met with chiefly below the umbilicus, and occurs with equal frequency in the two sexes after middle life. Direct inguinal hernia may be regarded as a variety of this form, occurring at the lowest part of the linea semilunaris.

Herniæ in Relation to Cicatrices of the Abdominal Wall.—These, which are often described as *traumatic ventral herniæ*, may be found at any part of the abdominal wall which is the seat of a scar resulting from a wound or from suppuration. They are most commonly met with after laparotomy wounds below the umbilicus where primary union has not taken place. While suppuration of the wound is the most important factor in their production, the occurrence of ventral hernia may be favoured by imperfect suturing, by too early removal or absorption of the sutures, by inefficient support to the wound, and too short a period of rest in the recumbent position after operation.

Such conditions may be typically represented by cases of acute suppurative appendicitis treated by laparotomy and drainage. The tendency to ventral hernia is to be combated whenever possible by preserving intact the different muscular layers of the abdominal wall, and securing primary union and prolonged rest in the recumbent position.

The hernia takes the form of a diffuse bulging which appears when the patient stands up. It may attain a great size, and

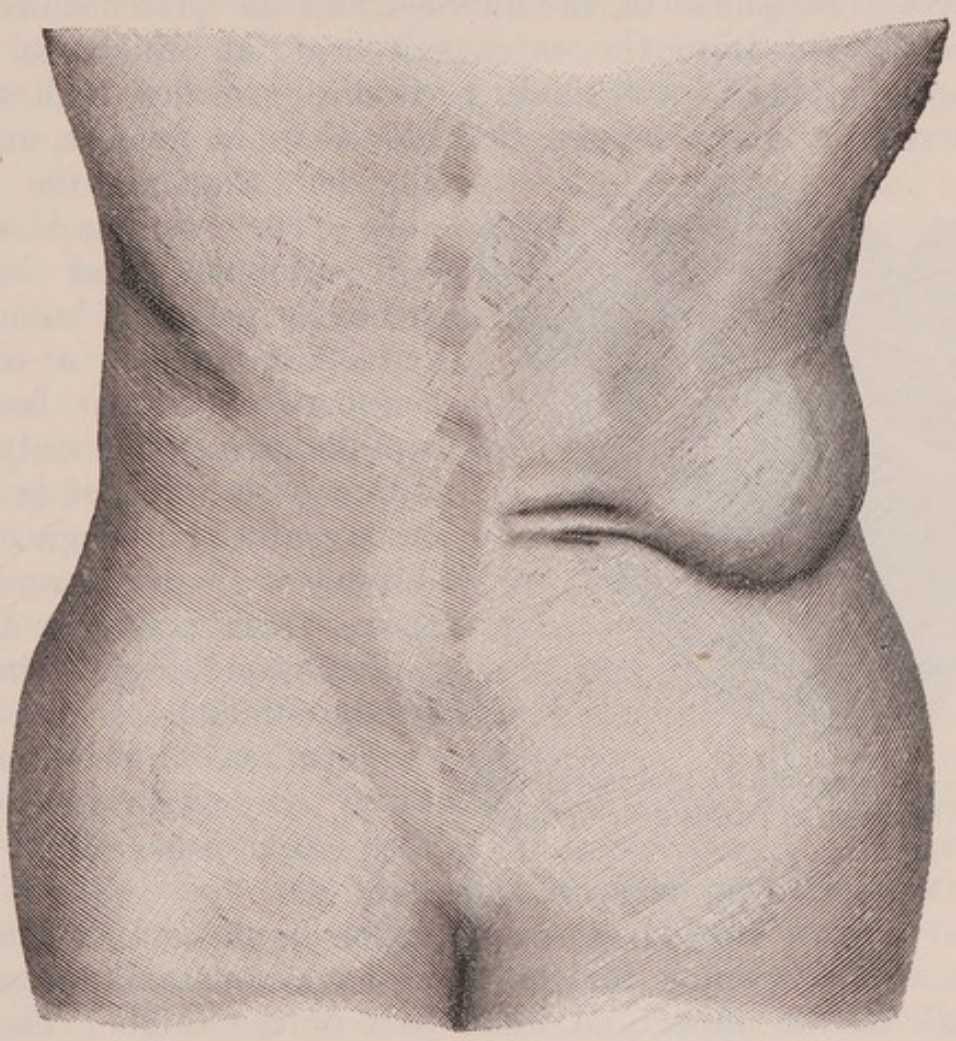

FIG. 77.—Lumbar Hernia, in site of Scar of Lumbar Abscess.

cause a sense of weakness and incapacity for any exertion, and is often attended with gastric and intestinal disturbances. When the patient is recumbent the protrusion is easily reduced, and the fingers may invaginate the area of the scar into the interior of the abdomen. From the large size of the opening such herniæ are very rarely strangulated. The treatment consists in the use of an appropriate belt and shield, or in operation, which consists in reconstituting the abdominal wall, and ensuring prolonged rest in the recumbent position.

LUMBAR HERNIA.—This term is restricted to hernial pro-

trusions which appear in the space between the last rib and the crest of the ilium. Apart from cicatricial weakening of the parietes in this region, the hernia usually escapes through the triangle of Petit (Fig. 77). This triangle is bounded by the anterior edge of the latissimus dorsi, the posterior edge of the external oblique, and the iliac crest. Its floor is formed by the stout fascia covering the internal oblique, and beneath this by the aponeurosis of the transversalis. As causes of this form of hernia may be mentioned defective development of the muscles, and the presence of fatty masses derived from the extra-peritoneal fat which, in their outward bulging, draw small peritoneal pouches with them. The hernia is more common in males than in females, and on the left than on the right side. The swelling is small, soft, globular and readily reducible. It may become irreducible, and in a certain number of cases becomes strangulated. The only condition with which it is liable to be confused in diagnosis is a dumb-bell shaped chronic abscess, which may have an impulse on coughing, and may be partly reducible.

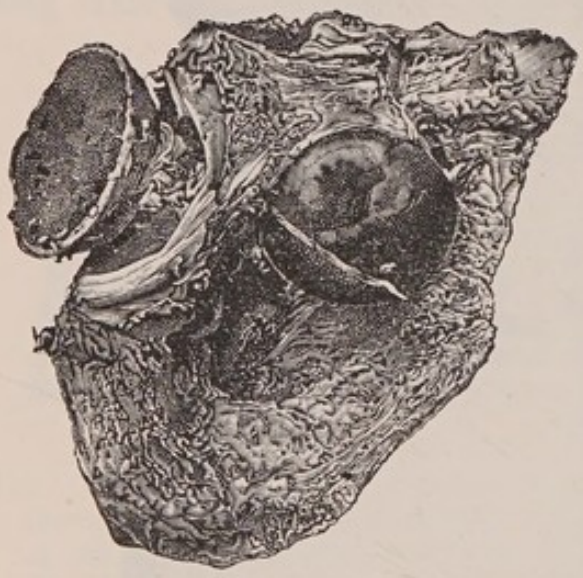

FIG. 78.—Strangulated Obturator Hernia. Obturator nerve passes over bowel.

Lumbar herniæ rarely cause any symptoms, and they are either left alone or are supported by means of a truss or belt.

OBTURATOR HERNIA.—An obturator hernia escapes from the pelvis at the opening for the obturator vessels and nerve, and emerges in the upper and inner part of the thigh. The protruded viscus—which is nearly always small intestine—carries before it the peritoneum, the subperitoneal fat, and the pelvic fascia. Beyond the foramen it may pass between the obturator membrane and the obturator externus muscle, and remain deeply placed; or it may make its way above the muscle and become more superficial, being covered by the pectineus and adductor brevis. The vessels and nerve are usually to the outer side of the sac, less commonly in front (Fig. 78).

Obturator herniæ are most frequently met with in elderly females, and the development of the hernia is sometimes associated with rapid loss of flesh in a person who was previously stout.

The majority of the recorded cases have been recognised only after the onset of strangulation, and after the abdomen has been opened for symptoms of acute intestinal obstruction. A loop of small intestine is then discovered engaged in the obturator opening.

As a rule there is little or no swelling in Scarpa's triangle, although in some cases a fulness may be found below the inner end of Poupart's ligament somewhat resembling a femoral protrusion. It is most readily felt from the inner side of the thigh behind the origin of the adductor longus, when the limb is flexed, abducted, and rotated outwards. The inner aspect of the obturator aperture should be explored by the finger introduced into the rectum or vagina. Disordered sensation, in the form of pain and numbness along the course of the obturator nerve, is met with in about one-half of the cases.

If the condition is recognised apart from strangulation, it should be treated by operation. The thigh is abducted, and an incision is made below the inner end of Poupart's ligament. The interval between the pectineus and adductor longus muscles is opened up, or the pectineus may be divided. The sac and the structures in relation to it must be thoroughly exposed before proceeding to the radical cure.

When strangulation has occurred a similar operation may be performed, or the abdomen may be opened in the middle or in the semi-lunar line, and the strangulated intestine released from the abdominal aspect of the obturator foramen. If the ring requires division, it should be incised in a direction downwards and inwards to avoid injuring the obturator artery. Great care must be taken to avoid infecting the peritoneal cavity in cases in which the bowel has become gangrenous.

Diaphragmatic hernia is described at page 420.

Hernia of Individual Viscera.—**Hernia of the Cæcum and Appendix.**—The cæcum and appendix are most frequently met with in acquired scrotal herniæ of the right side, but cases are recorded in which they have been found in left-sided herniæ. The peritoneal relationships of the cæcum within the hernia are the same as those which obtained within the abdomen. In the great majority of cases the cæcum and commencement of the ascending colon are entirely invested with peritoneum, and there is then a complete sac. In exceptional cases the posterior surface of these viscera is uncovered with peritoneum; the bowel is then adherent to the posterior wall of the sac; the hernia, under these circumstances, is usually irreducible, and is best treated by operation.

In *congenital hernia of the cæcum* the visceral descent is the result of the action of the gubernaculum. When the cæcum is present in a congenital sac, there is usually a peritoneal fold—the plica vascularis—uniting the bowel to the testis. This fold contains the spermatic vessels, vas deferens, and upper part of the gubernaculum; and as the testis passes into the scrotum it occasionally pulls the bowel after it by means of the plica (Lockwood). The cæcum bears the same relation to the sac as it did to the parietal peritoneum before the descent began.

In the operative treatment of these cases in which the cæcum does not lie free in the sac, but is attached to its posterior surface, the removal of the whole sac is impracticable.

The *vermiform appendix* may accompany the cæcum, or it may be the only viscus found in the hernial sac. It can sometimes be distinctly palpated through the coverings of a scrotal hernia. It is liable to become adherent to the sac or to the testis, and while it is very rarely strangulated, it may become the seat of inflammation—*appendicitis within a hernial sac.*

Hernia of the sigmoid flexure is met with in scrotal hernia of the left side under conditions similar to those described as occurring in hernia of the cæcum.

Hernia of the Ovary.—In the *congenital* form, which is that most frequently met with, the ovary is protruded along a patent canal of Nuck. In infants the ovary may be felt in the inguinal canal or beyond the external ring as a small, rounded, solid body, which slips about when pressed upon, and is attached to a cord—the Fallopian tube—which can be traced to the internal ring. The ovary rarely reaches the labium. In infants the condition may be only a temporary one, the ovary returning within the abdomen as the child grows. It may, however, become irreducible.

In adults the ovary is less readily identified, as it forms a mass very like adherent omentum. Occasionally it may be made to move by traction on the uterus through the vagina. If the patient menstruates, it may become swollen and sensitive at each period. The condition is best treated by operation. If the ovary is normal and can be easily replaced, it is reduced; if on the other hand it is diseased or irreducible, it should be removed.

In the *acquired* form the ovary is usually accompanied by omentum or intestine.

Hernia of the Urinary Bladder.—*Cystocele.*—This comparatively rare form of hernia is met with chiefly in men after middle life, and occurs almost exclusively in relation to inguinal

protrusions. Three chief varieties are recognised according to the peritoneal relationships of the protruded portion of the bladder—(1) The *extra-peritoneal* form, in which the bladder lies wholly without the hernial sac; (2) The *intra-peritoneal*, in which the protruded portion of bladder is entirely covered by peritoneum and lies within the hernial sac; (3) The *para-peritoneal*, in which the inner wall of the hernial sac is partly represented by the peritoneum covering the postero-lateral aspect of the bladder, the rest of the bladder outside the abdomen having no peritoneal coating. The viscus, therefore, is not one of the contents of the sac, but merely projects into it. The third form is the most frequent.

Hernia of the bladder is alleged to be acquired as the result of some obstruction to the outflow of urine, whereby the bladder becomes frequently distended and dilated, or even pouched. Minor varieties of the condition are sometimes produced by the surgeon during the operation, through exercising undue traction upon the sac.

Few cases of hernia of the bladder have been diagnosed before operation. When, however, a large portion of the bladder is protruded, the symptoms are suggestive. The hernial tumour appears to contain fluid, and is subject to rapid and considerable variations in size as a result of micturition. The patient may micturate in two stages: first, emptying the normal intra-pelvic portion of the bladder; and then, after applying pressure over the hernia and causing the urine it contains to return within the pelvis, passing the residue, the hernial tumour at the same time diminishing in size. Conversely, the hernial sac may be distended by injecting fluid into the bladder. In the case of a small protrusion, however, especially when it is of the nature of a diverticulum communicating with the bladder by a small opening, these features may not be sufficiently marked to aid in the diagnosis.

Before operation the condition is apt to be regarded as an irreducible omental hernia. The chief danger consists in the likelihood of the bladder being opened while operating for the radical cure of the hernia. The appearances met with in operating are an unusual amount of extra-peritoneal fat around the sac, and the presence in many cases of what appears to be a second sac to the inner side of the hernial sac proper.

Treatment.—The hernia being irreducible, operative treatment is indicated. The details of the operation depend on the variety of hernia. If the bladder be accidentally wounded in the course of operation, its wall should be sutured, the organ

replaced, and the external wound closed except for a drain leading through the hernial orifice to the site of the sutures in the bladder. Sometimes the injury to the bladder is not recognised at the time of operation, and is only suggested by the patient passing blood-stained urine by the urethra, and by the onset of septic complications associated with urinary infiltration, the escape of urine from the wound, and the formation of a urinary fistula.

In multiparous women a hernial protrusion of the bladder into the vagina—*vaginal cystocele*—is by no means uncommon.

CHAPTER XXVI.

THE STOMACH.

Surgical anatomy—Methods of suture—Operations on the stomach—Injuries: *Contusion; Rupture; Penetrating wounds; Effects of caustics; Foreign bodies in stomach*—Ulcers of stomach and duodenum: *Surgical aspects; Operative treatment of uncomplicated ulcer; Complications of gastric ulcer: Hæmorrhage; Perforation; Perigastric abscess and fistula; Perigastric adhesions; Effects of cicatricial contraction following gastric ulcer; Stenosis of pylorus; Hour-glass stomach*—Tumours: *Carcinoma; Other tumours*—Pyloric obstruction of infants—Gastroptosis—Dilatation of the stomach, gastrectasis.

Surgical Anatomy.—The stomach normally occupies the left hypochondrium and the left part of the epigastrium, the cardiac orifice and fundus lying under the left vault of the diaphragm, while the pylorus joins the duodenum under cover of the left lobe of the liver about one inch to the right of the middle line. The cardiac orifice is deeply placed, being about four inches from the surface behind the sternal end of the seventh left costal cartilage. In the female, as a result of tight lacing, the stomach is often displaced downwards and lies more vertically than normal.

When the stomach is empty the muscular walls are contracted, and its long axis is nearly horizontal.

When it is distended, both the cardiac and pyloric ends become enlarged and rounded, a distinct sacculus—the *antrum pylori*—forming at the pyloric end. The viscus occupies a larger area of the left hypochondrium and epigastrium, and may even extend into the umbilical region. The whole organ becomes elongated and the pylorus is moved towards the right. As it distends, the long axis of the stomach becomes oblique from above, downwards, forwards, and to the right. The upper or anterior wall of the stomach lies under cover of the left lobe of the liver and left cupola of the diaphragm, and in contact with the anterior abdominal wall. As the stomach empties, it recedes from the anterior abdominal wall, and the transverse colon may pass upwards and come to lie in front of it. The lower or posterior surface rests upon the gastric surface of the spleen, the left kidney and supra-renal body, and the upper surface of the pancreas. Between these structures and the stomach is the lesser sac of the peritoneum. The lesser curvature of the stomach is attached to the liver by the gastro-hepatic or lesser omentum, between the layers of which run the coronary arteries. The greater

curvature is directed forwards and towards the left, and gives attachment to the gastro-colic portion of the great omentum, which contains the right and left gastro-epiploic vessels.

The *duodenum* occupies chiefly the right half of the epigastrium. Having no mesentery it is fixed to the posterior abdominal wall, and is separated from the aorta and vena cava merely by loose connective tissue. Its anterior surface alone is covered by peritoneum. In the concavity of its curve lies the head of the pancreas. The common bile-duct joins the pancreatic duct behind the second portion of the duodenum, and the two open by a common orifice on its inner aspect (Fig. 106). The duodenum joins the jejunum about one inch to the left of the middle line at the level of the second lumbar vertebra. In the vicinity of this junction the peritoneum forms a fossa—the *duodeno-jejunal fossa*—into which a portion of intestine may be prolapsed, constituting one form of internal hernia.

Operations on the Stomach.

To avoid repetition it is convenient here briefly to describe the methods of suturing the stomach and intestine, and certain operations which are performed on the stomach.

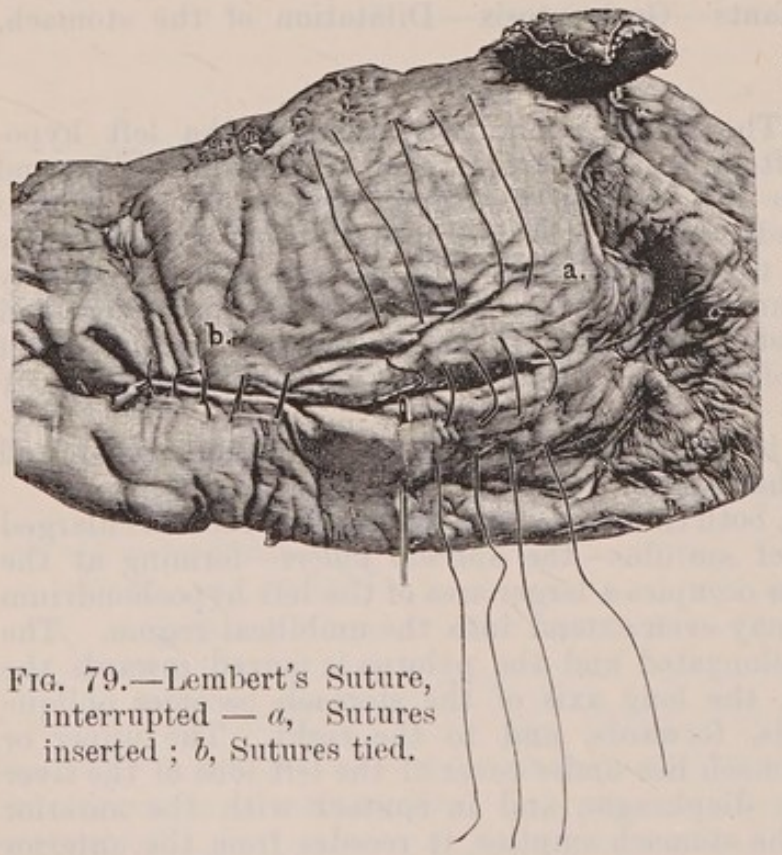

Fig. 79.—Lembert's Suture, interrupted — *a*, Sutures inserted; *b*, Sutures tied.

Sutures. — In closing wounds in the stomach or bowel, and in uniting divided ends of intestine, the sutures must be inserted in such a way as to prevent leakage of the intestinal contents into the peritoneal cavity. To ensure this the edges of the wound should be invaginated so that the mucous membrane is turned towards the lumen of the tube, and the serous surfaces on either side are brought into close apposition in order that they may adhere firmly to one another. The best material to employ is the finest Chinese-twist silk, and the stitches should be introduced with a round needle, which may be straight or curved as preferred. A milliner's needle suits the purpose admirably.

Lembert's Suture.—The most generally useful suture is that suggested by Lembert in 1826 (Fig. 79). The needle is introduced about a quarter of an inch from the edge of the wound, and passed through the serous, muscular, and part of the submucous coats, and, without entering the lumen of the bowel, is made to emerge close to the edge of the wound on the same side. It is next introduced to the same depth close to the edge on the opposite side, and made to emerge about a quarter of an inch farther out. When this stitch is tightened, the edges are inverted and the peritoneal surfaces are brought into close contact. These sutures may be interrupted or continuous.

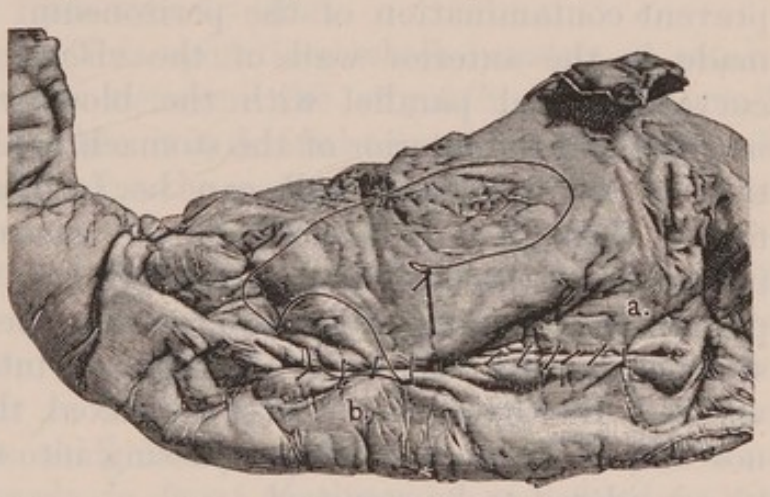

FIG. 80.—Czerny-Lembert Suture, continuous—*a*, Suture closing opening; *b*, Peritoneal Suture.

The *Czerny-Lembert suture* (Fig. 80) consists in introducing an ordinary continuous sero-muscular suture to bring the margins of the wound together, and then burying this by a Lembert suture which approximates the serous surfaces. The first row may be carried through all the coats.

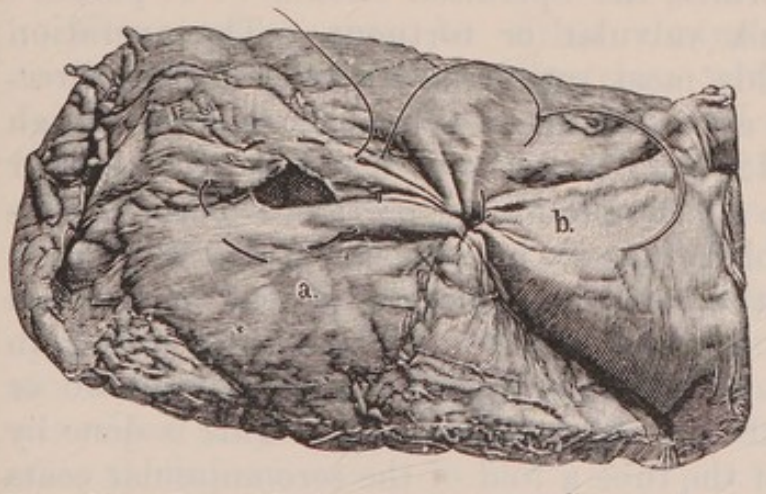

FIG. 81.—Purse-String Suture—*a*, Suture introduced around perforation; *b*, Suture tied, closing perforation.

A *purse-string suture* (Fig. 81) is made by carrying a continuous Lembert suture circularly round an area of bowel, for example, that around a perforation, in such a way that when it is tightened the enclosed area is puckered in, and the serous surfaces brought into apposition.

Operations on the Stomach.—The operation of *gastrotomy*, or opening the stomach, is most frequently performed for the removal of foreign bodies from the stomach or lower end of the

œsophagus. The incision is usually made in the middle line above the umbilicus. The stomach having been identified, and its contents pressed onwards into the duodenum, the part to be opened is withdrawn and packed round with sterilised gauze to prevent contamination of the peritoneum. An incision is then made in the anterior wall of the viscus, midway between its curvatures and parallel with the blood-vessels. A finger is inserted and the interior of the stomach explored. The examination of the posterior wall can be facilitated by passing two fingers through a hole made in the gastro-colic omentum and invaginating the back wall of the stomach. The patency of the pylorus may be judged by invaginating the anterior wall of the stomach, or by the finger introduced into the cavity of the viscus. If, when the sphincter is relaxed, the pyloric orifice does not admit of the index finger passing into the duodenum it may be considered to be stenosed.

After the exploration is completed the wound in the stomach is closed by a double row of sutures, and the organ returned to the abdomen.

Gastrostomy.—The object of this operation is to establish a gastric fistula through which the patient may be fed, for example, in cases of stricture of the œsophagus. To prevent leakage of the stomach contents, and consequent irritation of the skin around the orifice, the operation should be so planned as to make the fistula valvular or tortuous. The operation devised by Witzel yields most satisfactory results in this direction. The stomach is exposed, and an opening just large enough to admit a number 12 English catheter made in the anterior wall about the middle of the presenting portion. Through this opening a flexible rubber tube is introduced so that it projects about an inch into the cavity of the viscus, and is fixed in position by means of a catgut stitch. What may be called an artificial œsophagus is next made by embedding about two or three inches of the tube in the stomach wall. This is done by raising on each side of the tube a fold of the sero-muscular coats of the stomach, and uniting the two folds by a series of Lembert sutures. The part of the stomach from which the rubber tube emerges is then securely fixed to the parietal peritoneum by sutures. Finally, the tube is brought obliquely through the abdominal wound, and this is closed by sutures. The patient is fed by fluids through a funnel introduced into the outer end of the tube, and the first meal may with advantage be given before the patient leaves the operating table. Between meals the tube is occluded by an ordinary clamp or a wooden spill. Great care

must be taken during the first week not to displace the tube, as some difficulty may be experienced in re-introducing it, and in the attempt the sutures may be torn and leakage take place. After the fistulous track has become established, the tube may be removed and cleaned from time to time.

Gastro-enterostomy.—This operation, which consists in establishing a communication between the stomach and the small intestine, is performed when it is desired to rest the stomach and to provide a new outlet for the escape of its contents into the intestine.

As a rule the portion of intestine selected for anastomosis is the upper end of the jejunum—*gastro-jejunostomy*—and this is united to a dependent part of the stomach. The viscera are applied to each other in such a way that the direction of the peristaltic movements shall be the same in each. The jejunum may be brought upwards in front of the colon and fixed to the anterior wall of the stomach (Wölfler's operation), or it may be taken behind the colon and fixed to the posterior wall of the stomach (von Hacker's operation). An operation has been devised by Kocher in which the second part of the duodenum is united to the anterior wall of the stomach—*gastro-duodenostomy*.

Injuries.

The stomach may be either contused or ruptured from a severe blow over the epigastrium without there being any evidence of damage to the abdominal wall. The lesion is usually on the anterior wall of the stomach near the pylorus.

In a **contusion** the peritoneal coat is usually torn, and in some cases the muscular coat also is implicated, but the mucous membrane remains intact. There is marked shock, severe epigastric pain, and vomiting. The damaged portion of the stomach wall may subsequently become gangrenous, in which case signs of perforation-peritonitis suddenly ensue several days after the injury.

When there is a **rupture** of all the coats of the stomach, gas enters the peritoneal cavity, and may cause some distension of the abdomen and diminution of the area of liver dulness. The fluid contents of the stomach may also escape into the abdominal cavity and set up perforation-peritonitis. The patient is profoundly collapsed, the pulse small and rapid, and the temperature subnormal. The abdominal muscles are rigid, and the respiration is entirely thoracic. There may be vomiting of unaltered blood or of blood blackened by digestion. These symptoms are most prominent

when the stomach is full at the time of the accident. In most cases the liver or spleen is ruptured at the same time, and the patient shows signs of internal hæmorrhage. Severe bleeding may also occur from rupture of large vessels in the wall of the stomach or omentum.

Treatment.—Means should be taken to counteract shock by stimulant enemata, hypodermic injection of strychnin, and external warmth. The abdomen is opened in the middle line, and if a rent is found in the stomach it is closed by a double row of sutures. If the soiled area of peritoneum is limited to the region of the tear, gentle sponging with sterile normal salt solution is sufficient, but if the stomach contents have been widely disseminated, it is necessary to irrigate the whole peritoneal cavity with large quantities of fluid. In some cases the only hope of thorough purification lies in eviscerating the intestines, and carefully irrigating each coil. An additional opening above the pubes is useful in enabling the pouch of Douglas and the pelvic cavity to be thoroughly irrigated and drained.

Penetrating Wounds.—The stomach may be perforated by any sharp object, such as a knife blade or a spike, thrust through the abdominal wall, or by a bullet. Except when produced by a high-velocity bullet, the wound in the stomach is usually sufficiently large to permit of the escape of gastric contents into the peritoneal cavity, and not infrequently there is internal hæmorrhage from injury to the vessels of the stomach wall. If the penetrating body pass through the abdominal wall obliquely, the wound in the parietes may be valvular, and its external aperture may not lie opposite the level of the stomach, and so the existence of a gastric lesion may not be suspected. As there is comparatively little shock at the time of the injury, the immediate symptoms do not as a rule cause alarm, and it may be some hours before the gravity of the condition becomes manifest by the onset of symptoms of perforation-peritonitis. Occasionally the stomach is perforated from within by sharp bodies passed along the œsophagus, by "sword swallowers" for example, or by the unskilful passage of bougies.

Treatment.—In civil practice the invariable rule is to explore, and, if necessary, to enlarge the abdominal wound, or, it may be, even to make a fresh incision in order to ascertain the condition of the stomach and adjacent viscera. If a perforation is found, its edges, if damaged, should be pared with scissors, and, before it is closed by sutures, the interior of the stomach and its posterior wall should be examined for further injuries.

The peritoneal cavity and the external wound are then purified and closed, with or without drainage according to circumstances.

Effects of Caustics.—The stomach wall may be damaged by the patient swallowing concentrated acids or alkalis, or other caustic substances. The corrosive action is most severe on the lesser curvature and towards the pyloric end of the stomach, and it may prove fatal, either immediately from perforation of the stomach, or later from sloughing of its walls. When the destructive action does not at once extend to all the coats, cicatricial contraction subsequently ensues, and may cause stenosis of the pylorus, or an hour-glass constriction in the body of the stomach. As a rule the gullet also is damaged by the caustic and is the seat of stricture.

Foreign Bodies in the Stomach.—When such articles as small coins, buttons, beads or fruit stones are swallowed, being comparatively smooth and rounded, they usually traverse the pylorus and are passed by the rectum. Other bodies, such as tooth plates, large nails, pieces of bone, knives, forks, etc., are more liable to be retained in the stomach, either because they are too large to pass through the pylorus, or because they are sharp and irregular, and catch on the gastric mucous membrane. They seldom become impacted in the pyloric orifice. The progress of an opaque foreign body along the alimentary canal may be observed by a series of X-ray photographs. These bodies may perforate the stomach and cause fatal peritonitis, or they may lodge in the stomach and give rise to symptoms simulating those of gastric ulcer. Large bodies may be palpable through the abdominal wall, and when opaque they may be demonstrable by the Röntgen rays. In hysterical young girls large *balls of hair* are occasionally formed in the stomach by the gradual accumulation of fragments of the patient's own hair, which have been bitten off and swallowed. These "hair-balls" may be felt as round bodies which are freely movable within the stomach, and they give rise to gastric pain, indigestion and emaciation.

Treatment.—The passage of small bodies through the pylorus and intestines is facilitated by administering a large meal of porridge, rice-pudding or "pease-brose," which will enclose the foreign body and fill up any crevices in it. When there are any rough projections on the body, a quantity of chopped up worsted or string is a useful addition to the bolus, the strands being wound round the projections by the churning movements of the stomach. The stools should be mixed with water and strained through muslin till the object is found.

Large irregular bodies and hair balls should be removed by gastrotomy.

Ulcers of the Stomach and Duodenum.

The wall of the stomach is frequently the seat of a form of ulceration which is probably due to a digestive action of the gastric juice on a portion of the mucous membrane which has been slightly eroded by catarrhal inflammation or by injury. Similar ulcers are met with in the duodenum. These ulcers, which may be single or multiple, are usually rounded or oval, and measure from half an inch to four or five inches in diameter. In some cases, only the mucosa is destroyed, in others the muscular coat also is eroded, and the base of the ulcer is formed by the peritoneal covering. When the ulcer is situated on the posterior wall of the stomach—the most common site—adhesions are liable to form between the ulcerated portion of the stomach and the adjacent viscera—the pancreas or spleen—with the result that the base of the ulcer is formed by these viscera—the so-called "penetrating ulcer." In this way perforation into the peritoneal cavity is prevented. Adhesions rarely form between the anterior wall of the stomach and the parietal peritoneum—a fact which helps to explain the comparative frequency with which ulcers on the anterior wall perforate into the peritoneal cavity. As a rule the ulcer has a punched-out appearance, its edges dipping straight down, and being somewhat thickened and indurated. In some cases the edges shelve down, the mucosa being destroyed over a wider area than the muscularis (Fig. 83). The healing of a gastric ulcer is

Fig. 82.—The Peritoneal Aspect of the Pyloro-duodenal Junction, showing a minute circular opening, the result of a perforating ulcer.

(From Dr. Harvey Littlejohn's collection.)

Fig. 83.—Chronic Gastric Ulcer, showing a perforation which occupies about half the extent of the floor of the ulcer. The rest of the floor is formed by adherent pancreas. The stellate puckering of the surrounding gastric wall is well marked.

(Anatomical Museum, University of Edinburgh.)

frequently accompanied by marked cicatricial contraction which, according to the site of the ulcer, may lead to stenosis of the pylorus, to hour-glass constriction of the body of the stomach, or to puckering of its wall. There is reason to believe that a chronic ulcer may become the starting-point of cancer.

Gastric ulcer is most common in young anæmic and chlorotic women, and gives rise to severe epigastric pain and vomiting after taking food, and sometimes to hæmatemesis. Duodenal ulcers are usually met with in middle-aged males, who may suffer from dyspepsia, or may enjoy perfectly good health. When there is pain, it usually comes on some hours after food, and it is seldom accompanied by hæmatemesis. Melæna, however, is comparatively common. In the great majority of cases these conditions are amenable to medical and dietetic treatment, and it is only when such complications as profuse hæmorrhage, perforation, perigastric abscess, or cicatricial stenosis ensue, or when the condition lasts unduly long and resists medical treatment, that surgical intervention becomes necessary.

Operative Treatment of Uncomplicated Ulcer.—In cases where a course of medical treatment has failed to bring about the healing of the ulcer, and where the chronic ill-health of the patient interferes with the earning of a livelihood, surgical intervention is warranted, especially in view of the risk of perforation, of severe hæmorrhage, or of the subsequent development of cancer. The most suitable operation is gastro-enterostomy, the communication between the stomach and intestine being made at the most dependent part of the stomach to facilitate the passage of the food into the bowel. In this way the hyperacidity of the gastric contents, the spasmodic contraction of the pylorus, and the motor insufficiency of the stomach muscle, which are important factors in preventing healing of the ulcer, are corrected. Recurrence of the ulcer, although rare, is not unknown after this operation.

Pyloroplasty is indicated in cases in which the pylorus is stenosed by spasm or hypertrophy of its walls, but in which it is free of adhesions and is not contracted by scars. The drainage of the stomach is less perfect than after gastro-enterostomy, and, unless the cases are very carefully selected, relapses are more frequent.

Excision of the ulcer is only performed when there is reason to suspect the development of cancer, or when it lies in the area of the incision necessary for gastro-enterostomy or pyloroplasty.

Complications of Gastric Ulcer—Hæmorrhage.—*Gastrorrhagia.*—Hæmorrhage is one of the most common complications

of gastric ulcer. It may threaten life by repeatedly recurring at short intervals, and producing profound anæmia. In such cases the bleeding is usually from capillaries, and is controlled by medical measures. Sometimes, however, it is necessary to perform gastro-enterostomy to enable the ulcer to heal, and thus prevent these recurrent hæmorrhages.

A more serious form of gastrorrhagia is that which results from erosion of a large artery exposed on the base of the ulcer—for example, the coronary or splenic artery. Copious bleeding from a large vein is less common. In some cases capillary oozing is sufficiently profuse to prove rapidly fatal, and even on post-mortem examination the source of the bleeding may not be discoverable. As it is comparatively rare for a first hæmorrhage to prove fatal, medical measures should usually be tried before recourse is had to surgical treatment, but if the bleeding persists or recurs, operation is called for.

If, on exposing the stomach, the position of the ulcer can be recognised, the incision in the gastric wall should be made close to it; if not, an incision is made about the middle of the accessible portion of the stomach, and the interior of the organ systematically explored. If the ulcer is found on the anterior wall or lesser curvature, close to the pylorus, it should be excised, and the bleeding vessels secured by ligatures. If it is on the posterior wall, or high up near the cardiac end, and if the bleeding is taking place from a large, eroded vessel, it may be arrested by the cautery (Mikulicz). When no bleeding point can be discovered, or when the patient is very feeble and anæmic, gastro-enterostomy should be performed. Several pints of saline fluid should be introduced into the peritoneal cavity before closing the abdomen, or infused into a vein or into the subcutaneous tissue, and other means taken to counteract shock. Rectal injections of saline fluid every few hours are useful in restoring the circulation.

Perforation.—Perforation is a comparatively common complication. It occurs most frequently in anæmic young women, but may be met with in adults of either sex and of any age. The ulcers which most frequently perforate are those situated in the anterior wall of the stomach near the pylorus or lesser curvature, and those towards the cardiac end. It has been estimated that in about 20 per cent. of cases there is more than one perforation. The perforation varies in size from a pin-point opening to a hole large enough to admit the tip of the little finger. The edges of the aperture are usually sharply defined and slightly indurated, and a variable area of the surrounding stomach wall is thick and rigid. The perforation may occur directly on to the free surface

of the visceral peritoneum, and so open into the general peritoneal cavity, or it may take place at a point where the stomach has formed adhesions to the surrounding viscera, and give rise to a localised peritonitis or to a perigastric abscess. When the perforating ulcer is on the posterior wall of the stomach, it usually opens directly into the lesser sac of the peritoneum.

Clinical Features.—There may be a history that the patient has previously suffered from symptoms of gastric or duodenal ulcer, but in many cases the occurrence of perforation is the first indication of any gastric affection. The patient is suddenly seized with intense, cramp-like pain in the epigastrium, so severe at first as to cause her to writhe in agony. There is a variable, but usually considerable degree of shock, the pulse becomes small, soft and feeble, and varies in rapidity from 100 to 110. The temperature is subnormal, and the skin cold and pallid. Vomiting is more often absent than present. Palpation of the abdominal wall elicits tenderness, particularly in the region of the epigastrium, and the maximum point of tenderness usually corresponds fairly accurately to the site of the perforation. At this point there is sometimes a localised fulness. There is marked rigidity of the abdominal muscles, and the abdomen does not move with respiration. On percussion a uniform, tense, drum-like note is elicited all over the abdomen, and the area of liver dulness is usually diminished or lost.

The severity of these symptoms varies, being least marked when a small perforation is surrounded by adhesions or opens into the lesser peritoneal sac, and when the stomach is empty at the time the perforation occurs.

In the course of one or two hours reaction comes on, and the severity of the symptoms abates somewhat. The pain and tenderness are less marked, the pulse improves, the face becomes slightly flushed, and the patient both looks and feels better. The rigidity and immobility of the abdomen, however, usually persist. This temporary improvement is most marked when the perforation is small, when it opens among adhesions or into the lesser peritoneal sac, and when the stomach was empty at the time it occurred. It may be so marked that the patient is able to move about and to take nourishment without apparent discomfort. It is often misleading, as it suggests that the initial pain was of the nature of colic.

Sooner or later—usually within three or four hours of the perforation—the symptoms again become alarming, and are those of septic peritonitis. The pain returns, and, although less severe than at first, is more generalised over the abdomen. The pulse

becomes rapid (120-130) and feeble, and the temperature may rise. The features are drawn, the expression anxious, and the face livid. The abdomen becomes distended and tympanitic. On rectal or vaginal examination fluid may be detected by bulging of the pouch of Douglas, and the patient may be unable to empty the bladder. If untreated, death usually ensues in from twenty-four to forty-eight hours.

The *diagnosis* is usually easy, but in some cases there is difficulty in excluding such conditions as hepatic, renal, and intestinal colic, acute appendicitis—particularly in cases of duodenal perforation—and the rupture of an extra-uterine pregnancy or a pyosalpinx. On the other hand, patients with a definite history of old-standing gastric ulcer are sometimes seized with intense pain and collapse, and yet, on the abdomen being opened, no perforation can be found. These are probably cases of threatened perforation or of concealed hæmorrhage. In all doubtful cases an exploratory operation should be performed. The administration of more than one dose of opium for the relief of pain should be avoided until a definite diagnosis has been made, and the line of treatment decided upon.

Prognosis.—When the perforation occurs into the general peritoneal cavity, the only hope of saving the patient's life lies in operation, and this is seldom successful unless performed within eight or ten hours of the perforation. The prognosis is most favourable when the stomach is empty at the time of perforation. When the perforation occurs among adhesions or into the lesser sac, the patient may recover and subsequently develop a perigastric abscess, this being usually situated in the left subphrenic space.

Operation.—After the diagnosis of perforation has been made, no time should be lost in performing the operation. In making the preparations for operation the patient should be moved as little as possible. The abdomen is opened by an incision, usually in the middle line above the umbilicus. When the perforation has taken place into the general peritoneal cavity, and the abdomen is distended with gas, the parietal peritoneum and extra-peritoneal fat may be bulged into the wound after the muscles have been divided. On opening the peritoneum gas and a quantity of yellow, turbid fluid escape, and the abdominal wall becomes flaccid. When the perforation is in the duodenum, the fluid is usually bile stained, and there is little or no gas. The site of the perforation may be indicated by gas and fluid gushing from it with each respiratory movement, or by an accumulation of lymph in its vicinity. When not immedi-

ately evident, the perforation must be systematically sought for, the pyloric region, the anterior wall, the lesser curvature, and the cardia being in turn examined. If no perforation is found on the anterior surface of the stomach, the posterior surface should be explored through an opening into the lesser sac, made by tearing a hole in the gastro-colic omentum close to the great curvature. Whenever the perforation is found, it should be plugged with iodoform gauze to prevent leakage during subsequent manipulations. The affected portion of the stomach is pulled within reach, the parietal wound being enlarged, if necessary, to admit of this. If the stomach is full, the contents may be syphoned off by a small tube introduced through the opening, and the viscus washed out with saline solution or boracic lotion. The perforation is then closed by surrounding it with a purse-string suture, and introducing a double row of sutures. It is seldom advisable to pare the edges or to excise the ulcer. When, owing to its inaccessible position, or to rigidity or friability of the stomach wall, the perforation cannot be closed by sutures, it may be occluded by stitching a piece of omentum, or of the liver or other adjacent viscus, over it. The possibility of a second perforation must be borne in mind.

The second stage of the operation consists in cleansing the peritoneal cavity. When the perforation is a small one, and the leakage of gastric contents very limited, it is sufficient to mop up the fluid and lymph with gauze; but when the general cavity of the peritoneum is soiled, it should be thoroughly irrigated with a large quantity of saline solution at a temperature of 105° F. This irrigation should be carried out systematically, each portion of the cavity being freely flushed out. Special attention should be directed to the space between the diaphragm and the liver on each side of the suspensory ligament, the space between the stomach and the spleen, and the pouches in relation to the kidneys. A separate incision should be made above the pubes for the cleansing and drainage of the pouch of Douglas. Glass drainage tubes may be left in each wound for from twenty-four to forty-eight hours.

If the patient get over the initial shock and septic intoxication, there is still the risk of further complications, for example, leakage leading to septic peritonitis, the occurrence of perforation in relation to a second ulcer, septicæmia, pleuro-pneumonia, and pyophlebitis of the portal vein and hepatic abscess.

Perigastric Abscess and Gastric Fistula.—These complications are usually associated with the perforation of a chronic gastric ulcer which has become adherent to surrounding structures.

The stomach contents which escape from the perforation are therefore limited to its immediate vicinity, and set up a localised suppurative inflammation. This occurs most frequently in ulcers situated on the lesser curvature and towards the cardiac end of the stomach, and the resulting abscess forms below the left vault of the diaphragm, constituting one variety of *subphrenic abscess*. Ulcers on the posterior wall may give rise to a localised abscess in the lesser peritoneal sac, in the pancreas, or in the retro-peritoneal tissue, according to the disposition of the adhesions. When a duodenal ulcer perforates amongst adhesions, the abscess usually extends under the vault of the diaphragm.

When a perigastric abscess forms in connection with an ulcer on the anterior wall of the stomach, it usually projects below the costal margin in the left hypochondrium, or in the loin. When it bursts, it is liable to be followed by the formation of a *gastric fistula*, from which the stomach contents escape externally. The skin around the orifice of the fistula is irritated, and may undergo partial digestion. The patient emaciates from loss of nutriment. The abscess should be thoroughly drained, and if the fistula be small, it may heal spontaneously if the patient be fed for a few days entirely by the rectum. If it persist, the abdomen should be opened, the ulcer exposed and excised, and the stomach securely closed.

Fistulous communications occasionally form between the stomach and some part of the intestine, particularly the colon. The stools contain undigested food, and the patient complains of fœtid eructations and of vomiting of scybalous matter. This condition is treated by exposing the viscera, separating them by dissection, and closing the respective apertures by sutures.

Perigastric Adhesions.—In many cases adhesions between the stomach and surrounding parts give rise to no symptoms. In other cases, by fixing some part of the stomach and so disturbing its motor functions, or by causing kinking of the pylorus, they interfere with the onward passage of the gastric contents, and so lead to dilatation. The patient complains of a dragging pain in the region of the stomach, and of a sense of discomfort after a full meal. These symptoms are aggravated by exertion, but are relieved by lying down or by wearing a tight belt. Sometimes there are symptoms of gastric stasis and dilatation, with vomiting after food. When the anterior wall of the stomach is fixed by dense adhesions to the parietal peritoneum, a distinct tumour may be palpable in the epigastric region.

In mild cases relief may be obtained by restricting the diet,

wearing a tight belt, and resting for some time after food. In more severe cases it is necessary to open the abdomen and separate the adhesions—*gastrolysis*. If the adhesions are very extensive, and their separation appears to be attended with risk of injuring the stomach wall, gastro-enterostomy should be performed.

Effects of Cicatricial Contraction following Gastric Ulcer.—These include stenosis of the pylorus and hour-glass contraction of the stomach.

When **stenosis of the pylorus** results from cicatricial contraction of an ulcer in the vicinity of this orifice, the food is obstructed in its passage and accumulates in the cavity of the stomach where it undergoes fermentation. The stomach becomes hypertrophied and dilated to such an extent sometimes that the greater curvature may reach the level of the pubes. Peristaltic waves may be seen passing across the stomach from left to right, and splashing sounds may be elicited on palpation. The patient vomits large quantities of sour-smelling, partially digested food mixed with frothy mucus and containing large numbers of sarcinæ.

Treatment.—The symptoms may be palliated by careful dieting and by washing out the stomach periodically, but the condition can be cured only by operation. In some cases dilatation of the pylorus by Loreta's or Hahn's method, or by pyloroplasty, is sufficient, but in the majority a more satisfactory result is obtained by gastro-enterostomy. When there is reason to suspect the existence of cancer of the pylorus, the operation of pylorectomy should be performed.

Loreta's operation consists in opening the stomach near the pyloric end, and stretching the orifice by passing through it the fingers or a series of dilators. *Hahn's method*, which is safer and easier, consists in invaginating the anterior wall of the stomach through the pylorus by means of the forefinger; as the resistance of the sphincter is overcome, two or even three fingers may be inserted until the channel is well opened up. *Pyloroplasty* consists in dividing the anterior wall of the pylorus by a longitudinal incision about two inches long, and, after separating the edges of the wound widely, stitching them at right angles to the original line of incision.

Hour-glass contraction of the stomach (Fig. 84) is usually a result of the cicatrization of a horse-shoe shaped ulcer in the body of the stomach, or of perigastric adhesions which fix the central area of the viscus to the anterior abdominal wall. It is frequently accompanied by some degree of stenosis of the

pylorus. The size and situation of the communication between the two compartments vary widely.

The *clinical features* resemble on the whole those of dilatation of the stomach associated with pyloric stenosis. After the stomach has been washed out until the fluid returns clear, a sudden, unexpected gush of dirty, fermented stomach contents makes its appearance, due to reflux from the pyloric compartment of the stomach. After apparently emptying the stomach with the tube, splashing may still be elicited in the epigastric region, the pyloric segment not having been emptied. On the stomach being distended with air a sulcus may be recognised, separating two dilated cavities. In some cases the condition simulates obstruction of the cardiac orifice.

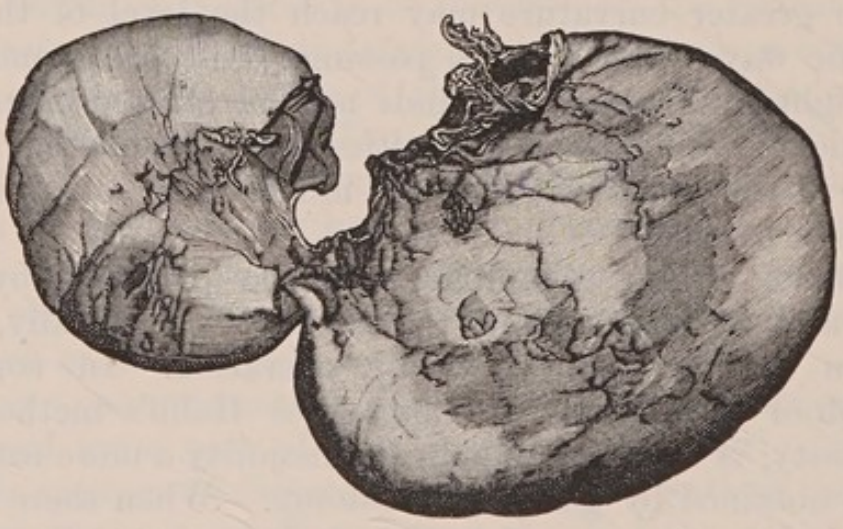

FIG. 84.—Hour-glass Contraction of the Stomach following Gastric Ulcer.

The *treatment* is operative, and the procedure suitable to a given case can only be decided upon after the stomach has been exposed and the exact nature of the deformity discovered. When the isthmus is near the centre of the stomach, and the compartments are not much dilated, a *gastroplasty* carried out on the same lines as pyloroplasty may suffice. When the isthmus is near the lesser curvature, and the compartments sag downwards so that they meet below the isthmus, *gastro-anastomosis*—that is, the establishment of a communication between the lower part of the two pouches—is indicated. The steps of the operation are similar to those of gastro-enterostomy. If the pylorus is stenosed, gastro-enterostomy will be required in addition. In some cases both compartments must be united to the intestine. When the cicatrix is the seat of cancer it must be resected, and the divided ends of the stomach brought together by sutures—*circular resection of the stomach.*

Tumours of the Stomach.

Carcinoma.—Carcinoma is by far the most common form of tumour met with in the stomach, and it may develop in any part of the viscus. It occurs with about equal frequency in the two sexes, and usually appears between the ages of forty and sixty. The pathological and clinical features vary according as the tumour is situated at the pylorus, in the body of the stomach, or at the cardiac end. Special mention must be made of the fact that cancer is very liable to develop in an old-standing gastric ulcer—so called "ulcer-cancer" of the stomach.

The region of the lesser curvature near the *pylorus* is that most frequently attacked, the growth being situated there in fully 60 per cent. of all cases. It is in this situation also that "ulcer-cancer" is most likely to develop. The tumour is usually of the scirrhous variety, and forms a small, hard, annular growth, which tends to surround and occlude the pyloric orifice. It increases slowly, shows little tendency to invade the duodenum, but spreads towards the body of the stomach, and along the lesser curvature in the line of the main lymphatics. The glands lying between the layers of the gastro-hepatic omentum along the lesser curvature of the stomach are usually infected, and those in the great omentum along the greater curvature may also become involved. The tumour is liable to form adhesions with the liver, the gall-bladder, the head of the pancreas, and, through the retro-peritoneal tissue, with the main blood-vessels.

Tumours of the *body of the stomach* are usually more cellular in character, the cylindrical carcinoma being the most common form. They grow more rapidly, tend to infiltrate a large area of the stomach wall, and are more liable to ulcerate and bleed. They frequently undergo colloid degeneration. All the lymphatic glands related to the stomach are early and widely infected. Metastasis to the liver and lungs is comparatively common, and in some cases diffuse infiltration of the peritoneum occurs. In cases of hour-glass stomach, due to cicatricial contraction of a gastric ulcer, cancer frequently develops at the isthmus.

Cancer at the *cardiac end* of the stomach is usually a squamous epithelioma which has spread from the œsophagus.

Clinical Features.—The first symptoms are a gradual loss of appetite and loss of flesh, developing without obvious cause in an individual previously in good health. In course of time the patient becomes anæmic, and being easily tired is disinclined for

exertion. Pain or discomfort after food is usually complained of, especially when the cancer involves the pyloric orifice, and vomiting of food, sometimes mixed with altered blood, is frequently observed. Free hydrochloric acid is absent from the contents of the stomach, and for the purpose of examination, these should be drawn off with the stomach tube after a test meal of bread and tea; lactic and butyric acids make their appearance when fermentation changes have occurred. There is usually marked leucocytosis. The presence of a palpable tumour in the epigastric region is exceptional, and should not be relied upon for diagnostic purposes.

In cases of pyloric cancer the stomach is usually dilated, and the characteristic symptoms of gastric stasis are present. Inflation of the stomach may demonstrate the enlargement, and may render evident an otherwise impalpable swelling.

The tumour is more frequently palpable when it occupies the body of the stomach, and particularly when situated on the anterior wall. In such cases the swelling may be so circumscribed, firm and mobile as to be mistaken for a floating kidney or an enlarged and movable spleen. Tumours of the cardiac end are quite beyond the reach of palpation from without, and the stomach is usually small and atrophied. The symptoms resemble those of cancer of the œsophagus, the most prominent being dysphagia.

In cases of "ulcer-cancer" pain is a fairly constant and early symptom, and free hydrochloric acid not only is present in the gastric contents, but may be in excess.

Tumours of the stomach have to be diagnosed from tumours of the colon, the omentum, the gall-bladder, the liver, the pancreas and the abdominal wall. Also from swellings resulting from perigastric adhesions, and from a floating kidney or spleen. In many cases it is only by performing an exploratory laparotomy that the diagnosis can be made certain. This operation should only be performed when there is reason to expect that the tumour is removable, or that a palliative operation will relieve the symptoms, and when the general condition of the patient is such as to warrant the more serious operation being attempted—that is to say, it should not be performed merely for purposes of diagnosis.

Treatment.—Complete excision of the tumour and of the infected lymphatic glands is the only means of curing the disease. In many cases it is only after the tumour and its surroundings have been exposed by laparotomy that it is possible to say whether or not the radical operation is feasible.

If the tumour is confined to the stomach, and has not formed any adhesions to surrounding viscera, if the glands are not infected, or, if infected, are capable of being removed, and if there is no evidence of metastasis having occurred, an attempt may be made to extirpate the growth. The operation of *gastrectomy*, or resection of the stomach, consists in removing a wedge-shaped or elliptical portion of the stomach, or, it may be, a complete segment of the organ. The former operation involves less complicated stitching than the latter, and is to be preferred when by it the whole disease can be removed. The term *pylorectomy* is applied when the operation is performed for malignant disease of the pylorus, although considerable portions of the stomach and duodenum must also be removed at the same time.

Mere extent of the disease is not in itself a bar to operation, as is shown by the fact that the whole stomach has been successfully removed. The mortality from the operation is about 30 per cent., the chief causes of death being shock, peritonitis, pneumonia, and gangrene of the colon. If the patient survive the operation, he rapidly puts on weight, and may completely regain his health. Immunity from recurrence for four years may be considered as constituting a permanent cure. The prognosis appears to be most favourable in cases of columnar carcinoma.

The radical operation is contra-indicated when the gastric tumour has infiltrated surrounding structures, for example, the colon, omentum, liver, pancreas or abdominal wall, or when metastasis has occurred. Infection of the deeper glands, particularly those along the upper border of the pancreas, and in the retro-peritoneal tissue, also forbids excision. Under these circumstances the surgeon has to decide whether or not a palliative operation is calculated to relieve the patient's symptoms. When the pylorus is obstructed, and the patient suffers from symptoms of gastric stasis and dilatation of the stomach, considerable relief is usually afforded by gastro-enterostomy. When gastro-enterostomy is impracticable, jejunostomy may be performed, and the patient fed through the opening in the intestine. The vomiting ceases, the nutrition improves, and for a time the patient may feel quite well. In some cases, however, no benefit follows these operations. In the majority of cases the patient succumbs to the primary disease in the course of a few months, although in a few cases of undoubted cancer the patient has survived as long as three and a half years.

The symptoms in cancer of the cardiac end of the stomach may be relieved by gastrostomy.

Other tumours of the stomach, for example, myomata, adenomata and sarcomata, are rare. They are seldom diagnosed before being exposed by operation, and are treated on the same lines as cancerous growths.

Pyloric Obstruction of Infants.—This condition, which is due to an hypertrophy of the muscular coat of the pylorus, probably congenital in origin, is characterised by intractable vomiting, which is unattended by retching, and occurs within a few minutes of taking food. The vomited matter consists of unaltered food, mixed with mucus, but free of bile. When the condition has lasted for some time, peristaltic waves may be seen passing along the stomach from left to right, and a palpable tumour can sometimes be recognised in the region of the pylorus. Unless relieved by operation the condition usually proves fatal within a few months. The operative treatment consists in opening the stomach and dilating the pylorus with bougies or dressing forceps. In a few cases gastro-enterostomy has been successful.

Gastroptosis, or prolapse of the stomach, is a condition in which the pyloric portion of the stomach, either alone or along with other abdominal viscera, sinks to a lower level than normal in the abdomen. If the patient swallow a large quantity of water while in the erect posture, the stomach stands out prominently, and the lesser curvature and pylorus may be found to have descended as low as the umbilicus, while the greater curvature may reach the level of the pubes or the left iliac fossa. The pancreas may sometimes be palpated as a transverse cord a little above the level of the umbilicus. The chief symptoms are epigastric pain—which is aggravated by standing and exercise, and is apparently due to stretching of the nerve plexuses of the stomach—and stagnation of the gastric contents. There is usually splashing on succussion after a prolonged fast, and other evidence of dilatation of the stomach.

Relief may be afforded by the wearing of a supporting bandage, massage, attention to diet, and the occasional use of the stomach-tube. If these measures fail, the abdomen should be opened, and the gastro-hepatic omentum and other superior attachments of the stomach shortened by passing through them a series of silk sutures in such a way that, when they are tightened up, the stomach is raised to its normal level, and is prevented from becoming prolapsed when the patient assumes the upright posture—*gastropexy*. If the pylorus is stenosed or

kinked, pyloroplasty or gastro-enterostomy may be indicated. If the stomach is much dilated, its capacity may be diminished by gastroplication.

Dilatation of the Stomach or Gastrectasis.—Dilatation of the stomach has already been referred to in connection with pyloric stenosis, due to cicatricial contraction and to cancer. It may also result from external pressure on the pylorus or duodenum, for example, by tumours of the pancreas, gall-bladder, liver or retro-peritoneal tissue. Further, the pylorus may be dragged upon and kinked by perigastric adhesions, especially those resulting from gall-stones, or by a movable right kidney. In a limited number of cases there is no discoverable cause for the dilatation, and the condition is then regarded as a neuroparesis. The treatment is directed towards the removal of any existing cause by surgical measures or otherwise. Failing the fulfilment of this indication, or in addition to it, it may be necessary to drain the stomach by means of a gastro-enterostomy, or the size of the organ may be reduced by *gastroplication*. This operation consists in making a series of horizontal folds or tucks in the anterior wall of the stomach by means of wide Lembert sutures passing from the lesser to the greater curvature. The sutures are of silk, and when tightened up they approximate the two curvatures, and so diminish the capacity of the stomach (Bircher).

CHAPTER XXVII.

THE INTESTINES.

Surgical anatomy—Methods of examination—Operations on the intestine—Injuries: *Contusion, rupture, wound*—Intestinal obstruction—Ileus: *General facts; Pathology and morbid anatomy; General clinical features; Acute obstruction; Chronic obstruction; Chronic obstruction terminating acutely; Differences between the features of obstruction in the small and large intestine*—Conditions giving rise to obstruction—Particular forms of obstruction: *Strangulated hernia; Internal hernia, varieties; Strangulation by bands and through abnormal apertures; Adhesions, kinking, and matting of the bowel, and cicatricial contraction of the mesentery; Volvulus; Intussusception; Impaction of gall-stones and other foreign bodies in the lumen of the bowel; Stenosis of the bowel: stricture, malformations and tumours of the bowel; Pressure of tumours outside the bowel; Fæcal accumulation.* OTHER AFFECTIONS OF THE INTESTINES: *Embolism and thrombosis of the mesenteric blood-vessels; Perforation of typhoid ulcer; Dysentery; Intractable colitis; Tuberculosis; Actinomycosis; Intestinal fistulæ; Tumours; Enteroptosis.*

Surgical Anatomy.—When the abdominal walls are reflected, and the great omentum displaced upwards, the small intestine is seen to be arranged in a series of coils or loops; the jejunal coils occupying the upper and left portion of the abdominal cavity, while the ileum lies below and to the right. Individual coils, however, are so liable to vary in position that the only certain means of identifying a particular part of the bowel is by tracing the intestine, either from the duodeno-jejunal junction above, or from the cæcum below. There is an insensible transition from jejunum to ileum, but if one of the upper coils of the jejunum be compared with one of the lower coils of ileum, the former is found to be larger in calibre, darker in colour, and its walls are thicker because of the greater size and number of the valvulæ conniventes. In the lower part of the ileum the valvulæ conniventes are small and widely separated, but the Peyer's patches are large and numerous. The duodenum is not visible from the front, being covered by the liver above and by the transverse colon below. Attention may be directed to certain common variations in the position of certain parts of the large intestine. The transverse colon, for example, may hang down for a variable distance in front of the small intestine, sometimes as a V-shaped loop with its apex reaching as low as the symphysis pubis. The sigmoid flexure—or, as it is now called, the pelvic colon—has a well-developed mesentery, and

forms a large S or omega-shaped coil which usually lies in the cavity of the pelvis. It may, however, be found in the abdomen proper, and sometimes even on the right side, in the neighbourhood of the cæcum, or at a higher level, in the vicinity of the liver. The ileo-cæcal valve, although believed to be pervious to gas or fluid introduced into the colon by way of the rectum, is remarkably competent, as is shown by the fact that in cases of stricture of the pelvic colon the entire large intestine may be enormously distended, even to the extent of rupture of the cæcum, without the valve giving way. The separate bands of longitudinal muscular fibres and the appendices epiploicæ constitute a certain means of distinguishing the large from the small intestine.

Bacteriology.—Under normal conditions the number of bacteria in the upper portion of the intestine is comparatively small, but beyond the region of the lower ileum the number is greatly increased, and below the ileo-cæcal valve organisms are found in great number and variety. In the stomach the growth of bacteria is inhibited by the presence of free hydrochloric acid. In the small intestine, in spite of the loss of acidity of the bowel contents, the bile and other secretions appear to play an important part in preventing the development of bacteria. This regulation of bacterial growth is liable to be disturbed, especially in diseases which originate primarily in the intestine, and the disturbance first shows its effects in the neighbourhood of the ileo-cæcal junction, for example, by the occurrence of inflammatory affections, such as appendicitis. The lower ileum is most liable to specific infections, such as those of tuberculosis and typhoid. While in a state of health the wall of the intestine possesses a considerable capacity of resisting the action of organisms; when damaged, either directly by trauma, or indirectly through interference with its innervation or blood-supply, the organisms are able to invade and pass through the walls, setting up disease of the bowel itself, or of the peritoneum, the cellular tissue or the blood-vessels in relation to it.

The methods of examination in surgical affections of the intestines include inspection, palpation, and percussion of the abdomen, and digital examination of the rectum and vagina. Distension of the large bowel with air by means of a ball syringe and a rubber tube introduced into the rectum, or the introduction of fluid by means of a soft tube connected with a funnel, may be useful in certain cases both for diagnostic and therapeutic purposes. Water thus introduced may sometimes pass through the ileo-cæcal valve into the small intestine. The entire large intestine will hold on an average about three quarts of fluid.

Operations on the Intestine.

Enterotomy consists in making a temporary opening in the bowel for the purpose of removing from the lumen some obstructing agent, such as a gall-stone, or to evacuate the contents of a distended loop during an operation for obstruction. The opening is made in the long axis of the gut on the side farthest from the mesenteric attachment, and is closed by Lembert or Czerny-Lembert sutures, preferably inserted in such a way that the line of suture is at right angles to the long axis of the

bowel. The closure of such a wound, or of a perforation or rupture of the bowel, is known as *enterorraphy*.

Enterostomy consists in making a communication between the bowel and the surface of the abdomen. When the operation is performed to enable nourishment to be introduced directly into the intestine, for example, in certain cases of gastric cancer, the opening is made as high as possible in the jejunum—*jejunostomy*—and is carried out on similar lines to Witzel's gastrostomy. When the object is to establish a fæcal fistula, for example, in cases of obstruction of the small intestine, the opening is made as low down as possible in the ileum—*ileostomy*. The loop of bowel selected is brought to the surface and stitched to the parietal peritoneum and transversalis fascia by a continuous serous suture. If the condition of the patient permit, the opening of the bowel should be delayed for twenty-four or forty-eight hours, to diminish the risk of infection of the peritoneal cavity, and to prevent the infective contents of the bowel coming in contact with the wound in the abdominal parietes. Before opening the bowel the skin should be smeared with vaseline to protect it from the irritant effects of the evacuations.

The term *colotomy*, or more correctly *colostomy*, is applied to an operation in which the colon is opened with a view to establishing a permanent outlet for the fæces, this being known as an artificial anus. The operation is usually performed for cancer of the rectum. A loop of colon—preferably the pelvic colon—is pulled out, its mesentery transfixed with a strand of gauze or a glass rod, the bowel fixed by a few sutures passed through its serous coat, or its mesentery, and the parietal peritoneum. If possible, the opening of the bowel should be postponed for a day or two to enable adhesions to form, and so to shut off the peritoneal cavity. Two sero-muscular sutures, the ends of which are left long, should be inserted on the convexity of the loop to serve as guides in opening the bowel. The opening may be made with the knife, scissors or thermo-cautery.

Enterectomy consists in excising a segment of the bowel, for example, for tumour, gangrene or injury. The gut above and below the segment to be resected is clamped, and the affected portion cut across with scissors. This operation when performed on the large intestine is known as *colectomy*.

The means taken to re-establish the continuity of the tube—*entero-anastomosis*—vary with the condition for which the resection is performed, and the length and relations of the portion of bowel implicated. *End-to-end suture* (Fig. 85) is the method of choice. The divided ends are brought into apposition, and

a continuous sero-muscular suture introduced to approximate the adjacent edges. Over this an ordinary continuous Lembert suture is made to bring together the serous surfaces. *Lateral implantation* (Fig. 86) consists in occluding one end of the divided bowel by a Czerny-Lembert suture, and stitching the other end to an opening made in the side of the occluded segment. Doyen's method of occluding the bowel is simple, rapid and efficient. The divided end is compressed by powerful forceps (enterotribe), and in the constriction ring thus formed a silk ligature is tied. The stump beyond the ligature is trimmed with scissors and cauterised with the actual cautery, and is then invaginated into the lumen by means of a purse-string suture.

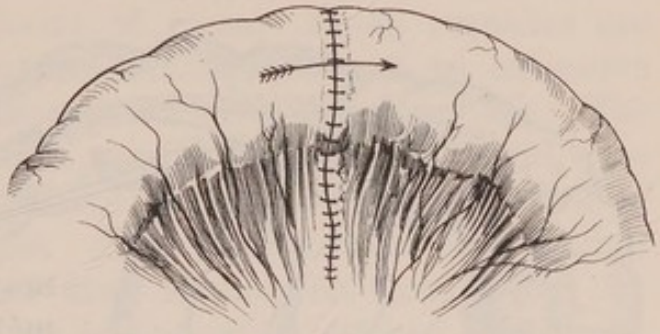

FIG. 85.—End-to-End Suture of Small Intestine.

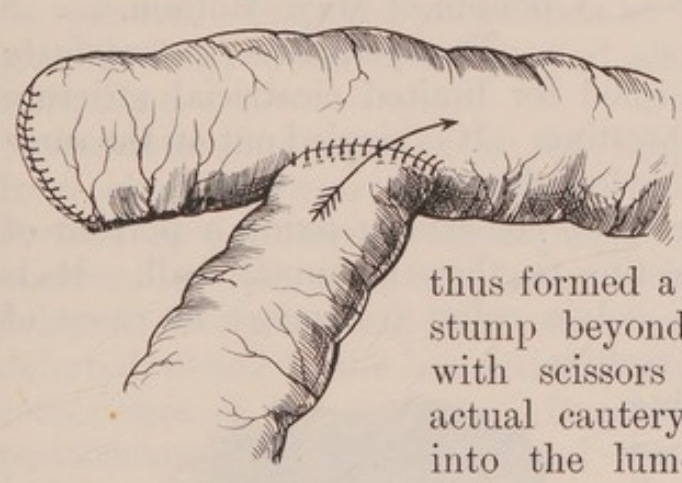

FIG. 86.—Lateral Implantation.

Lateral anastomosis (Fig. 87) consists in occluding both ends of the divided bowel, and forming a communication by making an opening in the adjacent sides of each, and uniting these after the same method as in end-to-end suture.

FIG. 87.—Lateral Anastomosis.

The term *exclusion of intestine* implies the formation of a lateral anastomosis between adjacent loops of bowel in such a way as to prevent the passage of fæces through the intervening segment (Fig. 88). This plan of "short-circuiting" the bowel is adopted in certain cases of irremovable cancer and tuberculous stricture.

Various mechanical aids to the union of bowel have been devised with the object of ensuring accurate apposition, and facilitating the introduction of the sutures, as well as of maintaining the patency of the bowel during the healing process. Of these may be mentioned Murphy's metal button, and various forms of absorbable buttons and bobbins, of which perhaps the best known is the decalcified bone bobbin of Mayo Robson.

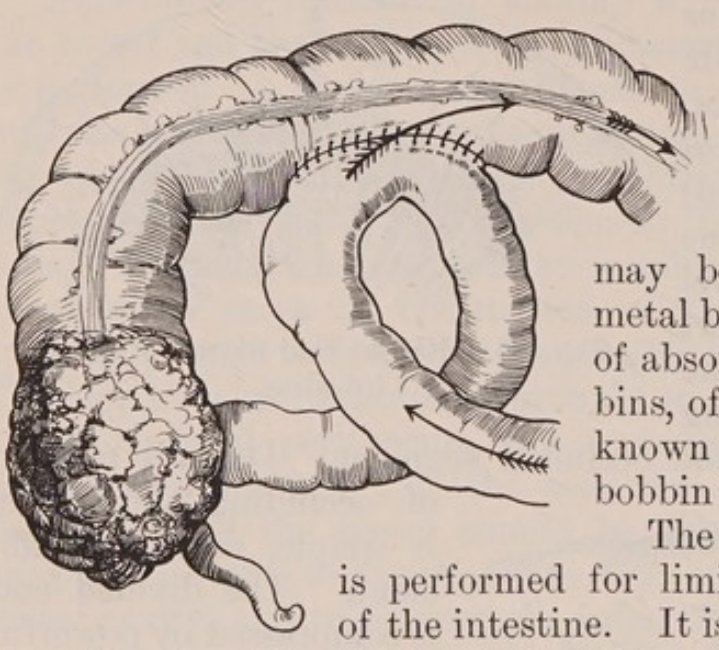

Fig. 88.—Short Circuiting of Intestine.

The operation of *enteroplasty* is performed for limited cicatricial stricture of the intestine. It is carried out on the same lines as pyloroplasty.

Enteropexy consists in fixing a portion of the intestine to the abdominal wall. It is usually performed on the pelvic colon (*colopexy*) in cases of chronic prolapse of the rectum.

Injuries of the intestine resulting from violence applied to the anterior abdominal wall by blunt objects, most frequently involve the small intestine, it may be the duodenum where it crosses the vertebræ, or the more centrally placed coils of the jejunum and ileum. The wall of the bowel may be merely contused, or it may be ruptured. In the latter case the contents escape into the peritoneal cavity, unless the bowel happens to be empty at the moment of injury, or the perforation is closed by adhesions with the omentum. A contused area of bowel may undergo necrosis and subsequently separate as a slough, or it may become the seat of cicatricial contraction, causing one form of non-malignant stricture of the bowel.

Fig. 89.—Complete Rupture of Small Intestine with Tearing of Mesentery.

(From Dr. Harvey Littlejohn's Collection.)

The clinical features and diagnosis have been already considered with abdominal injuries in general. The treatment is operative in the great majority of cases. Small ruptures are closed by a double tier of sutures; in the case of an extensive rent it is safer to resect the portion of bowel involved. The possibility of a second rupture should be borne in mind, also the fact that in bullet wounds of the abdomen perforation of the bowel is usually multiple. Slight contusions may be left alone; if severe, the injured area should be invaginated by Lembert sutures, and a portion of omentum stitched over it, or, if the bowel appears likely to give way, the segment of intestine should be resected. In the rare cases in which the intestine is torn from its mesentery the separated portion of bowel should be resected. Ruptures or wounds of the mesentery may accompany lesions of the intestine, and should be dealt with at the same time.

Subcutaneous injuries of the large intestine usually result from crushing forms of violence. In those parts of the colon covered by peritoneum the sequence of events is similar to that observed in lesions of the lesser bowel; extravasation may be delayed, however, and the occurrence of peritonitis thereby deferred, owing to the less active peristalsis and the more solid consistence of the contents. Rupture of the colon behind the peritoneum results in the gradual onset of cellulitis and abscess, which may rupture externally and be followed by fæcal fistula, or the infection may spread to the peritoneum and cause peritonitis. The treatment is carried out on the same lines as in the small intestine.

Intestinal Obstruction—Ileus.

The clinical term "obstruction of the bowels" implies a combination of symptoms of which the most obvious are cessation of the passage of intestinal contents, abdominal pain, persistent vomiting, and distension of the abdomen. It is always a serious condition, and frequently endangers life. In acute cases the initial symptoms—pain, collapse, and vomiting—are due to the profound impression made upon the sensory nerves of the abdomen, and are those of abdominal shock, to which the term "peritonism" has been applied by Gubler. They are not peculiar to intestinal obstruction, but attend upon all acute abdominal affections. The later symptoms—collapse and failure of the circulation—are due not merely to occlusion of the lumen of the intestine, but also to the absorption of poisonous materials

from the stagnating contents of the bowel above the seat of obstruction. In other words, when death results, it is from auto-intoxication, and if a sufficient quantity of poison has been absorbed, death takes place whether the obstruction is relieved or not. Hence the surgical treatment of intestinal obstruction should be undertaken before the patient has absorbed a fatal dose, and in addition to relieving the actual cause of the obstruction, the bowel above the block should be emptied of its decomposing contents to prevent further absorption.

Pathology and Morbid Anatomy.—*When the occlusion is sudden and complete*, as when the intestine is snared by a band, the changes are very similar to those seen in strangulated hernia. The intestine below the obstruction is pale, contracted and empty, while that above is usually distended with gas and fluid, and its mucous membrane is swollen and injected, and may show hæmorrhages and superficial erosions. The surface epithelium is shed, and organisms are thus enabled to pass through the wall. The gaseous distension of the intestine above the obstruction is the result not only of the accumulation of intestinal flatus, but also of the bacterial decomposition of the contents of the bowel, and this latter is chiefly dependent upon the impairment of vitality in the intestinal wall, the result of altered circulation and innervation. The gaseous distension may be so great that, when the abdomen is opened, the affected coils of bowel are projected from the wound, and when thus deprived of support the peritoneal coat may give way, and wide rents form on the surface opposite the mesenteric attachment. Sometimes the erosions on the mucous membrane become deepened into minute, sharply circumscribed, necrotic ulcers, which by extending through the whole thickness of the wall may eventually lead to perforation. Perforation is most likely to occur when the affected coils are being separated from one another by the exploring fingers, or are allowed to escape from the abdomen, and we have seen cases in which there were several

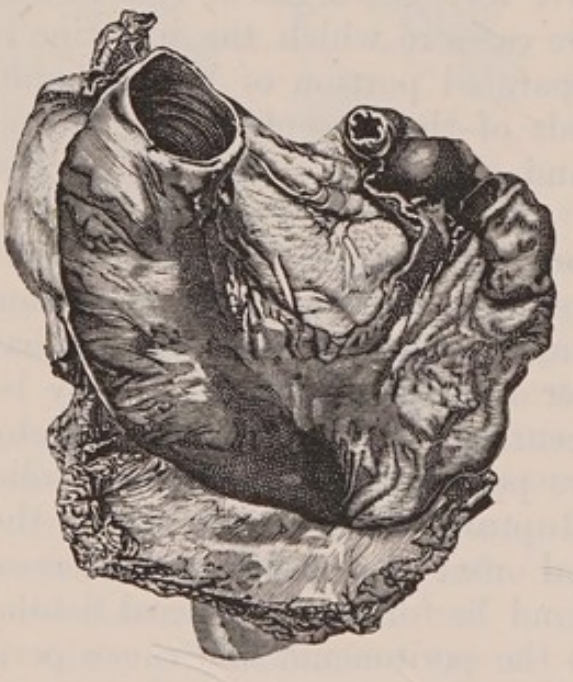

FIG. 90.—Acute Obstruction of Small Intestine (Strangulated Obturator Hernia), showing distended bowel above and contracted bowel below the obstruction.

minute perforations like pinholes, through which the fluid contents escaped under considerable pressure.

It is an interesting fact that the phenomena above described may be met with apart from any mechanical obstruction of the bowel, as for example in embolism of the mesenteric blood-vessels.

When the obstruction is gradual and incomplete, as in the case of stricture, the lumen of the bowel is narrowed, but not occluded, and the contents pass with difficulty. The intestine below is empty and contracted. The bowel above is not merely distended, but its walls are hypertrophied as the result of persistent efforts to drive the contents through the narrowed segment of the gut (Fig. 98). The hypertrophy is most marked in the case of the small intestine, its coats becoming thicker and firmer, chiefly from hypertrophy of the circular muscular fibres. In the case of the large intestine distension is more prominent than hypertrophy, and the colon may attain enormous dimensions—as much as a foot in diameter. The mucous membrane is in a condition of chronic catarrh, and this may be associated with ulceration—partly mechanical as a result of the pressure of fæcal masses, but chiefly bacterial in origin and associated with decomposition of the contents. Sometimes the ulceration extends through the wall of the bowel, and results in perforation either into the peritoneal cavity or into the retro-peritoneal cellular tissue.

Clinical Features.—Following the classical description of Treves, cases of intestinal obstruction may be grouped into three classes: (1) cases of acute obstruction; (2) cases of chronic obstruction; and (3) cases in which symptoms of acute obstruction supervene on those which characterise the chronic form.

Acute Intestinal Obstruction.—The attack is sudden in onset, and in the majority of instances no exciting cause is apparent. The patient is seized with severe abdominal pain, which is usually referred to the region of the umbilicus, sometimes to the seat of the obstruction. The patient may be "doubled up" by the pain, or roll in anguish on the floor. The pain is of the nature of colic, and is usually constant, although liable to exacerbations. There is, at first at least, little if any tenderness of the abdomen. In the more severe cases the patient is collapsed, in a state of great depression, with pallor, sunken eyes, a rapid, feeble pulse, a cold sweat over the face, and sighing respiration. Vomiting appears early, and is one of the most distressing and persistent symptoms. The ejected matter is at first composed of the contents of the stomach, later it becomes bilious, and still later

brownish or yellowish and offensive. Finally, the vomited matter becomes stercoraceous, which means that it has a fæcal odour as a result of bacterial decomposition. Stercoraceous vomiting is most often met with in obstruction of the small intestine, and is uncommon in obstruction of the colon.

The pain in acute obstruction depends on several factors. It may be due in part to traction on the sensitive parietal peritoneum. It is due chiefly to irregular and cramp-like peristaltic movements excited in the intestine above the seat of obstruction. The recurrent exacerbations of pain or colic are due to the passage along the intestine of periodic peristaltic waves that "hurl themselves, as it were, against the obstruction." This variety of pain is aggravated by any interference with the patient, and is markedly relieved by opium. In the later stages pain may be due to the great distension of the gut or to the onset of peritonitis.

Neither fæcal matter nor flatus is passed by the rectum. The abdomen becomes more or less distended, and towards the end of the illness is apt to become tender. The abdominal muscles are fixed, and the respiration is thoracic and superficial. In very acute strangulation distension may be absent, especially if the obstruction be high up in the jejunum. The temperature is subnormal, and the amount of urine is diminished. If the obstruction is unrelieved, the symptoms persist; the tongue becomes dry and brown, and there is intense thirst, the face is drawn and anxious, and the eyes sunken. The patient rapidly becomes exhausted, and dies with symptoms of septic intoxication like those which mark the termination of acute peritonitis. He usually remains conscious to the last, and often fails to realise the gravity of his condition. Vomiting and thirst remain the most prominent and distressing symptoms.

Chronic Intestinal Obstruction.—The onset of the malady is gradual, and its progress irregular or intermittent. Attacks of abdominal pain often follow the ingestion of food, and are frequently ascribed to indigestion. At first they attract little notice, but in time become more frequent and more severe. They are attended with occasional vomiting, and the patient complains of more or less constant uneasiness within the abdomen. There is a history of increasing difficulty in getting the bowels to move; opening medicines are efficacious in the early stages, later they act with less and less effect, and finally only cause griping pains and sickness. There is frequently a history of occasional diarrhœa, but this is a result of catarrh in the bowel caused by retained fæcal matter above the obstruction,

and does not result in emptying the bowel. It is chiefly met with when the obstruction is seated low down in the colon. Between times the patient may feel fairly well and be able to go about. In the majority of cases, as the bowel becomes distended and hypertrophied above the seat of obstruction, the abdomen becomes more and more prominent, and there are frequent rumbling and gurgling sounds in the belly—"stenosis-noises." In thin subjects individual coils of bowel may be seen to stand out prominently through the abdominal wall, and on palpation exaggerated peristaltic movements may be recognised, the bowel becoming firm and rigid under the examining fingers, the patient at the same time complaining of colicky pains. Distended small intestine may present an arrangement of parallel coils described as of the "organ-pipe" or "ladder" pattern. When the large intestine is distended the transverse colon and sigmoid flexure are the segments most readily identified in virtue of their characteristic contour and their situation, but they do not show peristaltic movements. If the obstruction is unrelieved, the symptoms become more pronounced and continuous, the patient loses flesh, and becomes cachectic as a result of the absorption of poisonous material from the stagnating and decomposing contents of his intestine. The mouth is foul and the breath most offensive. Finally, death takes place from exhaustion, or from some complication such as perforation of the bowel.

Chronic Obstruction terminating acutely.—In a considerable proportion of cases of chronic obstruction acute symptoms supervene as a result of the narrowed bowel suddenly becoming completely blocked. This may be due to impaction of fæcal matter, or to kinking or torsion of the affected segment of the gut sometimes brought about by rapid gaseous distension, by exertion, or by the use of purgative medicines. The occurrence of peritonitis also may bring about the phenomena of complete obstruction. In not a few instances attention has first been called to a malignant stricture of the intestine by the onset of acute obstruction, the patient having previously complained only of vague colicky pains and constipation.

Differences in the clinical features between obstruction situated in the small and in the large intestines.—There are no distinctions which may be considered as absolute and invariable (Treves). In both, the clinical features depend more upon the nature of the occlusion than upon its situation. In the case of the small intestine vomiting appears earlier, is more distressing and more persistent, and the vomited matter is more copious and sooner becomes stercoraceous. In the case of

the large intestine, on the other hand, vomiting is often late in appearing, is intermittent and scanty, and may occasionally be absent. Constitutional disturbance, in the shape of shock, is, on the whole, most marked in acute obstruction of the small intestine. Meteorism, as expressed by general distension of the abdomen, is on the whole more pronounced the lower in the intestine the obstruction is situated. Although it is by no means so easy to identify visibly dilated coils of intestine as might be supposed, it is sometimes possible from their situation and outline to form a reliable inference; the transverse colon or sigmoid flexure may, for example, be thus recognised, while the small intestine may be identified by the ladder pattern of the abdomen. It is not safe to infer from the presence of visible moving coils of small intestine that the obstruction is situated in the small gut; we have observed such coils in cases of malignant stricture beyond the transverse colon. Information obtained by estimating the amount of fluid which can be introduced by the rectum is of little or no value in determining the seat of the obstruction, and may actually prove misleading.

Particular Forms of Obstruction.

Strangulated hernia is the commonest form of acute intestinal obstruction, and in all cases presenting the symptoms above described a systematic examination of the hernial openings accessible to the fingers should be made. It is quite possible for a patient to be ignorant of the existence of a hernia, especially when of small size and situated in the femoral or obturator region. Cases are occasionally met with in which a hernia is present, and yet there is some doubt as to whether or not it is the cause of obstruction. In such cases it is usually advisable to explore the hernia by operation before proceeding to open the abdomen.

Internal Herniæ.—Under this term are included such forms of hernia as do not protrude outside the cavity of the body. Several varieties are met with. In *diaphragmatic* hernia a portion of the abdominal contents, usually the stomach or colon, is thrust into the thorax through an opening in the diaphragm. The opening may be congenital or may result from rupture or wound of the diaphragm, and in either case it is usually situated on the left side. The existence of a hernial sac is quite exceptional. The condition is rarely diagnosed by clinical methods. It is only remediable by operative measures, and the thoracic route affords the best access.

Hernia *into the fossa duodeno-jejunalis* is the commonest form of retro-peritoneal hernia. This fossa occurs in about 50 per cent. of bodies. It is formed by a reflection of the peritoneum at the duodeno-jejunal junction, and it lies immediately to the left of this, its orifice looking upwards. The gut as it enters the fossa pushes the peritoneal lining in front of it, so as to form a sac which lies behind the posterior parietal peritoneum. The usual contents are small intestine, and when they are strangulated the constriction is produced by the margins of the orifice of the sac. It is seldom diagnosed except by an exploratory laparotomy. The only treatment is by operation, the contents being reduced and the neck of the sac obliterated.

In hernia *into the foramen of Winslow* a portion of the intestine passes through the foramen into the lesser sac of peritoneum. In *inter-sigmoid* hernia the bowel is thrust into the inter-sigmoid fossa, which is a funnel-shaped depression between the layers of the pelvic meso-colon. In *pericæcal* hernia the bowel is thrust into one or other of the pouches met with in the region of the ileo-cæcal junction.

FIG. 91.—Diaphragmatic Hernia. The intestines, with the stomach and spleen, occupied the left pleural cavity.

(Anatomical Museum, University of Edinburgh.)

Strangulation by Bands or through Abnormal Apertures. — The commonest form of *band* is a stretched adhesion between two peritoneal surfaces. The band has usually two points of attachment, one of which is nearly always to the mesentery, frequently over a diseased mesenteric gland, while the other is to the parietal peritoneum, to another part of the mesentery, or to one of the abdominal or pelvic viscera. Bands vary greatly in length, and those which result from antecedent peritonitis are frequently multiple.

An adherent portion of the lower border of the great omentum may be formed into a band by the dragging and rolling movements of the bowels. An *omental band* frequently develops in

relation to a femoral hernia, and its parietal attachment is usually in the vicinity of the femoral opening. A persistent *Meckel's diverticulum*, attached at one extremity to the lower ileum and at the other to the anterior abdominal wall in the region of the umbilicus, may constitute a band (Fig. 92). Its distal end may become separated from its attachment at the umbilicus, and become attached to the mesentery or to one of the viscera. Other structures may constitute bands—for example, a vermiform appendix which has become adherent by its tip to the mesentery of the ileum, an adherent Fallopian tube, an elongated epiploic appendage, or the pedicle of an ovarian cyst.

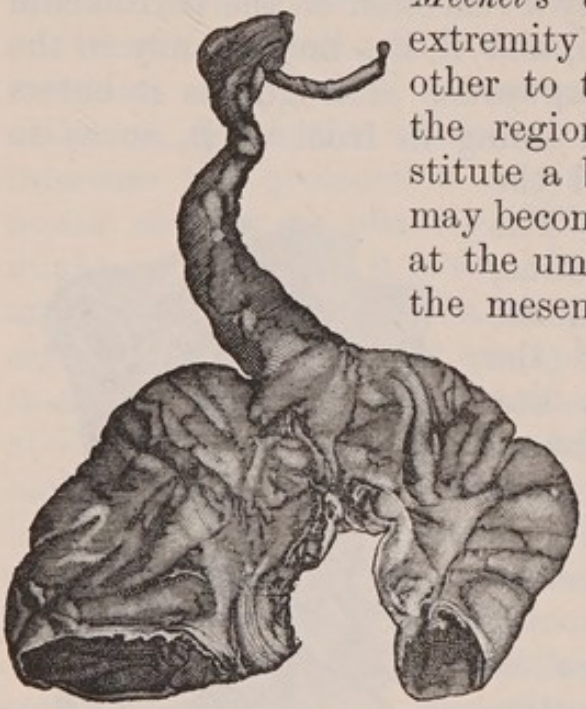

FIG. 92.—Meckel's Diverticulum, forming a "band" which caused obstruction and was itself gangrenous.

A band may bring about strangulation either by one or more coils of intestine passing underneath it—as beneath a shallow and narrow arch (Fig. 93); or by the bowel being snared and constricted by a noose formed by the band itself. The first is the more common mode, and is associated with a short band; the latter is rare, and requires a long and loose band. In either case the loop of bowel engaged is apt to undergo rotation, and this may be the chief factor in the actual obstruction of the gut. Probably there are other factors concerned, such as exaggerated peristalsis, venous congestion and swelling of the intestine, and the development of gas in the strangulated loop of bowel. Obstruction may be immediate and complete almost as soon as the bowel is engaged, or may not assume serious proportions until the secondary factors have come into play. This form of obstruction affects almost exclusively the small intestine, because of its free mobility and its capacity of forming a knuckle or loop. The lower portion of the ileum is the segment most often in-

FIG. 93.—Strangulation of Small Intestine by diverticulum of Small Intestine.

(Anatomical Museum, University of Edinburgh.)

volved, and the lesion is usually situated in the lower part of the abdomen because of the frequency with which adhesions and bands form in relation to appendicitis, pelvic peritonitis, and hernial openings, or from a Meckel's diverticulum. Bands resulting from tuberculous peritonitis and disease of the mesenteric glands are most frequently situated in the umbilical region. The average length of the strangulated loop is about fifteen inches, and the changes which take place in it are precisely the same as those already described as occurring in strangulated hernia. The peritoneal exudation which occupies the abdominal cavity is often copious, and in acute cases is blood-stained.

Smooth, rounded or slit-like *apertures*, through which a knuckle of bowel may pass and become strangulated, are occasionally met with, chiefly in the mesentery of the lower ileum. These openings may be congenital, or may result from a tear, or from neglect to stitch up the mesentery after the operation of resection of the bowel.

The *clinical features* associated with strangulation by bands or through apertures, are usually those of acute intestinal obstruction, and they closely resemble those of strangulated hernia. Although there is no age limit the patients are usually between the ages of twenty and forty, and there is often a history of a former attack of peritonitis or other condition likely to lead to the formation of adhesions. In the majority of cases the onset of obstruction is sudden and acute. Less frequently there is a history of abdominal discomfort or pain, or a previous threatening of obstruction. In the instances in which the onset has been gradual, the patient has usually had some pain with trifling vomiting and incomplete constipation for some days before the development of the signs of acute strangulation. In typical cases pain, vomiting, and collapse are prominent features. Examination of the abdomen and of the rectum usually yields negative results. It is exceptional to discover a tumour or swelling composed of the strangulated loop of bowel, or to recognise dulness from the effusion of fluid into the peritoneal cavity. In several of our own cases there has been a considerable discharge of blood by the rectum. A definite diagnosis can rarely be made, but the lesion may be inferred from the history of the patient and by excluding other causes of obstruction.

The *treatment* consists in opening the abdomen in or near the middle line below the umbilicus. Blood-stained fluid is found in the peritoneal cavity. If the strangulated bowel is not within easy reach of the wound, it can usually be dis-

covered by tracing any loop of collapsed bowel which is found, or by sweeping the fingers round the region of the navel, and the brim of the pelvis. If a band is found, it may be torn through or divided between ligatures. It must be borne in mind that more than one band may be present. A Meckel's diverticulum or a vermiform appendix should be resected, and the exposed mucous membrane covered over by peritoneum. In the case of strangulation through an abnormal aperture the bowel must be withdrawn from the opening, and to allow of this the opening may require to be enlarged. If the loop of bowel involved in the strangulation is viable, the operation is completed by closing the abdomen. If the bowel is not viable, or is already dead, it must either be resected then and there, or brought outside the wound, opened, and drained, the resection being postponed for a few days until the conditions are more favourable. We have met with cases in which the amount of intestine involved in the strangulation was so great that the initial shock proved fatal within a few hours.

Obstruction by Adhesions, Kinking, or Matting of the Bowel, or by Cicatricial Contraction of the Mesentery.—This group includes cases in which the obstruction results directly or indirectly from peritoneal adhesions due to antecedent inflammation or traumatism. The mere fixation of a segment of bowel by an adhesion to the abdominal wall interferes with the passage of its contents; if, in addition to being fixed, the bowel is also bent or kinked, it readily becomes occluded. The symptoms vary widely; they may be those of acute obstruction, such as result from strangulation by a band, or they may simulate the chronic and incomplete obstruction associated with stricture. The obstruction may involve either the small or the large intestine. Adhesions may contract and bring about compression of the gut, especially of any segment which is at the same time adherent to the parietes or to another viscus. In the absence of kinking the clinical features resemble those of stricture of the bowel.

Matting by adhesions may affect only one loop, or several coils may be bound together into a confused mass. This is most often met with in cases of disease of the mesenteric glands or of tuberculous peritonitis. The symptoms may come on suddenly, but are usually gradual and progressive, or intermittent, culminating in complete stoppage. Sometimes the matted coils form a tumour-like swelling. Matted coils of bowel occupying the pouch of Douglas may be felt by the rectum.

In this group may also be included cases in which the bowel

is narrowed as a result of *cicatricial shrinking of its own mesentery*, subsequent to inflammation associated with disease in the mesenteric glands or antecedent disease in the appendix. The bowel affected is usually the lower end of the ileum, the cæcum, and ascending colon. The peritoneal investment of the mesentery is thickened, fibrous and opaque, and is so contracted as to interfere with the peristalsis of the bowel.

The *clinical features* resemble to a certain extent those produced by stricture of the bowel. There are sudden attacks of pain in the belly and vomiting, which subside and recur without going on to actual obstruction. Distended coils of bowel may be observed engaged in peristaltic movements, and there is frequently a history of antecedent trouble in the abdomen and of increasing difficulty in getting the bowels to move.

In these forms of obstruction it is rarely possible to make an accurate diagnosis as to the cause of the symptoms until the abdomen is opened, and each case must be dealt with on its merits. Limited adhesions may be separated. When there is extensive matting an anastomosis may be established between the bowel above and below the obstruction, or a temporary opening may be made in the bowel above (the selected coil being made to present in the wound). Although the conditions within the abdomen may look far from promising, such cases, especially those of tuberculous origin, usually do remarkably well. In cases of cicatricial contraction of the mesentery the thickened peritoneum is divided parallel with the long axis of the bowel, and sutured again at right angles to this.

Volvulus.—This term refers to a twisting or rotation of a segment of bowel around its mesenteric axis. Volvulus most commonly affects that portion of *the sigmoid flexure* (which is now called the pelvic colon), chiefly because it forms a comparatively long omega-shaped loop. The commonest cause is chronic constipation and unequal loading of the loop, so that it hangs down into the pelvis. In some cases the peritoneal investment of the meso-sigmoid is thickened and contracted so that the two ends of the loop are unduly approximated. In other cases, there is believed to be a malformation of the sigmoid flexure which predisposes to its rotation. The actual twist is brought about by irregular peristalsis, by alterations in the position of the body, or by the movement of adjacent coils of bowel or other organs. The rotation usually amounts to a half or a whole circle ; but sometimes the bowel is twisted two or three times on its mesenteric axis. The ends of the loop are occluded by their

pressure on one another, and the loop itself becomes engorged with blood and distended with gas, and is so distended that it may extend up to the umbilicus, or even into the right hypochondrium, lying in front of the small intestine and filling up the abdomen. Peritonitis develops early in relation to the affected loop and spreads thence by continuity. The congestion of the loop becomes more and more marked, the walls become dark red or black, are infiltrated with blood, and tear readily, and, if the patient live long enough, they present irregular areas of gangrene.

The *ascending colon and cæcum* when provided with a long mesentery are also subject to volvulus.

Volvulus may also affect a single loop of small intestine, especially as a complication of strangulation by a band, or it may affect the greater part of the ileum. The rotation is usually in the direction of the hands of a watch, and amounts to one complete turn or more. The morbid changes are the same as in the pelvic colon. There is usually blood-stained fluid in the abdomen.

Clinical Features.—Volvulus of the sigmoid is most often met with in men between forty and sixty. The onset is usually sudden ; there is severe pain with exacerbations, referred to the region of the umbilicus, or less frequently to the left iliac fossa. Vomiting is not a prominent feature and may be entirely absent, or its appearance may be delayed. Collapse is not so marked as in acute strangulation of the small intestine. The abdominal walls soon become rigid, partly from distension, and partly from the onset of local peritonitis. Distension of the abdomen appears early, and may attain considerable proportions ; it may be localised at first, appearing as a rounded elevation in the left segment of the umbilical region, but it very soon becomes general. As peritonitis commencing in the twisted loop is very constant, tenderness is developed in the first instance over the gut affected, and then over the entire abdomen.

The *treatment* consists in opening the abdomen and discovering the twisted loop of bowel. As much of the loop as possible is brought out at the wound and inspected. If greatly distended it should be opened at once and emptied of its contents. If it is viable and capable of being untwisted, the opening is closed and the bowel returned within the abdomen. If the twist cannot be reduced, or if the bowel is not viable, it must be resected either at once or after an interval. Should the latter course be decided upon, the bowel is drawn well out of the wound, and an artificial anus established above the seat of the volvulus.

The relapse of volvulus when the bowel has been simply

untwisted has been recorded more than once; to prevent it, the mesocolon may be stitched to the parietal peritoneum—colopexy. There is no tendency to relapse when an artificial anus has been temporarily established because of the adhesions which result.

Intussusception.—This is one of the commonest forms of intestinal obstruction, and may be defined as the invagination of one part of the intestine into the lumen of the immediately adjoining part. An intussusception forms a solid, sausage-shaped tumour composed of three concentrically arranged tubes of bowel which are differentiated as follows: an internal, known as the entering tube; a middle, known as the returning tube; and an external, known as the sheath, receiving tube or *intussuscipiens*. The middle and internal tubes together constitute the invaginated portion or *intussusceptum*. The highest part, where the returning tube joins the sheath, is known as the neck, the lowest part, where the middle and inner tubes join, as the apex. The three concentric tubes of bowel are well seen in a transverse section of an intussusception, and they are so arranged that mucous membrane is always in contact with mucous membrane, and peritoneum with peritoneum.

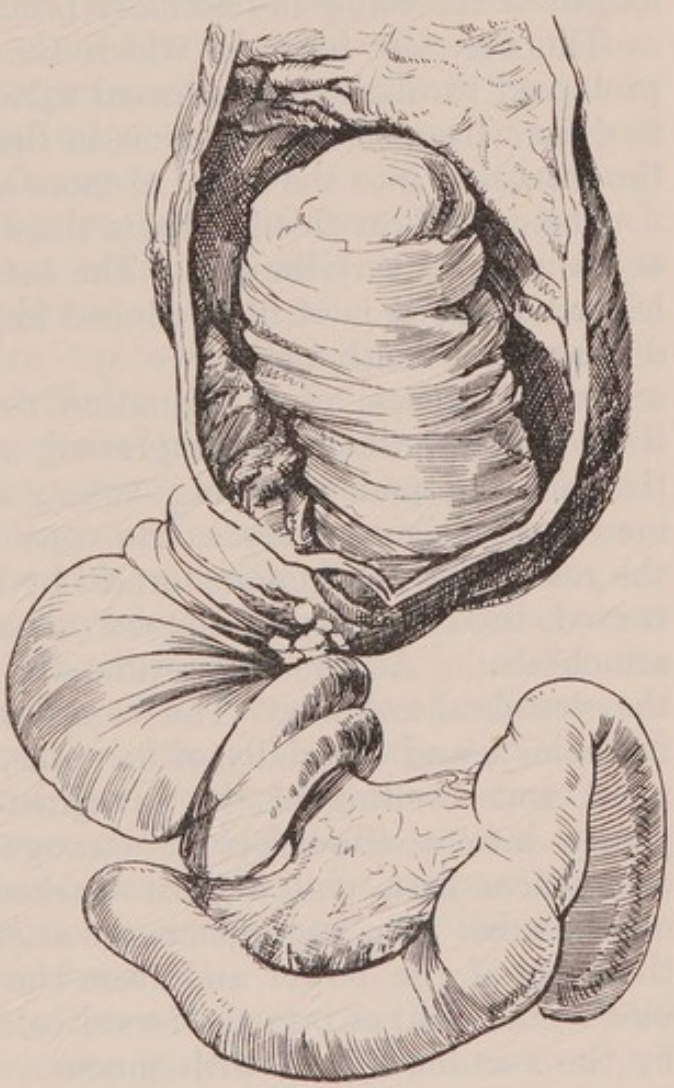

FIG. 94.—Ileo-cæcal Intussusception. The ensheathing colon has been laid open.

(Museum Royal College of Surgeons, Edinburgh.)

Varieties.—The commonest variety, at least in children, is the *ileo-cæcal*, in which the ileum and cæcum are invaginated into the colon, and the ileo-cæcal valve forms the apex of the intruding portion. For its occurrence, the colon must be considerably larger than the ileum, and must also be unduly movable, so that it readily allows itself to be invaginated when once the process has begun.

Once the invagination has commenced, it increases at the expense of the receiving tube, the apex of the intussusception remaining the same, and folding more and more of the sheath over it as it passes down. This variety often attains very considerable dimensions, and the apex of the intussusception may traverse the whole length of the colon and actually protrude at the anus.

The *ileo-colic* form, in which the lower end of the ileum is prolapsed through the ileo-cæcal valve, is much less common, and it differs from the other forms in that the increase results from the intrusion into the colon of more and more ileum.

The *colic* form chiefly affects the descending or sigmoid colon and is usually very limited. The *enteric form* is confined to the lesser bowel; it is of little clinical importance as it chiefly occurs during the "death agony."

In the process of invagination the bowel is accompanied by its mesentery, which is compressed and closely packed between the entering and returning tubes, and as the intussusception increases, the mesentery exerts considerable traction on it, with the result that the tumour formed by the intussusception becomes curved, the concavity of the curve being towards the mesenteric attachment. At the same time the tumour is drawn towards the vertebral column. The compression of the vessels of the mesentery, and especially of its veins, results in venous engorgement and swelling of the invaginated bowel which gradually passes into a condition of strangulation. The engorgement commences first, and is most marked at the apex and in the middle tube. The engorgement is attended with hæmorrhage into the coats of the bowel and from the exposed mucous surfaces; blood thus escapes into the bowel below, and is commonly passed by the rectum, mixed with mucus. The actual obstruction is due to the manner in which the lumen is filled up by the reduplicated and swollen tubes of bowel. After a variable period the intussusception becomes irreducible. This may be due to the swelling of the invaginated portion, the apex especially being often swollen into a large knob; or to the formation of adhesions fixing together the opposed serous surfaces of the inner and middle tubes, this also being most commonly observed towards the apex. Thus it may happen that, with the exception of the last few inches the whole intussusception can be readily reduced.

In severe and advanced cases the interference with the nutrition of the bowel is followed by bacterial invasion of its coats, and this may, as in strangulated hernia, result in peritonitis or in gangrene, or in a combination of these con-

ditions. Gangrene is most frequent and most extensive in the acute form, and usually appears first in the middle tube. The whole intussusceptum may become gangrenous, and may, after separation at the neck of the tumour, be discharged by the rectum as a blackish-green, tubular slough, varying in length from a few inches to several feet. Recovery has occasionally followed upon separation and extrusion of the gangrenous bowel. Ulceration and gangrene of the sheath is rare. In chronic cases the gangrene may be limited to the mucous membrane in the region of the apex.

The *etiology* of intussusception has been the subject of much controversy. The view most commonly held is that while a segment of gut is in a condition of spasmodic contraction, the flaccid gut below is drawn up over it by the contraction of the longitudinal muscular fibres. Once the invagination has commenced, its increase is probably due to exaggerated peristalsis forcing the intussusception farther along the bowel. Clinical facts support this supposed association of intussusception with disturbance of the normal peristaltic movements, for example, its following upon the taking of indigestible food, and upon attacks of colic and diarrhœa in children in whom the bowel is exceptionally irritable. The frequency of intussusception at the ileo-cæcal junction is due partly to the difference in size, mobility, and activity of the ileum and cæcum respectively, and partly to the rigid nature and sphincter-like action of the ileo-cæcal valve. The ileo-cæcal orifice may be compared to the anal orifice, and intussusceptions in the region of the valve to prolapse of the rectum (Leichtenstern).

Clinical Features of Acute Intussusception in Children.—This condition forms the most common variety of obstruction to which children are liable. Considerably over 50 per cent. are met with during the first ten years of life, and about 25 per cent. during the first twelve months. Male children are more often affected than female. A history of colicky attacks probably indicates the previous occurrence of slight degrees of intussusception which have been recovered from.

An acute attack is usually ushered in by the child suddenly screaming or crying out, turning pale, and vomiting; a normal motion may be passed soon after the onset of the attack. Attacks of pain recur at frequent intervals, and after some hours blood and mucus are passed by the rectum. Between the attacks of pain the child is quiet and listless, or may be apparently quite well. The pulse and temperature are usually normal. On examination a cylindrical or sausage-shaped tumour, curved with

its concavity towards the umbilicus, is the most constant and reliable sign of ileo-cæcal intussusception. It is most often felt in the position of the descending or of the transverse colon. It becomes hard and prominent during the attacks of pain. When the tumour has reached the lower part of the colon, it may be felt in the rectum as a soft, conical mass with a central depression resembling the os uteri, and the examining finger when withdrawn is stained with bloody mucus resembling red-currant jelly. Its presence in the rectum is usually associated with tenesmus and relaxation of the sphincters. The tumour may finally protrude from the anus, presenting the appearances of congestion or of gangrene. The child exhibits the general features of intestinal obstruction, although distension of the abdomen is absent or but little marked, and the vomiting rarely becomes fæcal.

The abdominal or recto-abdominal examination which is so important in the *diagnosis* of intussusception is best made under chloroform.

Treatment.—Success depends on the promptness with which the condition is recognised and treated. The choice of methods lies between immediate abdominal section, and making an attempt to reduce the intussusception by inflating the lower bowel with air or distending it with fluid.

Inflation is carried out under anæsthesia; the buttocks are raised and the hand of the surgeon is placed over the abdomen in order to follow what is going on within. Air is pumped in by a bellows; or olive oil or salt solution, at a temperature of 100° F., is allowed to flow into the rectum through a soft rubber tube connected with a funnel held at a maximum height of two feet above the patient. When from ten to thirty ounces have entered the colon, and an interval of ten minutes has elapsed, the fluid is allowed to escape and the abdomen is again examined. If the tumour has entirely disappeared, a minute dose of opium is given, and the patient is re-examined in from three to six hours, and at subsequent intervals. If the tumour does not disappear, operation should be proceeded with at once.

Against inflation it is urged that it is often impossible to determine whether the intussusception has been completely reduced or not, and that in the event of failure valuable time has been lost, and the possible chance of reduction by operative means has gone by. The alleged recurrences of intussusception after reduction by inflation are probably instances of incomplete reduction.

Operation.—If the tumour is confined to the region of the

ascending colon, the incision is made there; in other cases it is made in or near the middle line, with its centre about the level of the navel. The fingers are inserted into the abdominal cavity, and an attempt made to deliver the tumour. In reduction the tumour should be straightened as far as possible, and an attempt made to force back the intussusception by compressing the sheath just below the apex of the tumour. On no account should the entering bowel be pulled upon. Most difficulty is experienced at the end of the procedure, and to prevent damage to the bowel at this stage, and to render the compression more uniform, the bowel should be wrapped round with a thick layer of gauze wrung out of saline solution. After reduction has been successfully accomplished, the intestines are replaced and the wound closed.

If reduction is impossible, or if the intussusception is already gangrenous, the outlook is grave in the extreme. Immediate resection of the invaginated portion inside the colon has yielded the best results. The sheath and the intussusceptum are first united by a continuous suture through the serous and muscular coats at the neck of the tumour, the sheath is then laid freely open and the intussusceptum removed, and the operation is completed by sewing up the wound in the sheath. If the sheath and returning tube are too adherent to allow of this, or if the sheath is not viable, the whole tumour must be resected, or, in the case of adhesions, an anastomosis may be made between the bowel above and below the lesion. The practice of bringing the bowel out at the wound, and forming an artificial anus above the intussusception, affords very little prospect of recovery.

Chronic intussusception in children is usually of the ileo-cæcal variety. The course of the malady may extend over several months, or may be protracted even for a year; the clinical features are often ambiguous and the progress most irregular. There are occasional attacks of pain and vomiting, the bowels are irregular, and blood may be passed in the stools. Coils of intestine are often to be seen in movement beneath the abdominal wall. A tumour is to be made out in about one-half of the cases, and it may be observed to vary considerably in its position within the abdomen from time to time. It may come down into the rectum and protrude at the anus, and is thus liable to be mistaken for prolapse or polypus. In the early periods of the disease, and in the intervals between attacks of pain, the child may appear to be in fair health. The symptoms are often aggravated by the taking of food. The abdomen must be opened both for purposes of diagnosis and for treatment. The

invagination is dealt with on the same lines as in acute cases. After reduction a longitudinal tuck or fold may be made in the mesentery, or, in the ileo-cæcal variety, the vermiform appendix may be anchored by sutures to the parietal peritoneum (Ball), in order to prevent a recurrence of the invagination. In irreducible cases a typical resection of the bowel is performed. The results of operation are much better in chronic than in acute cases.

Intussusception in the Adult.—Chronic intussusception of the colon occurring in association with a carcinomatous growth is the variety most frequently met with in adults, although cases of the acute variety occasionally occur. The new growth usually precedes the invagination, and is found at the apex of the intussusceptum. A similar form of intussusception may originate in relation to an innocent tumour of the bowel—benign polypus—of the nature of an adenoma, fibroma, or fibro-myoma.

FIG. 95.—Gall-stone Obstruction of Jejunum. The stone, the size of a pigeon's egg, was firmly grasped by the wall of the bowel.

(Dr. C. W. MacGillivray's case.)

Obstruction due to Impaction of Gall-Stones and other Foreign Bodies in the Lumen of the Bowel.—The most important form in this group is that known as *gall-stone ileus.* The gall-stone which is likely to cause intestinal obstruction is one which has been formed as a cast in the gall-bladder, and made its way into the bowel, not by the ducts, but through a fistulous channel formed by ulceration. The stone most frequently ulcerates into the duodenum, but the most common seat of impaction is the lower ileum. Larger stones may impact high up in the jejunum. A comparatively small stone (three-quarters of an inch in diameter) may block the bowel, assisted by spasmodic contraction of the circular muscular coat. In some cases the stone may have increased in size after entering the gut by the deposit on it of fæcal matter. If the stone remain impacted, the mucous membrane is liable to ulcerate and thus favour the spread of infection to the peritoneum; perforation is exceptional.

Clinical Features.—Gall-stone ileus is met with chiefly in patients over fifty years of age. There is usually a history of symptoms referable to gall-stones, and there may also be the more recent history of symptoms referable to the passage of the

gall-stone from the gall-bladder into the intestine—pain and tenderness below the right costal margin, along with evidences of local peritonitis. Both sets of symptoms are occasionally absent. The onset of obstruction is usually abrupt. Pain, although sometimes a prominent feature, may be altogether absent. Vomiting occurs early and is very persistent; the ejected fluid is abundant and bilious; after the second day it may become stercoraceous. There is less shock than in acute strangulation of the bowel; the patient complains of cold and thirst, and becomes exhausted by the incessant vomiting. There is little distension or tenderness of the abdomen. If the abdominal wall is thin and is relaxed by an anæsthetic, and if there is no distension, the gall-stone may be felt through the parietes, and in a few cases it has been observed to change its position. It has also been felt by the rectum in the pouch of Douglas.

Less commonly gall-stone ileus assumes a chronic or intermittent character. In its passage along the intestine the stone may become arrested at different points as a result of spasm of the bowel, and repeatedly cause symptoms of obstruction, with intervals of days or weeks between the attacks. Such cases may terminate in complete obstruction, or the stone may finally be passed by the rectum and the patient make a complete recovery.

The *diagnosis*, in the absence of a history of previous gall-stone affections, is usually a matter of conjecture. It is one of the conditions most likely to be present in cases of sudden obstruction in elderly women.

Treatment.—The possibility of the stone being passed by the natural channel may justify a preliminary trial of belladonna and opium, which not only relieves pain, but, by arresting the spasm of the bowel, may favour the passage of the stone; and at the same time the stomach may be washed out, and large quantities of saline fluid introduced into the colon. Inasmuch, however, as the diagnosis is rarely certain, it is safer to operate without delay. The abdomen is opened in the middle line by an incision large enough to admit two fingers. The loop of bowel containing the stone is usually found without difficulty if the condition is suspected and sought for. The loop is brought outside the wound and surrounded with gauze; the bowel is opened by a longitudinal incision, the stone expressed, and the incision is then closed by two tiers of continuous suture inserted at right angles to the long axis of the bowel to avoid narrowing the lumen. In advanced cases with great distension of the

bowel, it is advisable to evacuate the contents through the opening made to extract the stone, and if the bowel itself is much damaged, it should either be resected or brought out at the wound, fixed there, and drained. If the stone is not found, an artificial anus must be made in the lowest distended loop of bowel.

Among the other solid bodies which may block the intestine may be mentioned fæcal concretions or enteroliths, concretions of insoluble drugs, such as magnesia or salol, taken over a long period in large doses, plates of false teeth, and the various foreign bodies swallowed by lunatics, and by mountebanks to "gain a livelihood." The clinical features may be those of intestinal obstruction, or of ulcerative and septic conditions, for example, perforative and other forms of peritonitis, abscess, and fæcal fistula, due to pressure of the foreign body on the bowel. The diagnosis is difficult unless an accurate history is forthcoming, or the foreign body can be demonstrated by means of the Röntgen rays. Treatment is conducted on the same lines as in gall-stone ileus.

Stenosis of the Bowel, including Stricture, Malformations, and Tumours.—It may be stated generally that the appearances observed on post-mortem examination do not always accurately represent the degree of narrowing of the lumen of the bowel which results from the various forms of stricture. As in other tubes provided with an abundant blood-supply and with circular muscular fibres—for example, the gullet, the urethra, or the pylorus—the elements of congestion and spasm which may be present during life sometimes add considerably to the narrowing of the bowel. Hence the features of obstruction are liable to vary from time to time, although the cicatricial element is constant throughout.

Simple stricture is a comparatively rare lesion, and nearly always affects the small intestine. It is met with chiefly as a sequel to tuberculous ulcers in the lower end of the ileum, and is then often multiple—from three to five separate constrictions may be present (Fig. 99). The gut between the individual strictures is markedly dilated, and its peritoneal coat may present a number of scattered greyish or yellow tubercles. Stricture may follow on a strangulated hernia which has been reduced by operation, the cicatricial contraction taking place in the site of the constriction groove at one, or at both ends of the loop of bowel implicated in the hernia. Stricture is extremely rare as a sequel of wounds of the bowel and of incomplete rupture of its coats. The coils of bowel above that which is narrowed present a

marked degree of hypertrophy, and exhibit during life an increase in their peristaltic movements; the bowel below is contracted and empty.

The *clinical features* develop insidiously. There is colicky pain, aggravated by the ingestion of solid food, and attended with loud gurgling noises. There is vomiting, which is attended with little nausea, the patient bringing up large quantities of greenish-brown watery fluid at irregular intervals, it may be of two or three days. The motions are scanty, and vary in consistence; diarrhœa is not uncommon. The patient loses flesh. There may be little distension of the abdomen, and the abdominal wall usually remains flaccid. The hypertrophied coils above the stricture may exhibit spontaneously, or when stimulated by handling, exaggerated peristaltic movements, and they frequently arrange themselves in a pattern suggestive of a ladder or of the pipes of an organ. Splashing sounds may be elicited, and the distended coils, if full of fluid fæces, may yield a dull note on percussion. The progress of the malady is slow and intermittent, and the patient may be able to go about, and even continue to follow his occupation. In exceptional cases the first symptoms are those of acute obstruction brought on by blocking of the narrowed bowel by indigestible food or inspissated fæcal matter.

Even in typical cases of chronic obstruction due to stricture of the lesser bowel, it is seldom possible to be certain as to the cause of the obstruction without performing an exploratory operation. A similar train of clinical features may be brought about by new growths, by matting, bending, or compression of the gut from adhesions or from shrinking of the mesentery. It is, fortunately, unnecessary to differentiate between these various conditions, as laparotomy is the first step in the treatment of all of them.

Treatment.—The sooner the condition is subjected to operative interference the easier and more successful will this prove. The abdomen is opened in the middle line, unless the seat of the stricture is indicated by some definite localising factor, such as an antecedent hernia. There is rarely any difficulty in finding the affected loop of intestine, or in bringing it out at the wound, except when adhesions are present, in which case these must first be divided or separated. If there is a single annular stricture, the lumen of the bowel is most easily restored by making a longitudinal incision through the stricture on the convexity of the bowel, opposite the mesenteric attachment, and suturing the wound at right angles to its long axis—a procedure known as *enteroplasty*. The sutures may be inserted with

greater nicety if a bone bobbin is introduced into the lumen of the bowel.

If the segment of bowel affected is the seat of a tubular stricture, or of several strictures in close proximity to one another, and especially if it is bent on itself and involved in adhesions, the alternative lies between performing an immediate resection (enterectomy), and establishing an anastomosis between the bowel above and below the diseased segment (entero-anastomosis). Enterectomy is the more satisfactory procedure if the conditions are favourable for its performance. It is essential that the resection should extend beyond the disease to such a distance that a section of healthy bowel is obtained for immediate union by sutures. Inequality in the size of the lumen of the respective sections is overcome by cutting across the lower contracted bowel obliquely, and by slitting it on the side opposite the mesenteric attachment. Entero-anastomosis is preferred where there is extensive matting from adhesions. Recourse should only be had to the formation of an artificial anus—*enterostomy*—in critical and urgent cases, because of the irritating effects of the contents of the small intestine on the surrounding skin, and because of the loss to the patient of nutrient matter. There is serious risk of starvation if the opening is situated in the jejunum. If an artificial anus is necessary to tide the patient over a critical period, a second and curative operation must be performed as soon as possible—not later than a week or ten days after the first.

Congenital Malformations.—Certain congenital malformations of the bowel may give rise to clinical features closely resembling those of stricture, for example, narrowing of the gut due to the presence of *a diaphragm or septum* stretching across the intestine, with a central aperture through which only fluid is able to pass. Obstructive symptoms may occur at any time from changes in the intestinal contents, or from inflammatory changes in the wall of the gut, although the condition is quite compatible with the attainment of adult life.

Complete obliteration of a longer or shorter segment of the intestine proves fatal within a few days after birth, and is not amenable to surgical treatment, although life may be prolonged for a time by the formation of an artificial anus.

An interesting variety of congenital abnormality is that which causes what used to be described as "*idiopathic dilatation of the colon*" in children. It appears to depend upon a congenital contraction of the rectum and lower part of the colon, or upon kinking of the bowel at the junction of pelvic colon and rectum.

This rare affection is characterised by obstinate constipation, which finally resists all attempts to open the bowels. It is also characteristic that the child is unable to pass wind, and that when a tube is passed up the rectum flatus escapes under considerable pressure. There are attacks of pain and vomiting, the abdomen becomes enormously distended (Fig. 96), and may show the contour of the dilated colon, and visible peristaltic movements. On post-mortem examination the distension of the colon may be so great that the bowel has been found to measure over eighteen

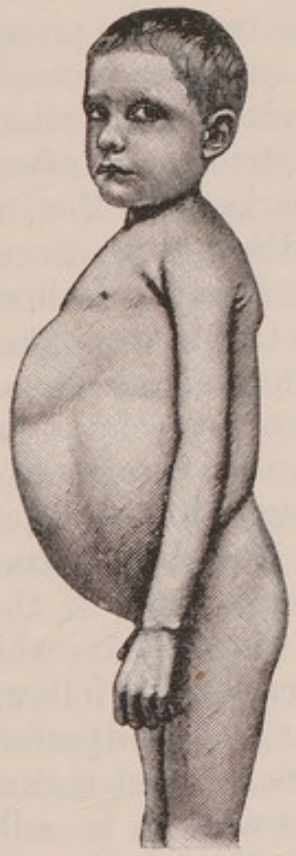

FIG. 96. — Boy, æt. 10, suffering from "idiopathic dilatation of the colon."

FIG. 97.—"Idiopathic dilatation of the colon" as seen on *post-mortem* examination.

inches in circumference. Surgical treatment aims either at affording relief by making an artificial anus in the dilated sigmoid, or at a radical cure by resecting the contracted segment of the gut.

Malignant Stricture.—In the great majority of cases, this is associated with the growth of a columnar-celled carcinoma originating in the mucous membrane of the large bowel. The tumour grows very slowly, and tends to spread circularly around the gut. The epithelial elements usually undergo necrosis, while the fibrous stroma contracts, producing an annular stricture. Viewed from the outside, a comparatively small

amount of gut seems to be involved in the growth, the typical appearance being as if a string had been tied round the bowel (Fig. 98). Viewed from within, the lumen of the bowel is contracted to the size of a lead pencil or a crow-quill by a well-defined ridge or ring representing the oldest, central portion of the growth, while above and below this the cancer extends in the mucous membrane for a varying distance, but seldom farther than one inch in each direction. The free surface of the growth is ulcerated and bleeds readily. The bowel above is altered as the result of attempts to drive the contents through the stricture, although the hypertrophy is never so pronounced as in stricture of the small bowel, and is sooner succeeded by paralytic dilatation. The distension is often most marked in the cæcum, although the cancer may be situated as low down as the pelvic colon. The mucous membrane above the stricture shows chronic catarrh from the stagnation and pressure of the bowel contents, and it may be the seat of ulceration which is occasionally followed by gangrene and perforation. The affected segment of bowel may be adherent to others in its vicinity, to the omentum, or to the parietes, without any extension of the cancer into these adhesions. On the other hand the cancer may infiltrate the parietes, especially in the case of growths in the cæcum, or it may invade and open into an adjacent loop of bowel, or into the bladder or other organ, producing an internal fistula. Cicatricial contraction of the mesocolon is a common cause of fixation of the tumour, when, as in the case of the sigmoid, it would otherwise be movable. Secondary growths in the mesenteric glands, peritoneum, or liver are exceptional, partly because the symptoms of obstruction usually ensue before these have time to develop. The occurrence of more than one malignant stricture is exceptional. Cellulitis, or the formation of abscess in the extra-peritoneal cellular tissue, is occasionally observed, especially in cancer of the cæcum, and by simulating

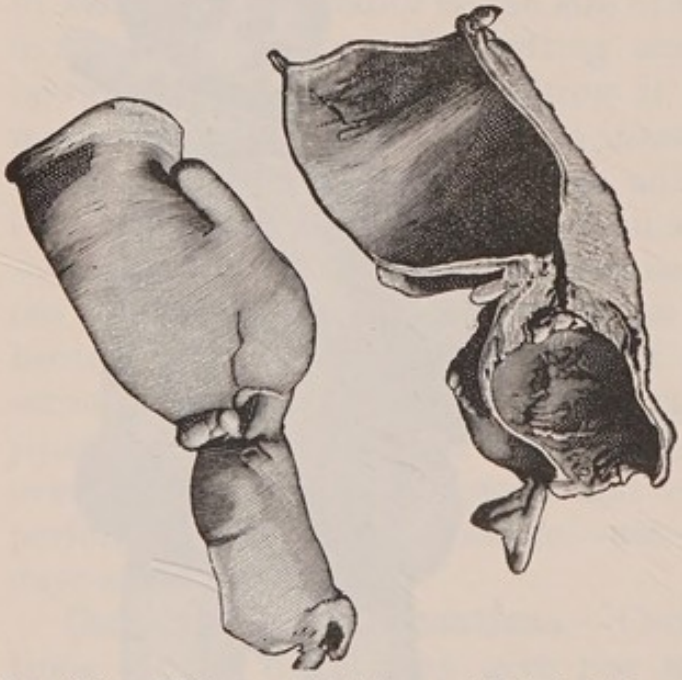

FIG. 98.—Malignant Stricture of Pelvic Colon.

appendicitis may prove a source of difficulty in diagnosis. The rupture of the abscess may be followed by the development of a fæcal fistula. The sites of malignant stricture may be stated in order of frequency thus: pelvic colon, cæcum, descending colon, transverse colon, splenic and hepatic flexures, small intestine.

Clinical Features.—It is a remarkable fact that a malignant stricture of the colon, in which the lumen of the bowel is reduced to the size of a crow-quill, or even smaller, is often attended with so few symptoms that the condition may remain unsuspected until the onset of acute obstruction. During the latent period the patient may complain of flatulent distension, of increasing difficulty in getting the bowels to move, and of paroxysmal pains in the abdomen, loin, and back. Constipation is the commonest complaint, and the lower the seat of the tumour in the colon the more pronounced is it, because of the greater solidity of the intestinal contents. He may have attacks of diarrhœa alternating with constipation, and even slight threatenings of obstruction with considerable periods of comfort between the attacks. The passage of blood and mucus by the rectum, or the presence of traces of blood in the stools, is suggestive of cancer in the descending colon or sigmoid. Loss of flesh and of strength may be altogether absent, and is rarely sufficiently marked to afford grounds for suspecting malignant disease. If the abdominal walls are thick or loaded with fat, or if there is some general distension of the bowels, external examination usually yields negative results. Under favourable conditions, however, it may be possible to recognise a tumour, and to venture an opinion as to the segment of the bowel it affects, from its situation, its degree of mobility, its behaviour when the colon is filled from the rectum, and from other clinical features. The tumour which is felt on examination, may not be the strictured segment of bowel, but a mass of omentum, or another coil of bowel which is adherent to it. Growths at the splenic or hepatic flexures, being under cover of the ribs, cannot be detected unless displaced. Tumours in the cæcum and ascending colon can often be palpated. A growth in the sigmoid is usually more or less fixed in the left iliac fossa, but, if the mesentery be long and free, it may be found near the centre or on the right side of the abdomen. A growth in the transverse colon is usually placed centrally. A malignant stricture low down in the sigmoid may be recognised on bimanual examination, or may be seen with the aid of a long rectal speculum. When the disease produces a sufficient degree of stenosis to cause secondary changes in the bowel above, these

may be of assistance in diagnosis, both as to the nature and as to the site of the growth. Stricture in the cæcum or ascending colon is more often attended with distension and exaggerated peristalsis in the lower coils of the ileum than when the seat of obstruction is in the lower colon, but we have seen an organ-pipe pattern of small intestine in malignant stricture as low down as the sigmoid. In stricture of the transverse colon or of the hepatic and splenic flexures, the distension may be more marked in the right flank, while in stricture of the sigmoid the distension is in both flanks. Peristaltic movements of the large bowel are usually too feeble to be visible through the parietes, so that the outline of the distended colon is rarely to be made out, but it is often possible to satisfy oneself that the distension is most marked, and, if the bowel is loaded with fæces, that there is dulness on percussion, in those parts of the abdomen which are normally occupied by the large intestine. The recognition of large masses which indent beneath the fingers may occasionally help to identify the loaded bowel above the stricture. Tenesmus is often present in stricture of the colon low down on the left side.

The majority of cases of malignant stricture of the colon first come under observation when *obstruction* is the prominent feature. The symptoms of obstruction may gradually supervene on those described above, or they may come on suddenly in a patient who has hitherto had no reason to complain of his bowels. The explanation of the abrupt change in the clinical features is not always to be discovered, even on post-mortem examination. It may be that the narrowed lumen is suddenly blocked by a fæcal mass, that the overtaxed bowel above has become paralysed, or that the affected segment has been bent on itself. It is noteworthy that the acute symptoms have sometimes followed the taking of a strong purgative. The features of the complete obstruction are in no sense characteristic of malignant stricture, and the diagnosis is usually impossible unless a history of the symptoms described above is forthcoming. The seat of the pain is of little diagnostic value. Vomiting is a late symptom, and even towards the end, when it becomes constant, is not very distressing, and does not always become stercoraceous. In some cases there is no vomiting. Hiccough is often troublesome. Absolute constipation may last for as long as a week or ten days without the symptoms becoming urgent. Ballooning of the rectum—that is, dilatation from paralysis—is often present in stricture of the descending or sigmoid colon, but is not peculiar to this affection. The abdomen becomes more and more distended, it may be in such a form as to indicate the seat

of obstruction, or it may be blown up so tensely and uniformly that no inference as to localisation of the block is possible.

Diagnosis.—In the absence of symptoms of obstruction, if no tumour is to be felt, the diagnosis is conjectural and based on probabilities. When there is a palpable tumour in the ileo-cæcal region, the diagnosis is to be made from a tuberculous mass and from appendicital lesions. Tumours in the hepatic flexure, the transverse, or the descending colon, are to be differentiated from tumours of the kidney, gall-bladder, liver, or stomach. In women tumours of the sigmoid flexure may resemble those originating from the uterine appendages.

When symptoms of obstruction are present, the diagnosis is to be made from such other causes as stricture of the lesser bowel, volvulus, incomplete strangulation by a band, matting of the bowels, fæcal accumulation, and tumours of other organs pressing on the bowel. In the majority of cases the difficulty is not cleared up until the abdomen is opened.

Treatment.—In the latent period, that is, before the onset of obstruction, the removal of the affected segment of bowel affords a good prospect of radical cure because of the rarity of secondary growths. Before the abdomen is opened it is not always possible to determine if the tumour is removable by operation. The ideal method of resecting the bowel and establishing an immediate junction between the divided ends is not always practicable, because of the difficulty of bringing these together. Nor is it always advisable, because the bowel above the stricture, although free from cancer, is dilated and semi-paralysed, and its mucous membrane may be the seat of ulceration—all adverse conditions for primary union and restoration of the intestinal functions. A *two-stage operation*, therefore, is to be preferred, and is now usually practised, except in the case of the cæcum or sigmoid flexure, where the conditions for immediate junction are more favourable. At the first stage the affected segment of bowel is brought out and fixed at the wound, and at the second—some days later—it is removed. A Paul's tube may be inserted into each of the open ends of the bowel. After the upper segment of colon has thoroughly emptied itself and recovered its normal state, the resulting artificial anus is closed by one or other of the methods to be described later. If the conditions found on opening the abdomen exclude the prospect of a radical cure, recourse may be had to one or other of the palliative procedures —exclusion of the affected segment, entero-anastomosis, or artificial anus.

Entero-anastomosis obviates the stricture by providing a short

cut or circuit, and being the simpler procedure it is to be preferred in weakly patients. The formation of an artificial anus is indicated when the cancer is too low down in the sigmoid to allow of either of the above procedures, or when there is complete obstruction of the bowels. If practicable a curative operation may be had recourse to when the patient has got over the obstruction, and the intestine is in a condition to favour surgical measures.

In the presence of actual obstruction relief must be given by opening the bowel above the block without delay. As it is seldom possible to be certain of the site of the obstruction or of its nature, it is usually advisable to open the abdomen to the right of the middle line at the level of the umbilicus. If the cæcum is found distended, there is reasonable certainty that the stricture is below this, and the condition of the transverse colon is investigated. If distended it is brought out into the wound, and an artificial anus is established. If the cæcum is empty, the obstruction is probably situated in the lesser bowel, and it will be possible from the same wound to bring out and open the lowest distended coil. In conditions of great urgency, when the above exploration is inadmissible, the incision is made in the right iliac fossa, and the cæcum, if distended, is opened straight away.

When the obstruction is tided over, and the parts have returned to a normal state, the removal of the cancerous segment of the bowel may be undertaken under more favourable auspices.

Sarcoma of the bowel is a rare affection. It is most frequently situated in the lower ileum, and usually assumes the form of a diffuse infiltration of the coats of the intestine, converting the bowel into a rigid tube. If the lumen is narrowed, the clinical features are the same as in innocent stricture of the ileum, only the development and progress of the disease are more rapid. If the lumen is not encroached upon, the symptoms are those of an abdominal tumour. Treatment is more successful in the former variety, as it is more likely to be subjected to operation at an early stage. Removal is carried out as in cancer. We have observed a case in which the patient was quite well three years after the removal of a sarcoma of the ileum.

Pressure by Tumours external to the Bowel.—Obstruction is most likely to result from the pressure of large tumours of the uterus, ovary, kidney, mesentery, or omentum. The rectum is the segment of bowel most likely to be pressed upon. The onset of obstruction may be acute from a sudden change in the position of the tumour, or from kinking or strangulation of

the bowel; more often it is gradual, the features resembling those of stricture. In some cases the constipation simply increases until it becomes absolute. The diagnosis is often difficult in tumours with a pedicle, as twisting of the latter may simulate obstruction. Treatment must be directed not only to the condition of the bowel, but to the tumour causing the pressure. In the case of large tumours, such as an ovarian cyst, it may be necessary to remove or empty the tumour before the condition of the bowel can be investigated.

Fæcal Accumulation. — Considering the frequency of obstinate constipation, it is remarkable that fæcal accumulation is so rarely a cause of obstruction. It would appear that when obstruction does occur it is due to some additional factor, probably in the near vicinity of the rectum, such as bending or torsion of the sigmoid flexure, from its being unequally loaded with masses of hardened fæces. Such variations from the normal arrangement of the bowel, as pouching of the cæcum so that it hangs down into the pelvis, looping of the transverse colon into a V with its apex hanging down to the symphysis, or undue length of the sigmoid, so that when loaded it gravitates into the pouch of Douglas, also favour the occurrence of obstruction. Several of these factors may be combined in the production of this form of obstruction. The accumulation of fæcal matter may be enormous, and the colon may be so distended as to fill the greater part of the abdomen. The cæcum especially suffers from distension, and its mucous membrane may be extensively ulcerated and the bowel be actually perforated. Fæcal accumulation is met with after middle life, and is said to be most common in women. The history is not unlike that met with in malignant stricture, only it is much longer, and dates back many years. The patient has all his life been troubled with constipation, and may have had previous threatenings of obstruction with colicky pains and distension, which were tided over by enemata, and were followed by intervals of comparative well-being. Such patients have an unhealthy appearance, the outcome of chronic intoxication from the absorption of the products of decomposition within the bowel. The distension may be so great as to displace the diaphragm and cause embarrassment of the heart and lungs. Vomiting is not a prominent feature, and rarely becomes stercoraceous. The rectum is usually found to be full of hard fæcal masses.

With regard to *treatment* it is to be noted that the condition of the patient may be as urgent as in those forms of obstruction which call for laparotomy. The chief aim is to empty the

colon, and this is best effected by the use of enemata. The procedure is attended with considerable pain which may necessitate the administration of a general anæsthetic. It is also attended with some risk, for if fluid be rapidly poured into the already over-distended bowel, the latter may give way. If a general anæsthetic be employed, the patient is placed in the lithotomy position with the buttocks raised, and the sphincters having been dilated with the fingers, the fæcal mass is softened with hot saline solution or olive oil run in through a funnel and soft rubber tube, like that used for washing out the stomach. The fingers, protected with rubber gloves, are the safest instruments to employ if the expulsive power of the bowel is in abeyance. The rectum having been emptied, saline fluid is allowed to run gently into the colon, and at the same time the abdomen is massaged with the object of exciting peristaltic movements. It is encouraging if large quantities of gas come away, with simultaneous diminution in the tension and prominence of the abdomen. The heart may require to be stimulated by strychnin and by saline infusion into the cellular tissue. We have observed the case of a middle-aged man, an alcoholic, who was sent into hospital on five occasions at intervals of from three to six months, each time critically ill with obstruction, which on four occasions was relieved by the above measures. On the last occasion the colon gave way during the process of irrigation, and he died within twelve hours.

It need scarcely be added that, after the obstruction has been relieved, means should be taken to prevent a recurrence of the accumulation; chief reliance is to be placed on measures intended to restore peristalsis—such as massage and electricity to the abdomen, appropriate exercises and the administration of strychnin and belladonna, cascara, and other bowel tonics.

Embolism and Thrombosis of the Mesenteric Blood-Vessels.—The lesions included under this head present a close clinical resemblance to primary affections of the intestine, and may thus give rise to mistakes in diagnosis. In spite of the abundant blood-supply to the intestines and of the free anastomosis between the individual arterial branches in the mesentery, blocking of one or other of the main trunks, and especially of the superior mesenteric artery, leads to serious changes in the condition of the bowel supplied by it. If it is the *artery* that is blocked, these changes are of the nature of a hæmorrhagic infarction, which is very liable to terminate in gangrene of the bowel.

In embolism of one of the main arterial trunks there is

sudden onset of intense colic, and in the majority of cases profuse hæmorrhage from the bowel and progressive anæmia. In some cases the symptoms are indistinguishable from those of intestinal obstruction, and depend on paralysis of the bowel—a result of the hæmorrhagic infarction. This may be recovered from, but there is a great tendency towards gangrene of the bowel and death from septic peritonitis. The diagnosis is always extremely difficult, even when conditions are present which are liable to cause embolism. In all cases the prognosis is very grave. When the abdomen is opened, it is found to contain blood-stained fluid, and a greater or less extent of the small intestine —from a few inches to many feet—is found to be firm, dark, swollen, and rigid like a sausage, while the bowel below is collapsed and empty. At a later stage the affected bowel shows evidence of loss of vitality or of commencing gangrene. Immediate resection of the damaged bowel holds out the only chance of recovery, but in many cases the operation is impracticable and should not be proceeded with.

In thrombosis of the *mesenteric veins* the anatomical and clinical features are very similar.

Perforation of Typhoid Ulcer.—This is one of the most fatal complications of typhoid fever. The perforation may occur in an individual who is going about—suffering from a mild or "ambulant" form of the disease—and is then the first distinguishing feature of typhoid. More frequently it occurs in a patient who is under treatment for the disease, usually during the second or third week of the fever, although it may happen during convalescence. Perforation is much more common in men than in women; it is usually solitary, although occasionally multiple, and it is most often situated within the last two or three feet of the ileum.

The *clinical features* are marked by the sudden onset of severe abdominal pain, with collapse and sudden fall of the temperature, followed by signs of peritonitis usually commencing in or referred to the right iliac fossa. There is local tenderness and rigidity. While these are the classical features of perforation, there is frequently a want of certainty in the diagnosis, and when there is a reasonable doubt, the safe course is to make a small exploratory opening. The sooner this is done the better, as success largely depends on the shortness of the interval between the occurrence of perforation and the operation for its closure. Local anæsthesia is to be preferred. A small incision is made in the vicinity of the right semilunar line. The cæcum is identified and examined,

and then the lower coils of the ileum. Enlargement of Peyer's patches is easily recognised on inspection and manipulation. The perforation is often obscured by purulent lymph and adhesions. When the opening is found, it is closed by a series of sutures. If there are areas in the adjacent bowel which appear likely to perforate, these should be invaginated by Lembert sutures, or covered over with an omental graft. Sometimes the bowel is so extensively damaged as to call for resection, but the patient's general state will seldom permit of this being carried out. The infected area of the peritoneum is cleansed by means of gauze wrung out of hot saline solution or by irrigation, and is drained by strands of worsted brought out at the wound. The feeble reparative power of the patient is often shown by the parietal wound failing to unite. Cases are recorded of a second perforation, when convalescence from the first is well established, calling for a second laparotomy. It is quite the exception to find a circumscribed abscess around a perforated ulcer.

Dysentery.—In acute dysentery the chief symptom is frequent passage of slimy or bloody stools, attended with colicky pains and tenesmus. The colon, either throughout or in parts, is in a condition of acute inflammation, frequently associated with ulceration and sometimes with gangrene. In cases which resist medical treatment the question of performing colotomy may be considered, in order to give rest to the bowel, and to allow of irrigation of the colon and the direct application of remedial agents to the inflamed mucous membrane.

In chronic dysentery similar features persist or recur from time to time, and there may also be symptoms of narrowing of the colon from cicatricial changes in the wall of the bowel, or from adhesions interfering with its peristalsis. Surgical interference is more often called for than in the acute disease, and usually takes the form of colotomy. If the chief object of the operation is to admit of the colon being irrigated, this is most easily carried out by inserting and fixing a rubber tube in the cæcum in the same way as the tube is fixed in the stomach in a Witzel's gastrostomy. Normal saline solution and dilute solution of nitrate of silver (1·2000) are generally used, one after the other. When the fistulous opening is no longer required, it soon closes on withdrawal of the tube. If the chief object is to rest the bowel, an artificial anus is made in the ascending colon. Irrigation may also be carried out through this opening. A plastic operation is usually required to close the artificial anus when it is no longer wanted.

Intractable Colitis.—Apart from dysentery there are other forms of inflammation and ulceration which may affect the colon. The leading symptoms are diarrhœa, griping pains, and loss of flesh. The diarrhœa usually alternates with constipation; it is often offensive and associated with want of control of the sphincters. The motions may contain mucus, pus, and sometimes blood, and in a certain group of cases they contain mucous or membranous casts of the bowel. The membranous form is chiefly met with in neurotic women, and is attended with great pain on defæcation. In cases which resist medical treatment great benefit usually follows irrigation carried out on the same lines as in chronic dysentery. It is a remarkable fact that in many of the recorded cases, where the operation has been carried out in two stages, decided improvement has followed the fixation of the bowel to the parietes, and before it has been opened. The fistula in the colon should be kept open for a period averaging about six months.

Tuberculosis of the Intestine.—Apart from that met with in advanced phthisis, tuberculous disease of the intestine is most often met with in the ileo-cæcal region, in the form of stenosis of the gut, or of a tumour in the right iliac fossa.

The stenosis is most commonly due to *one or more fibrous strictures* which have formed in the situation of pre-existing ulcers. The stenosis may be augmented by adhesions between the affected loops of bowel, or between the bowel and the parietes. The peritoneal investment of the gut often shows miliary nodules of tubercle, and the glands in the corresponding segment of mesentery may be enlarged and caseous. The clinical features are those common to all forms of gradual stenosis and incomplete obstruction of the intestine, and it is often possible to infer the tuberculous nature of the lesion from the history and associated features of the case. If the affected coils are matted together, a sense of resistance or an ill-defined swelling is felt on palpation. The diagnosis is completed on opening the abdomen. The choice of curative procedure lies between an entero-anastomosis and a resection of the diseased segment of the gut (Fig. 99).

The tuberculous ileo-cæcal tumour is a well-defined clinical type of abdominal tuberculosis. The disease is often strictly limited to the ileo-cæcal segment, although it may extend for a variable distance along the ascending colon or the lower ileum. The tumour results from a great increase in thickness of the wall of the gut, and is sometimes added to by the adhesion of adjacent coils of small intestine. The associated mesenteric

glands are often enlarged, and it sometimes appears as if the disease had originated in these and then spread to the wall of the bowel.

The condition is most frequently met with between the ages of twenty and forty, but may occur much later in life. The discovery of a tumour in the right iliac fossa or flank may be the initial feature; more commonly there is a preliminary history of griping pains with alternate diarrhœa and constipation. If the lumen of the gut is much narrowed, there are threatenings of obstruction, and in emaciated subjects visible peristalsis and distension of the ileum. Blood in the stools is exceptional. Except in very stout subjects the tumour is easily recognised on combined palpation from the flank and loin. It is firm, little sensitive, roughly cylindrical, and its surface is uneven or bossy. The resonance over it is impaired. At first freely movable, it tends to become fixed as a result of adhesions and infiltration of the mesentery. Abscess may form, and if allowed to rupture externally may cause persistent sinuses or a fæcal fistula. The disease is very chronic, and may progress slowly for years with long periods of latency unless the lumen of the bowel is encroached upon. Apart from the risks of obstruction, danger to life results from extension of the tuberculous infection.

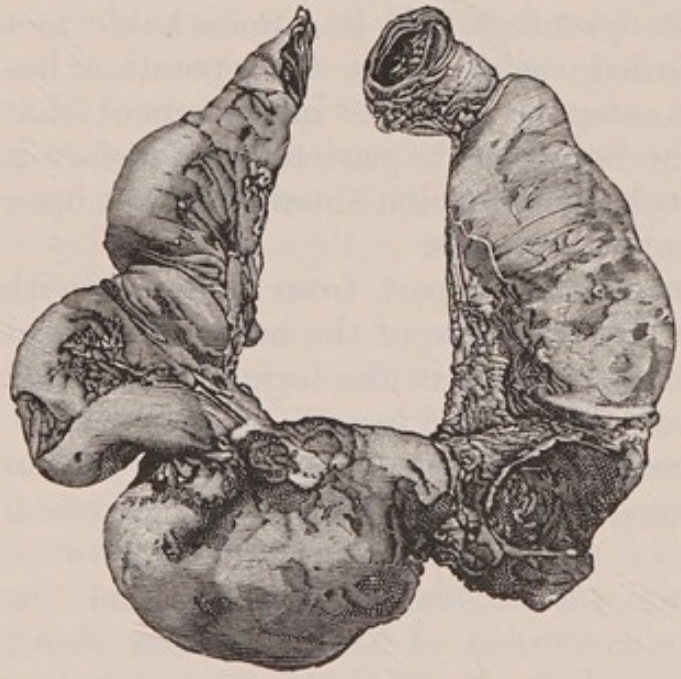

FIG. 99.—Portion of Small Intestine showing Multiple Strictures following on Tuberculous Ulcers. Resected in the case of a woman, æt. 30, suffering from chronic intestinal obstruction.

The differential diagnosis from chronic lesions in the vicinity of the appendix and from carcinoma of the cæcum may be exceedingly difficult.

Operative interference is indicated either because of stenosis, or because of the mere presence of the tumour, and is at first of the nature of an exploratory laparotomy. If there is doubt as to whether the lesion is tuberculous or carcinomatous, it is best to resect the bowel—in one or in two stages—if it is undoubtedly

tuberculous. An anastomosis between the ileum and the ascending or transverse colon will not only relieve the symptoms, but is usually followed by permanent cure.

Actinomycosis.—This is a less common, but more aggressive and dangerous disease than tuberculosis. The infection takes place from the mucous membrane of the bowel, and spreads through the various layers to the peritoneum. There is a great deal of inflammatory infiltration of the coats of the bowel and adhesion to adjoining structures, giving rise to an ill-defined, diffuse and fixed swelling, most often situated in the right iliac fossa. Abscess formation and persistent sinuses commonly supervene, and the fungus may be found either in the pus or in the granulation tissue in the wall of the sinus. Treatment consists in opening up sinuses, removing the infected tissues with the spoon and scissors, and the internal administration of iodides.

Abnormal Anus.—*Intestinal Fistula*—*Fæcal Fistula*—*Artificial Anus.*—These terms are employed indiscriminately to describe an opening in the skin through which the intestinal contents escape externally. The term fæcal fistula might with advantage be restricted to those openings which result from disease or injury, and the term artificial anus to those which are made by the surgeon for therapeutic purposes.

Conditions of Occurrence.—Apart from the fistulæ of congenital origin already described as occurring at the umbilicus, the following are the chief modes of origin :—

(1) From any *trauma* which damages the wall of the gut, such, for example, as a penetrating wound, a subcutaneous contusion or rupture, or an operation in which the bowel has been bruised—for example, in reducing a large hernia—or opened in the course of an operation and unsuccessfully sutured. The fistula which results from an untreated strangulated hernia may be included under this head ; the fistula may form directly on the seat of injury or through the mediation of an abscess ; in the latter case the external opening may be at a considerable distance from the opening in the bowel.

(2) From *inflammatory or ulcerative processes* in the wall of the bowel or in the tissues immediately adjoining it, such, for example, as appendicitis with sloughing of the wall of the cæcum, tuberculosis, actinomycosis, cancer, or foreign bodies impacted in the gut. When any segment of bowel is involved in the wall of an abscess, the suppurative process may extend into the lumen, as well as towards the skin surface, and thus cause a fæcal fistula.

(3) Lastly, there is the opening into the bowel made *for therapeutic purposes*, to which the term artificial anus may be appropriately restricted.

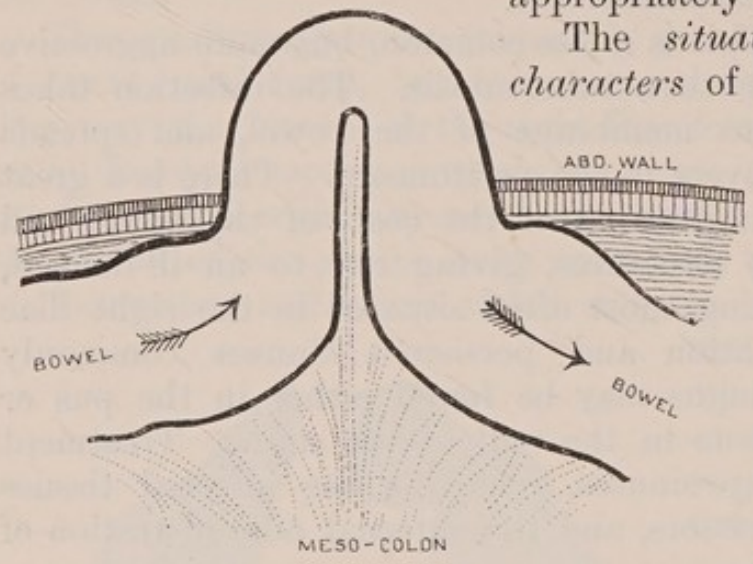

FIG. 100.—Formation of Artificial Anus in Pelvic Colon. First stage—the bowel is drawn out at the wound.

The *situation and anatomical characters* of the fistula vary with its mode of origin. In the artificial anus made in the pelvic colon to relieve the symptoms in cases of cancer of the rectum, the usual arrangement is that of two parallel tubes of bowel opening freely on the surface, with a septum or spur between them (Figs. 100, 101). The septum serves to divert all the intestinal contents out at the opening. This arrangement is quite exceptional in fistulæ of other origin, but an approach to it is sometimes met with in cases of strangulated hernia, where the convexity of a loop of bowel has sloughed.

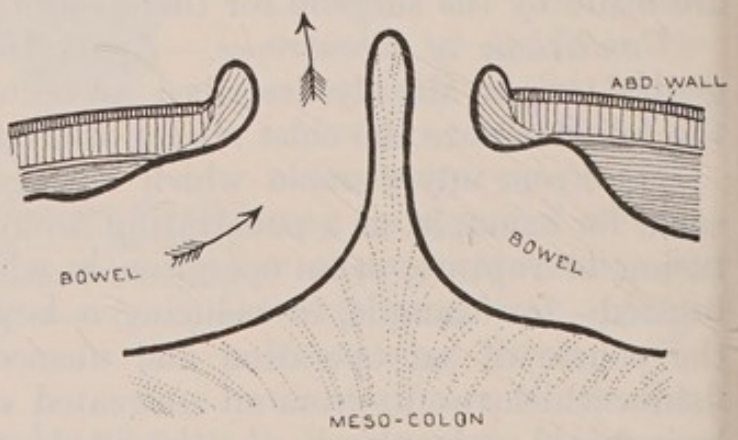

FIG. 101.—Completed Artificial Anus in Pelvic Colon. The edges of the bowel after being opened have become retracted, and united with the margins of the wound in the parietes.

In the temporary artificial anus which is made in the small intestine, and in the great majority of fæcal fistulæ, the opening in the bowel is comparatively small, and is situated on one aspect of the tube; hence it is that, provided there is no obstruction in the bowel beyond, only a proportion of the intestinal contents escape externally (Fig. 102). If the segment of bowel concerned is directly adherent to the parietes, it is usual for the margin of the fistulous orifice to be lined with intestinal mucous membrane, and this may protrude at the mouth of the fistula. If the opening is large enough, the bowel as a whole may prolapse as a result of any increase of the intra-

abdominal pressure or of peristaltic movements in the intestine immediately above the opening. On the other hand, if a suppurating channel or abscess cavity intervene between the bowel and the parietes, the fistula is lined by granulation tissue (Fig. 103).

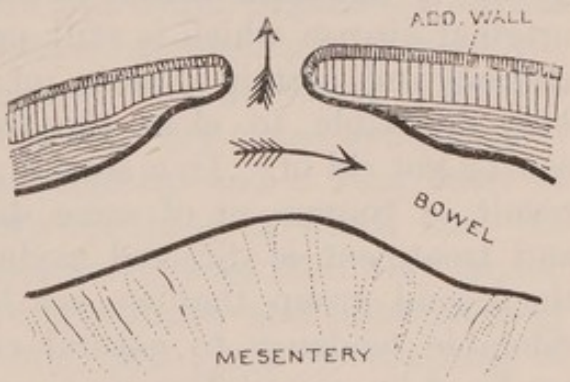

Fig. 102.—Fæcal Fistula of Small Intestine.

The *clinical features* vary with the distance of the fistula from the normal anus, with the proportion of intestinal contents which escapes, and with the nature of the lesion to which the fistula owes its origin. Fistulæ in the colon discharge fæcal matter, and if this be solid or semi-solid, as it usually is beyond the hepatic flexure, its escape is more or less under the control of a pad and bandage. The discharge from a fistula in the small intestine is fluid, and is composed of partially digested food material mixed with the various secretions discharged into the bowel, its appearance, chemical characters and nutritive value varying with the level of the fistula. If it is situated in the upper part of the jejunum, the loss of nutriment may cause rapid emaciation, and terminate in death by starvation. The fluid, moreover, is extremely irritating, and causes superficial ulceration of the surrounding skin.

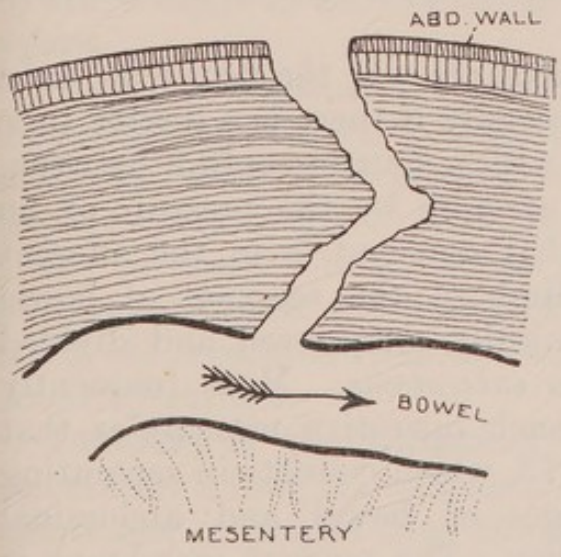

Fig. 103.—Fæcal Fistula of Small Intestine with Track of Suppuration between the Bowel and the Abdominal Wall.

In a general sense it may be said that the discharge from a fistula in the upper part of the jejunum is decidedly acid, and contains bile and undigested food material, while in the lower ileum its reaction is neutral or alkaline, and bile and undigested food materials are not recognisable, but personal observation has shown us that these and other reputed differentiating factors cannot be relied upon. The loss or gain in weight affords the most reliable information regarding the influence of the fistula on the nutrition and

health of the patient and the necessity of adopting means for its closure.

Treatment.—In considering the propriety of attempting to close an intestinal fistula, it is to be borne in mind that in one group of cases the fistula is only an incidental element of the original disease which is still present, for example, tuberculosis, cancer, and certain lesions of the appendix, and that it is only advisable to close the fistula if the primary condition can be got rid of. In a second group of cases the fistula is the result of trauma, or of some disease which has run its course, and treatment is directed exclusively to the fistula. It is with the second group that we are here concerned. There is a considerable tendency to natural cure, especially in fistulæ which are lined by granulation tissue, provided always that there is no obstruction in the bowel beyond. The patient should be confined to bed, the diet restricted to foods which leave little fæcal residue, and the bowels emptied by enemata. The irritation of the skin around the fistula is allayed by soothing applications. To make the fistula granulate from the bottom, the track is packed with iodoform worsted which is changed at frequent intervals. If there is an abscess cavity, it should be laid open and packed.

Natural cure is unlikely to take place if the fistula is lined with mucous membrane, and especially if there is a double tube of bowel opening on the surface with a spur or septum between. The septum may be caused to atrophy by the pressure of an india-rubber tube introduced so that one end is in the afferent and the other in the efferent limb of the segment of bowel concerned, or it may be mechanically compressed and divided by a screw clamp, known as an *enterotome*. More frequently recourse is to be had to some such operative measure as that suggested by John Duncan in 1873, which consists in separating by dissection the adherent edges of bowel and abdominal parietes, and stitching like to like. The mucous membrane is dissected up all round the abnormal orifice; it is then invaginated, and the raw surfaces stitched together by a series of interrupted catgut sutures; the margins of the skin are next pared and brought together by sutures of silkworm gut. For the closure of an artificial anus made in the colon by the surgeon, this simple procedure may require to be replaced by an operation in which the abdominal cavity is opened, the bowel separated from the parietes, and the opening in it closed by a double tier of sutures, usually inserted in a direction at right angles to the long axis of the gut. In some cases it is better to resect the

affected segment of bowel and join the ends. Although the abnormal anus has been discharging fæces up till the performance of the operation, it is usual to obtain primary union not only of the bowel, but also of the parietal wound.

Fistulæ between the Intestine and other Organs—Internal Fistulæ.—These result from disease originating either in the bowel or in the organ with which it communicates. Fistulæ between the small and large intestines only cause symptoms if the opening in the small bowel is high up and a long tract of the gut intervenes between the two openings, in which case the patient may emaciate, and bile and undigested food may appear in the stools. Fistulæ between the stomach and intestine may be attended with eructation of intestinal gases or vomiting of intestinal contents and the appearance of undigested food in the stools. Fistulæ between the biliary passages and the duodenum or colon result from gall-stone affections, and are seldom attended with any symptoms. Fistulæ between the intestine and the genito-urinary organs are chiefly met with in the pelvis, and concern the rectum; the intestinal contents may escape by the urethra or vagina, and the chief danger to life consists in an ascending septic infection of the urinary organs.

Operative measures for the closure of an internal fistula are only called for when it is a source of danger to life, and are only justifiable when it is possible to cure the disease to which the fistula owes its origin. Apart from fistulæ in the pelvis, in which it may be possible to get access from the perineum, it is usually necessary to open the abdomen; the organs connected by the fistula are separated from one another, and the opening in each closed by sutures.

Tumours of the Intestine.—An *adenoma* may originate in Lieberkühn's follicles, and form a sessile tumour in the mucous membrane, or project from the surface as a polypus. A solitary tumour, unless when seated in the rectum, rarely gives rise to symptoms; it may, however, form the starting-point of an intussusception. Multiple adenomata are sometimes met with in the form of disseminated polypi throughout the great part of the large intestine. This affection is met with chiefly in young adults, and is attended with diarrhœa, loss of blood, abdominal pain, and sometimes with symptoms of stenosis. There is a tendency to cancerous transformation of one or other of the adenomatous tumours. The sufferings of the patient may be greatly relieved by anastomosing the lower ileum with the sigmoid flexure. When this is not practicable, an artificial anus

may be established in the cæcum, in order to put the large bowel at rest and to allow of irrigation.

Lipomata and *fibromata* rarely cause symptoms unless by giving rise to intussusception or stenosis of the bowel.

Malignant disease of the intestine is described at p. 437.

Enteroptosis.—In the sense in which this term is used by Glénard, it implies a downward displacement of the stomach, transverse colon, and generally of the right or of both kidneys, accompanied by digestive disturbances, and often by symptoms of neurasthenia. The term splanchnoptosis may be used to indicate downward displacements of all the abdominal organs, enteroptosis being confined to those cases in which the bowel alone is displaced.

The transverse colon may descend to the level of the symphysis, the stomach may be found anywhere between the umbilicus and the pubes, and the small intestine sink into the lower part of the abdomen and pelvis. One or both kidneys are frequently displaced downwards; more rarely the liver and spleen. The uterus is commonly tilted backwards, and may be prolapsed or even protruded from the vagina.

The condition is predisposed to by impairment of the health, muscular debility, and by repeated pregnancies causing stretching and loss of tone in the muscular and fascial structures of the abdominal wall, and is aggravated by compression of the waist and the weight of the skirts forcing the viscera downwards. Adhesions resulting from pelvic peritonitis may cause descent of the viscera by direct traction.

The symptoms do not correspond to the amount of displacement. In many cases the complaints are those associated with neurasthenia. More frequently the patient complains of constant dragging pain in the abdomen and loins, aggravated by standing or exertion, and relieved by lying down. Special symptoms referable to the displacement of individual organs may be present.

The *diagnosis* is made by physical examination of the abdomen, the patient being placed successively in the recumbent, the knee-elbow, and the erect posture.

Treatment is directed towards improving the general health and increasing the amount of adipose tissue, removing any causal factors such as tight-lacing or over-exertion, regulating the stomach and bowels, and restoring the muscular tone of the abdominal walls by means of massage and suitable exercises. The falling down of the viscera may to a certain extent be controlled by an appropriate bandage, belt, or corset, applied while

the patient is in the Trendelenburg position, and so arranged that the pressure is from below upwards. A simple bandage is usually found to be quite efficient. During the sleeping hours the foot of the bed should be elevated. In aggravated cases which do not yield to these measures recourse may be had to surgical interference—the prolapsed organs being anchored by means of sutures in the position they should normally occupy.

CHAPTER XXVIII.

THE LIVER, GALL-BLADDER, AND BILE-DUCTS.

LIVER: Surgical anatomy — Injuries: *Stab and gunshot wounds; Rupture*—Diseases: *Hepatic abscess; Hydatids*; *Syphilitic gummata*—Tumours—Acquired deformities and displacements of the liver—Surgical treatment of ascites due to cirrhosis of the liver.

GALL-BLADDER AND BILE-DUCTS: Surgical anatomy—Injuries—Affections due to gall-stones—Cholelithiasis—Stones in gall-bladder: *Gall-stone or biliary colic; Recurrent biliary colic; Cholecystitis; Empyema of gall-bladder; Phlegmonous cholecystitis*—Stones in common bile-duct—Chronic obstruction of common bile-duct—Sequelæ of gall-stone affections: *Adhesions; Stricture of ducts; Abdominal abscess; Intestinal obstruction; Fistula; Cancer*—Distension of gall-bladder—Primary cancer of gall-bladder and cystic duct—Primary cancer of bile-ducts.

THE LIVER.

Surgical Anatomy.—The left lobe of the liver extends across the epigastric region into the left hypochondrium, and is in contact with the anterior abdominal wall. It is therefore more accessible than the right lobe, which is overlapped by the ribs and roofed in by the diaphragm. The space between the liver and the diaphragm is divided into a right and left compartment by the falciform or suspensory ligament. An accumulation of pus in one or other of these compartments constitutes a right or left subphrenic abscess. The highest part of the liver, which corresponds also to the highest part of the right arch of the diaphragm, during expiration reaches the level of the fourth intercostal space in the mammary line. In the erect posture the lower edge of the liver on the right side projects slightly below the costal margin. In the recumbent position it is entirely under cover of the ribs, except in the subcostal angle where the left lobe of the liver intervenes between the stomach and the anterior abdominal wall. On the inferior surface of the liver are found the gall-bladder and the larger bile-ducts and blood-vessels. The under surface of the right lobe is in relation from before backwards with the hepatic flexure of the colon, the duodenum at the junction of its first and second portions, and the right kidney and suprarenal capsule. Access to the lower margin and inferior surface of the liver is readily obtained by the abdominal route; if the costal cartilages which lie below the reflection of the pleura—eighth to eleventh—are removed, access is also obtained to the upper or parietal aspect of the viscus. To obtain access to the

convex surface of the right lobe, recourse must be had to the trans-pleural route. Portions of certain ribs—usually the seventh and eighth—are resected in the mid-axillary line, the pleural cavity traversed, and the diaphragm divided.

Injuries.—It has been shown experimentally that under aseptic conditions wounds of the liver heal readily, and also that there is great capacity of regeneration in liver tissue.

Penetrating wounds of the liver result from stabs and gunshot injuries. They are dangerous chiefly on account of hæmorrhage, the blood escaping externally as well as into the peritoneal cavity. Death may take place rapidly if the portal vein is wounded, as in the well-known case of President Carnot. There is rarely any escape of bile from the wound unless the patient survive for several days.

The *treatment* consists in enlarging the external wound in order to expose the injured liver. The hæmorrhage is arrested by approximating the edges of the wound by sutures of thick catgut passed deeply through the liver substance, and superficial sutures of fine silk passed through the divided capsule. Plugging the wound with gauze should only be had recourse to where sutures fail to arrest the hæmorrhage.

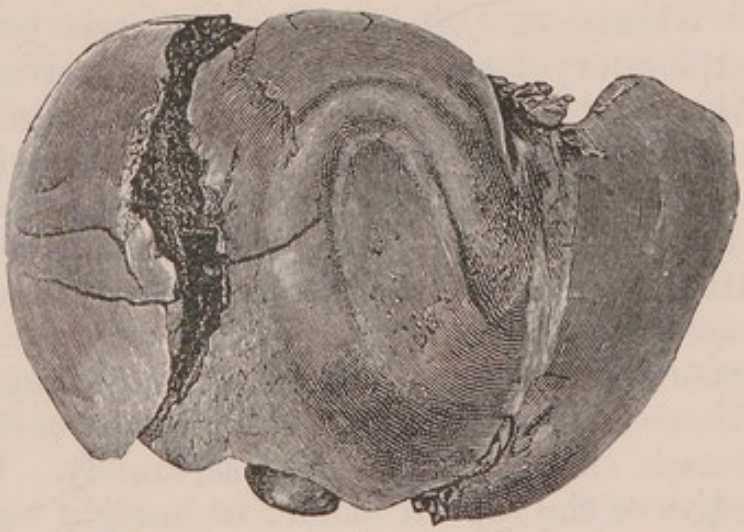

Fig. 104.—Rupture of Right Lobe of Liver from a crush between buffers.

Subcutaneous Injuries—Rupture of the Liver.—Rupture of the liver is a comparatively common accident as a result of such injuries as a fall from a height on to the feet, a blow from the shaft of a cart, a crush by the wheel of a waggon, or violent flexion of the body. The rupture assumes the form of a tear of the capsule and of the liver substance, and usually implicates the right lobe (Fig. 104). In extreme cases a large portion, or even an entire lobe, may be torn off and lie free in the peritoneal cavity. The condition, if left to nature, is usually fatal as a result of hæmorrhage into the peritoneal cavity, or at a later stage from absorption of bile (cholæmia). Less frequently death results from liver-cell embolism.

The *clinical features* resemble those attending injuries of other abdominal viscera. There is no particular sign characteristic of ruptured liver. There is usually evidence of internal hæmorrhage, the patient presenting the general features of the bloodless state. The blood tends to accumulate in the right side of the abdomen, being guided into the right iliac fossa by the mesocolon. An area of dulness, increasing from hour to hour, may be recognised at the lower part of the abdomen, corresponding to the accumulating blood. Jaundice occurs only in a small proportion of cases, and after an interval of three or four days. If there is simultaneous injury to the ribs, diaphragm, or lung, the breathing is much embarrassed.

Rupture of the liver is often overlooked, especially where it coexists with other serious abdominal lesions.

Treatment.—An absolute diagnosis being rarely possible, an exploratory laparotomy should be performed if there is any likelihood of the liver having been ruptured. The sooner the operation is performed the more likely is it to be successful. A vertical incision is made in the middle line, and may be supplemented by a transverse one across the right rectus. Having exposed the rupture, the hæmorrhage may in some cases be temporarily arrested by compressing the vessels in the gastro-hepatic omentum between the fingers and thumb, one of these being passed into the foramen of Winslow. Large open vessels should be ligatured separately. Whenever possible the edges of the rupture should be brought together by thick catgut sutures passed deeply through the liver substance. If the bleeding is not thereby arrested, recourse should be had to packing with gauze, the end of the gauze being brought out at the wound. The possibility of there being a second rupture should be borne in mind. Injuries of neighbouring organs must also be sought for and attended to.

The later complications of wounds and of rupture of the liver are for the most part the result of pyogenic infection, and include right-sided pleurisy, subphrenic abscess, and abscess of the liver itself.

Diseases.—**Hepatic Abscess.**—The commonest form of abscess is that which follows on dysenteric ulceration of the intestine. From the frequency with which it affects Europeans who have lived in tropical climates it is commonly spoken of as "tropical abscess." It is nearly always solitary, and is usually situated towards the convexity of the right lobe. The pus is mixed with broken-down liver tissue, is chocolate-coloured and glairy, and has a mawkish odour. It is usually sterile when

first opened, but on the third or fourth day it may be found to contain pyogenic organisms, and in some cases the amœba coli. Apart from the tropical variety, abscess of the liver may follow upon suppuration in the biliary passages, or upon any suppurative lesion in the territory of the portal vein, such as may occur, for example, in relation to the stomach or intestine.

The *clinical features* are sometimes remarkably latent. The prominent symptoms are pain, fever, and enlargement of the liver. The pain, which affects the right side and radiates to the shoulder, is chiefly due to perihepatitis, and is most marked when the abscess is near the surface of the organ. The fever is remittent, is attended with rigors and sweating, and may simulate that of malaria or of tuberculosis. The enlargement may affect the whole of the liver, or only a portion of it. If the abscess is near the peritoneal surface, there may be distinct friction accompanying the respiratory movements. A large abscess in the right lobe may bulge the thoracic parietes and displace the diaphragm upwards, and there may be a serous or purulent effusion into the right pleural cavity. The abscess may rupture externally or into one of the adjacent organs. If rupture take place into a bronchus, the pus is expectorated.

The risk of exploratory puncture as an aid to diagnosis appears to have been exaggerated, although it is advisable that it should only be employed when everything is ready for operation.

Hepatic abscess is to be diagnosed from hydatids, hydro- and pyo-nephrosis, empyema of the gall-bladder, pancreatic cysts, and subphrenic abscess.

Treatment.—The abscess should be evacuated and drained without loss of time. If it project below the costal margin, it should be opened by the abdominal route; and if the liver is not adherent to the abdominal wall, the peritoneal cavity must be shut off by means of sutures or gauze-packing before the abscess is incised.

An abscess which projects towards the upper and back part of the right lobe must be opened by the trans-pleural route. A large drainage-tube is inserted and the cavity of the abscess washed out with salt solution. The drainage-tube is gradually shortened, but is not removed until the cavity is obliterated and the discharge has ceased.

Those who have most experience of tropical abscess condemn operation by incision when the abscess is deeply seated, and recommend the method introduced by Patrick Manson, which consists in tapping the abscess with a large trocar and cannula,

introducing through the cannula a drainage-tube stretched upon a metal rod, and applying syphon drainage to carry off the pus.

The *multiple abscesses of the liver* met with in pyæmia are beyond the reach of surgical treatment.

Hydatids of the Liver.—Hydatid cysts may occur in any portion of the liver, but, like abscesses, are chiefly met with in the right lobe. The clinical features vary with the size and situation of the cysts. When the cyst projects downwards into the abdomen, it usually forms a painless, smooth, globular tumour in the epigastric or hypochondriac regions, obscurely fluctuating, elastic, and resisting. The characteristic "hydatid fremitus" or thrill, may be recognised on palpation if the wall of the cyst is lax. If the cyst wall is thick and calcareous, the tumour may appear to be solid. If the cyst is embedded in the right lobe, it produces no signs other than hepatic enlargement; if of large size, it may bulge the thoracic parietes, or project upwards towards the pleural cavity. Constitutional symptoms are slight or may be absent. Large cysts cause symptoms referable to pressure on the diaphragm, stomach, or abdominal veins. If the cyst suppurates, the features resemble those of hepatic abscess. While spontaneous cure is possible by desiccation and death of the parasites, rupture of the cyst is the commonest natural termination, and it may take place into one of the adjacent abdominal viscera, or into the pleura and lung. The diagnosis of hydatids may be confirmed by withdrawing some of the contents of the cyst through a hollow needle, and demonstrating the presence of scolices or hooklets. This procedure is not recommended except as an immediate preliminary to operation, because of the risk of leakage through the needle puncture into the peritoneal cavity.

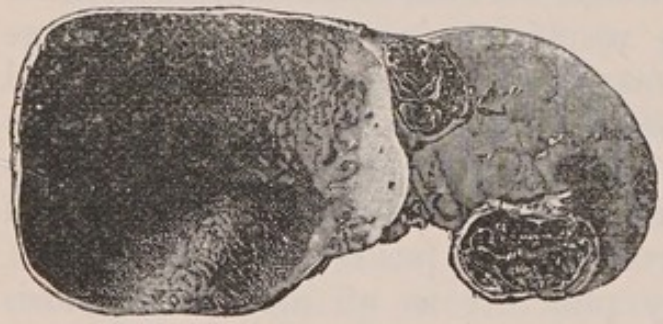

FIG. 105.—Hydatid Cysts of Liver. The right lobe shows one large cyst; the left lobe, two smaller ones.

(From Dr. Harvey Littlejohn's Collection.)

Treatment.—The nature of the interference varies with the site and characters of the cyst. Cysts projecting below the costal margin are dealt with by the abdominal route. If the cyst is pedunculated and has a narrow neck, this may be ligatured and divided and the cyst removed. If it is surrounded by liver

substance, it is incised and emptied; the cyst wall can frequently be shelled out entire. If the fluid contents are aseptic, the cavity may be closed again by means of sutures; if they are purulent, it must be drained. Cure of thick-walled cysts by means of drainage is very tedious. Cysts bulging the thoracic parietes and projecting upwards towards the lung should be dealt with by the trans-pleural route.

Syphilitic Gummata.—A solitary gumma, especially if pedunculated, may simulate a new growth so closely that such a swelling has been removed by operation, and its true nature only discovered on subsequent examination. Gummata have also been removed deliberately when iodides have failed to bring about their disappearance.

Tumours.—*Innocent tumours*, such as adenoma and angioma, are very rare. If solitary and well encapsulated, they lend themselves to removal by operation.

Primary cancer and sarcoma of the liver can only be diagnosed with certainty after making an exploratory incision, and are only amenable to interference if discovered at an early stage, and if definitely circumscribed and free from secondary nodules or infection of the glands in the portal fissure. Cases suitable for radical operation are extremely rare. For the successful *removal of hepatic tumours*, it is essential that they should be growing from an easily accessible part of the liver. The presence of a pedicle and the absence of adhesions to surrounding structures are favouring conditions. The pedicle may be controlled by an elastic ligature. The liver tissue is divided with the knife or Paquelin cautery, and the larger blood-vessels secured by ligatures. The wound in the liver is closed with catgut sutures; when this is not possible or does not arrest the bleeding it is packed with gauze, the end of which is brought out through the wound in the abdominal wall. The dressings may be stained with bile for a few days after the operation.

Acquired Deformities and Displacements of the Liver.—*The deformity of the liver due to tight-lacing* consists in a portion of the liver being segmented off from the rest of the organ, to which it remains connected by a bridge of variable thickness. The constricted lobe acquires a mobility independent of the organ as a whole, and appears to be separate from it; it also becomes thickened, and the lower margin becomes rounded off; hence it may closely simulate a floating kidney. For examination the patient should be placed on her left side; the liver lobe sinks towards the middle line, and the fingers may then pass between it and the kidney. The deformity is rarely attended

by definite symptoms. If such are present, and are not relieved by a supporting belt, the segmented portion may be fixed to the parietes by suture, or it may be removed.

Hepatoptosis—Prolapse of the Liver.—These terms are applied to a condition in which the attachments of the organ become relaxed, so that in the erect posture it descends to a lower level in the abdomen. Its shape is usually altered, and it is frequently rotated on one or more of its axes. If freely movable and capable of being replaced in its normal situation, it is described as a *wandering liver;* if fixed by adhesions in its new situation, it is said to be *dislocated.*

Prolapse of the liver is often associated with the descent of other abdominal organs, especially the right kidney, the stomach, and the bowels,—a condition to which the terms splanchnoptosis or Glénard's disease has been applied.

Clinical Features.—A tumour having the physical characters of the liver is found in the middle or lower part of the abdomen, and the normal liver dulness is replaced by resonance. There may be no subjective symptoms, and the condition is only discovered accidentally; or there may be complaint of pain and a feeling of weight in the right hypochondrium, aggravated by exertion, and relieved by lying down. In some cases the symptoms simulate those due to gall-stones. Neurotic or hysterical manifestations may be the most prominent features.

Treatment is conducted on lines similar to those employed in floating kidney. The abdominal walls may be supported, and the liver kept in place by a suitable belt or bandage. Symptoms of neurasthenia and nervous debility should be treated. When all other measures fail, the question of fixing the liver permanently in its normal position—*hepatopexy*—must be considered. The steps of this procedure consist in freeing the organ from adhesions which hold it in its abnormal position, replacing it, and anchoring it to the abdominal parietes by means of sutures. For at least a month after the operation the patient should remain recumbent, with the foot of the bed highly elevated, and an abdominal belt should be worn when she resumes the upright posture.

Surgical Treatment of Ascites due to Cirrhosis of the Liver.—In uncomplicated cases of ascites resulting from hepatic cirrhosis, where repeated tapping of the abdomen has failed to afford relief, the question of bringing about artificially a collateral circulation between the portal and systemic veins may be considered. This procedure, suggested by Talma of Utrecht, was first carried out successfully by Rutherford Morison.

The operation consists in opening the abdomen above the umbilicus, evacuating the fluid, and stitching the great omentum to the peritoneum of the anterior abdominal wall. A drainage-tube is passed into the pouch of Douglas through an opening above the pubes, in order to draw off the fluid and keep the peritoneal cavity dry, and so allow of close vascular adhesions forming between the omentum and the parietes. The omentum may be pushed between the peritoneum and the abdominal muscles to attain the same object.

Those who suffer from hepatic cirrhosis are necessarily bad subjects for operation, and the mortality of the above procedure is relatively high.

The Gall-Bladder and Bile-Ducts.

Surgical Anatomy.—The gall-bladder lies against the under surface of the right lobe of the liver. The fundus normally projects slightly beyond the free margin of the liver opposite the ninth or tenth costal cartilage, but varies considerably under pathological conditions. It may be displaced farther to the right, or it may be found high up beneath the liver and completely covered by it. From the fundus, the bladder gradually narrows until its neck ends in a sigmoid curve, the terminal portion of which turns downwards to join the cystic duct near the right end of the transverse fissure of the liver. The fundus and lower part of the bladder are invested by peritoneum, while above, it is connected to the under surface of the liver by connective tissue. Under normal conditions it is easily separated from the liver. The cystic duct passes backwards, downwards, and to the left for a distance of an inch and a half, and joins the hepatic duct at an acute angle to form the common bile-duct (Fig. 106). The hepatic duct is formed by the junction of a branch from each lobe of the liver, issuing at the transverse fissure, and it descends within the gastro-hepatic omentum to join the cystic duct as already described. The common bile-duct, about three inches in length, passes downwards and backwards in the gastro-hepatic omentum, lying in front of the portal vein, and having the hepatic artery on its left side. Along its course are several lymphatic glands which may become enlarged and indurated in inflammatory affections of the biliary passages, and may be mistaken for gall-stones when felt with the finger. If the finger be passed into the foramen of Winslow, the common duct may be felt in the gastro-hepatic omentum, where it forms the anterior boundary of this foramen. The duct then passes behind the first part of the duodenum, and is continued downwards on the inner and posterior wall of the second part in close relation to the head of the pancreas, and for a short distance in contact with the pancreatic duct. Along with this duct it perforates the muscular coat of the duodenum, and runs obliquely for three-quarters of an inch in the submucosa, and they open into the bowel by a common orifice—three inches beyond the pylorus. Just behind the orifice the duct is dilated to form the ampulla of Vater, in which a gall-stone may lodge. Although the cystic duct normally admits a No. 5 catheter, on account of the way in which its mucous membrane is thrown into folds the passage of a probe along the duct is

always difficult, and may be impossible. The common duct is slightly larger than the cystic duct, but at its entrance into the duodenum it is so narrow that it only admits a fine probe. The mucous membrane of the gall-bladder is abundantly furnished with mucous glands. The gall-bladder forms a reservoir of bile, but this function is apparently unimportant, as the gall-bladder may be excised without detriment to health. The gall-bladder is related to the hepatic flexure of the colon, and towards its neck with the first part of the duodenum, and occasionally with the pylorus. Under normal conditions the gall-bladder and bile-ducts are readily accessible to examination and to

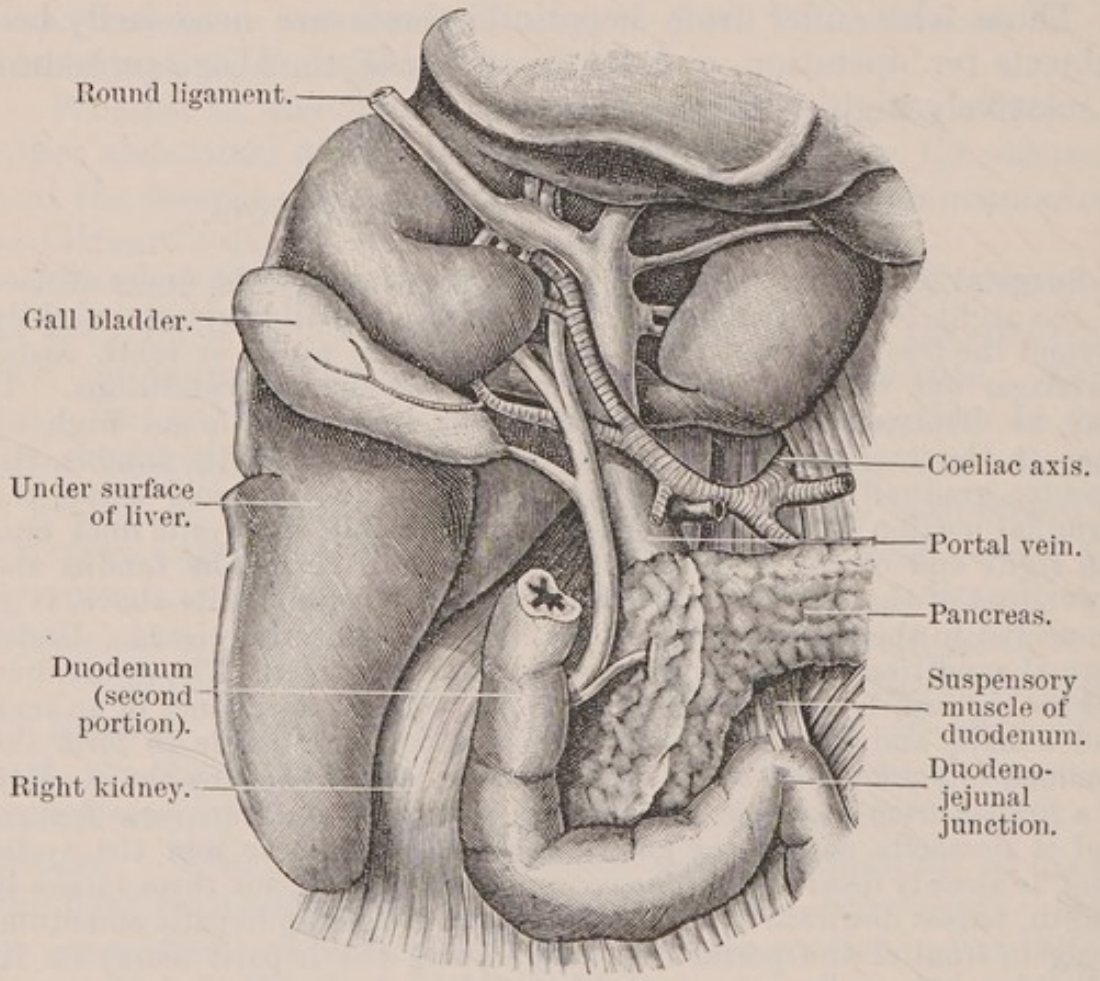

FIG. 106.—The connections of the Biliary and Pancreatic Ducts.

(After Zuckerkandl.)

operative interference, but where adhesions have resulted from inflammatory complications of gall-stones, it may be extremely difficult to discover and identify them.

Injuries.—These are not common, but may result from gun-shot or stab wounds, or from the passage of a heavy vehicle over the upper part of the abdomen. Apart from the shock, pain, and vomiting which attend all abdominal injuries, there are at first no distinctive features. There is no immediate risk to life, for, normal bile being sterile, septic peritonitis does not

occur. In the course of a few days the patient becomes jaundiced from absorption of the bile extravasated into the peritoneal cavity, and examination of the abdomen reveals the presence of free fluid in the cavity, sometimes in enormous quantity. The fluid consists of serum, bile, and blood, with flakes of fibrin, and there is a deposit of fibrin on the surface of the serous membrane. In penetrating wounds there is the usual risk of septic infection, and bile and blood may be discharged externally. The prognosis is on the whole more favourable than in similar lesions of other abdominal viscera. If the condition is diagnosed, the abdomen should be opened, the fluid evacuated, and the peritoneal cavity washed out. If the gall-bladder is merely torn, it may be stitched up, but if much damaged, it should be removed. The abdominal wound should be drained.

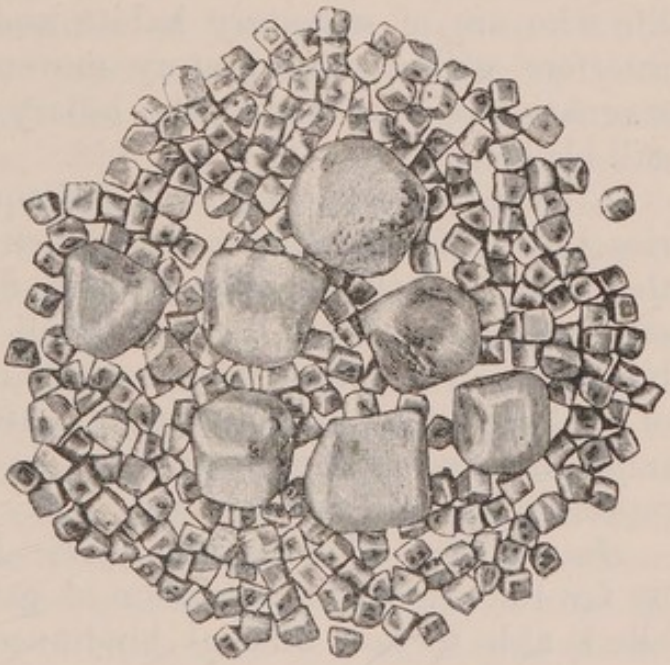

FIG. 107.—Gall-Stones removed from the Gall-Bladder of a Woman suffering from recurrent biliary colic.

Affections due to Gall-Stones — Cholelithiasis.—While gall-stones or biliary calculi are extremely frequent, they cause symptoms only in a minority of cases. Affections due to gall-stones are much more commonly met with in women than in men.

Characters and Formation of Gall-Stones.—Gall-stones present great variation in number and size. A solitary stone is usually shaped like an egg, a hazel-nut or a walnut; multiple stones are usually faceted (Fig. 107). They vary in colour from a whitish yellow to dark green or black, according to the proportion of bile pigment present. While usually firm and hard, they are sometimes so soft as to be readily crushed between the fingers. They are almost exclusively formed in the gall-bladder, very rarely in the hepatic ducts. Their chief constituent —cholesterin—is derived from the epithelium lining the gall-bladder and bile-ducts. Biliary calculi are believed to result from a catarrh of the mucous membrane following upon bacterial infection of the biliary passages, the infection being usually

derived from the duodenum. While normal bile is sterile, in the majority of cases of cholelithiasis micro-organisms are found either in the fluid contents of the gall-bladder or in the stones themselves. The colon bacillus is that most constantly present, but other organisms, such as typhoid bacilli, staphylococci, or streptococci, are occasionally met with. While bacterial infection is the essential cause, there are certain accessory conditions which predispose to the formation of gall-stones, for example, anything causing catarrh of the stomach and duodenum, such as indiscretions in diet or in the use of alcohol. Stagnation of the bile has long been regarded as a predisposing factor. Gall-stones are certainly much more frequent in women after middle life who are of sedentary habits, and whose clothing tends to interfere with the respiratory movements, and thus allows of stagnation of the bile in the biliary passages, especially in the gall-bladder.

Clinical Aspects.—Gall-stones frequently exist without giving rise to any inconvenience, and when they do cause symptoms these vary greatly in different cases, depending to a great extent on whether the stones are in the gall-bladder or in the common bile-duct. The symptoms are rarely due merely to the presence of gall-stones, but are largely attributable to superadded inflammatory changes occurring in the bile passages, and especially in the gall-bladder.

In the Gall-Bladder and Cystic Duct.—The gall-bladder is by far the commonest situation of gall-stones. So long as the bile is able to flow without hindrance in and out of the cystic duct, the stones do not cause any symptoms, and are said to be latent. When, however, a stone becomes displaced into the cystic duct, it excites contractions of the bladder, and these are signalised clinically by the occurrence of biliary colic. The stone may remain impacted in the cystic duct and block the passage, or it may fall back into the gall-bladder; in the latter case the bile is again able to flow, and the symptoms subside or disappear. A typical attack of *biliary or gall-stone colic* consists of severe pain beginning under the right costal margin, and radiating towards the epigastrium and umbilicus, and round the right side towards the shoulder. Its duration varies considerably. It is sometimes attended with collapse, and nearly always by retching and vomiting, thus simulating many other critical abdominal conditions. There is impaired respiratory movement and tenderness of the abdominal wall in the region of the gall-bladder. The seizure is not infrequently followed by slight and evanescent jaundice, which is due to an associated catarrh of the

bile-ducts interfering with the flow of bile into the intestine, and possibly also to a damming back of the bile as the result of the contractions of the gall-bladder and bile-ducts.

It occasionally happens that the stone passes from the cystic into the common duct, in which case the jaundice is a little more marked, and lasts till the stone is passed into the duodenum. Such a stone may be found in the motions if these are mixed with water and strained through a sieve. If the stone is faceted, it indicates that there are probably other stones in the gall-bladder. Every attack of biliary colic is probably attended with inflammation of the gall-bladder—cholecystitis.

Recurrent Biliary Colic.—The seizures of pain recur at irregular intervals over months or years—it may be over as long a period as twenty years—and besides causing great suffering, may interfere with the patient's occupation and with the ordinary duties of life. The onset of the seizures may be determined by the ingestion of food, by muscular exertion, by coughing or vomiting, or in some cases by the disturbance of the abdominal contents which attends parturition. Sometimes the attacks are due to a recrudescence of inflammation in the gall-bladder, and they may follow upon any condition likely to favour this. In the interval between the attacks the patient may enjoy normal health, or may suffer from a sensation of weight or dragging and other discomforts, and may have to restrict the diet and refrain from exertion. In such cases there may be only one stone in the gall-bladder, and around this the viscus is firmly contracted; or there may be a number of stones, of which one is occasionally passed by the natural channels, although this is exceptional. In cases where the cystic duct is blocked, the gall-bladder, whether distended with stones or with mucus, may be felt as an abdominal tumour. In cases where there is a history of recurrent biliary colic lasting for months or years, the bladder is usually small and contracted, and is so deeply placed beneath the liver that it is out of reach of the examining fingers. There is always, however, tenderness beneath the costal margin or between it and the umbilicus.

The affection is to be *diagnosed* from renal colic, and from painful affections in the vicinity of the pylorus.

Prognosis.—Apart from causing continued suffering and ill-health, gall-stones which are allowed to remain in the bladder may at any time become complicated by effects of pyogenic infection which are dangerous to life. Further, they may by their irritation eventually determine the growth of cancer.

Treatment.—This must always be directed, not only to the

stones, but also to the inflammatory condition of the gall-bladder which is associated with their presence. In recurrent biliary colic internal treatment may relieve the symptoms, but is rarely curative. The only certain means of getting rid of the offending gall-stones is to remove them by operation, and the advisability of having recourse to this measure must be considered in relation to each individual case.

The operation consists in opening and emptying the gall-bladder, and is known as *cholecystotomy*. In operations on cases of recurrent biliary colic evidence of chronic cholecystitis is nearly always found, and in cases of long standing the walls of the gall-bladder are usually thickened, the viscus itself is often contracted and hidden beneath the liver, and from extension of inflammation to the peritoneal coat omental and other adhesions are commonly present. The abdomen is opened by an incision parallel to the right costal margin, or by a vertical incision through the substance of the right rectus. The region of the gall-bladder is explored with the fingers. The gall-bladder, having been identified, is pulled forwards by means of two pairs of forceps, or a couple of stout sutures passed through its walls. The fundus is incised, any fluid which escapes is mopped up, and the stones are removed by means of a bent scoop, assisted by two fingers in the peritoneal cavity. It is essential that all the stones be removed, special attention being paid to the cystic duct, which may even require to be incised if a stone is very firmly impacted in it. If it is feasible, the edges of the wound in the bladder are stitched to the parietal peritoneum, and drainage provided for by means of a tube. Where this is impossible, a rubber tube is secured in the bladder by a purse-string suture around the opening in the viscus, and is brought out at the abdominal wound together with one or more strands of gauze. If the cystic duct is patent, the dressings in the course of a day or two become saturated with bile, and bile continues to discharge until, at the end of from three to five weeks, the wound closes.

In the operation known as *ideal cholecystotomy* the bladder is stitched up and returned within the belly. It is rarely indicated, because it does not allow of that drainage of the bladder which is so beneficial in the cholecystitis which accompanies gall-stones.

Excision of the gall-bladder—*cholecystectomy*—should be had recourse to when chronic cholecystitis is believed to be the cause of the patient's sufferings.

Inflammatory Affections.—While these affections are occa-

sionally met with as the result of typhoidal or influenzal infections, they are rarely attended by definite symptoms except when occurring in connection with gall-stones. In recent cases of *cholecystitis* the gall-bladder may be distended, though rarely to such an extent as to be palpable through the abdominal wall. As the inflammation subsides, the gall-bladder contracts and its walls become thickened, so that if the inflammation recur, the bladder is no longer capable of becoming distended, and it is usually found high up under cover of the liver. Under these conditions tenderness below the costal margin is the only symptom which points to the gall-bladder as the seat of the mischief. From extension of inflammation to the peritoneal coat adhesions are often present. In addition to gall-stones the gall-bladder usually contains thick, ropy mucus, but it may be so contracted that its cavity is practically obliterated. The symptoms are the same as in cholecystitis associated with gall-stones, except that the colic is less severe. Should medical measures fail to give relief, the gall-bladder should be opened and drained till the catarrh disappears. If the cavity of the bladder is almost obliterated, it may be wiser to perform cholecystectomy.

In **empyema or purulent catarrh** the gall-bladder contains pus mixed with mucus. This condition is almost always associated with gall-stones, and in practically every case the cystic duct is obstructed. The size of the gall-bladder depends on the antecedent conditions; it may be small, contracted, and buried beneath the liver as a result of previous attacks of cholecystitis, or it may be so enlarged as to be easily felt, its walls being thickened and adherent to the parietes or to neighbouring viscera.

The *clinical features* vary in different cases. There is often a history of biliary colic. There may be merely pain and tenderness beneath the costal margin, or there may be a palpable tumour projecting from under the right costal margin and moving with respiration. The swelling is pear-shaped, and is directed towards a point a little below the umbilicus in the middle line. The temperature is usually elevated two or three degrees, but fever may be absent. If the condition is left to itself, the pus may make its way to the surface and erupt on the abdominal wall, giving rise to a fistula which discharges pus and later mucus.

The *treatment* is conducted on the same lines as in simple cholecystitis. If there is a definite tumour the incision is made over it, and if the gall-bladder is found adherent to the parietal

peritoneum, it is opened within the adherent area. If the swelling is not adherent to the parietes, the peritoneal cavity must be packed off with gauze before the gall-bladder is opened. The contents of the bladder may be drawn off by an aspirator before the viscus is incised. Any gall-stones which may be present are removed. Drainage is then carried out as described under cholecystotomy, or the gall-bladder may be excised. The discharge does not contain bile unless the obstruction in the cystic duct is removed.

Phlegmonous or Acute Infective Cholecystitis.—This is a rare form and runs a very rapid course, usually terminating fatally in a few days. It may be regarded as analogous to the sloughing or gangrenous form of inflammation in the vermiform appendix. It is generally associated with gall-stones. The gravity of the condition seems to depend upon the fact that infective peritonitis is rapidly induced before there is time for the formation of localising adhesions. The gall-bladder is enlarged, and its walls rapidly become softened and readily give way. The contents are purulent, and have a foul odour.

The *clinical features* are those of acute peritonitis, originating in the right hypochondrium, with rigors, sweating and rapid failure of strength. Jaundice is sometimes present from catarrhal changes in the bile-ducts. Unless promptly treated by operation, the patient dies from general septic peritonitis.

Gall-Stone Obstruction of the Common Bile-Duct.—This is a comparatively rare affection, because the stones seldom leave the gall-bladder and cystic duct, and when they do they are usually driven onwards through the papilla into the duodenum. A distinction should be made between the *acute obstruction of the common duct* which results when it is first blocked by a stone, and the *chronic obstruction* due to a stone which has lodged for some time.

In the *acute form* the symptoms closely resemble those already described as resulting from a stone in the cystic duct; the colic, however, which is due to spasmodic contraction of the bile-duct, begins in the epigastrium, and radiates more to the left side of the abdomen, and through to the back between the shoulders. Tenderness, also, is most marked in the middle line between the xiphoid and the umbilicus. Jaundice is always present, but varies in intensity, according to whether the stone does or does not completely block the duct. If, as is frequently the case, the stone passes into the duodenum, the symptoms suddenly disappear. If searched for, it may be found in the motions; and if it is larger than a hazel nut, the suspicion is justified that

it has not passed by the natural channels, but by a fistulous communication between the bile-duct and the intestine. During the attack, morphin and atropin are injected hypodermically, and poultices are applied in the hope that the stone will be passed into the duodenum.

Chronic Obstruction of the Common Bile-Duct.—This is usually due to a single stone, but there may be a chain of stones. The mucous membrane of the duct is in a condition of catarrhal inflammation—*cholangitis*—and may be the seat of superficial ulcers, and the inflammatory products, like the bile, are prevented by the stone from draining into the duodenum. In a small proportion of cases the cholangitis assumes a suppurative character; the lesser ducts within the liver become dilated, inflamed, and filled with pus, and the liver may be greatly enlarged and studded throughout with small abscesses. The inflammation may extend to the tissues outside the duct, for example, to the peritoneum, leading to adhesions with the adjacent organs, or to the portal vein, giving rise to *pyelophlebitis*. The inflammatory processes in the common duct may lead to changes in the pancreas of the nature of chronic interstitial pancreatitis. If the duct become adherent to the intestine, the stone may ulcerate through into the bowel, and so bring about a natural cure, but if perforation takes place into the general peritoneal cavity, such a process of ulceration may terminate disastrously. In cases of chronic obstruction the gall-bladder is usually small and contracted from antecedent cholecystitis, and buried in adhesions resulting from pericholecystitis. If the obstruction is of long standing, the liver may become the seat of cirrhosis.

Clinical Features.—Pain is usually present, but rarely assumes the severe colicky type of recent obstruction. While jaundice is the rule, it varies in degree from time to time, and this variation is believed to depend on a ball-valve action of the stone, which floats to and fro in the distended duct, so that the bile is able at times to flow past the stone. When the stone is impacted in the ampulla of Vater, the jaundice is extreme and persistent. While there is jaundice the urine contains bile, and the motions are sometimes brown, sometimes clay-coloured. Intermittent fever is usual, with or without occasional rigors. When cholangitis is a prominent feature, the characteristic symptom is the occurrence at irregular intervals of ague-like seizures associated with remittent jaundice. Between the attacks the jaundice is much less pronounced. In suppurative cholangitis the temperature tends to pursue a hectic course, with rigors and

becomes distended with inspissated bile, and forms a movable tumour extending down to or below the level of the umbilicus. Stricture of the ducts can seldom be diagnosed with certainty, and is usually regarded as an instance of impacted calculus, the condition only being recognised after the abdomen is opened. In stricture of the cystic duct the best treatment is to remove the gall-bladder. In stricture of the common duct an opening may be made between the gall-bladder and the intestine (*cholecyst-enterostomy*), or between the dilated bile-duct above the stricture and the intestine (*choledoch-enterostomy*), or, failing either of these, the symptoms may be relieved by incision and drainage of the gall-bladder.

Abdominal Abscess.—Ulceration of the wall of the gall-bladder or bile-duct in relation to a stone may result in perforation into the peritoneal cavity, but if the site of perforation is shut off by adhesions from the general cavity, a localised abscess may form, corresponding to the circumscribed abscess so frequently met with as a result of appendicitis. The abscess is usually situated in the upper half of the abdomen on the right side. The origin of such an abscess from gall-stones is to be inferred from the antecedent history of biliary colic, and on operating is recognised by the character of the contents of the abscess, which are usually stained with bile pigment derived from the disintegration of the offending gall-stone. The immediate treatment consists in incision and drainage of the abscess, and at a subsequent operation the gall-bladder should be explored and emptied.

Acute Intestinal Obstruction.—When a large stone is extruded by a process of ulceration through the wall of the gall-bladder into the duodenum, it is liable to be grasped by the bowel, and cause symptoms of acute obstruction. The process of ulceration takes place slowly through adhesions between the gall-bladder and the intestine, and after the stone escapes into the bowel the fistulous track between them usually closes spontaneously. The process of ulceration, whereby the stone passes by other than the natural passages into the bowel, may be attended with symptoms so slight in character, that they escape notice, and the onset of intestinal obstruction is the first indication of the transference of the stone. On the other hand there may be a history of pain and tenderness in the region of the gall-bladder, irregular fever, evanescent jaundice, and hæmorrhage from the stomach or bowels.

Fistula.—Fistulæ not uncommonly result when cases of impacted gall-stone are left to nature. *Internal fistulæ* are

those in which the communication is between the gall-bladder and an adjacent hollow viscus. Those which communicate with the bowel do not give rise to any symptoms, and nearly always close spontaneously. When the communication is with the stomach, the bile is poured into that organ, and this may give rise to no unpleasant symptoms, or may be attended with persistent bilious vomiting. If operative interference is called for, it should take the form of cholecystotomy and drainage, to afford the fistula a chance of closing.

External fistulæ open on the skin surface, and usually owe their origin to the rupture of a localised abscess associated with an impacted stone. The skin orifice is usually near the umbilicus. When a fistula persists after an operation for gall-stones, it is usually because all the stones have not been removed, or because the edges of the gall-bladder have been stitched to the skin instead of to the parietal peritoneum.

Fistulæ may discharge mucus or bile. A *mucous fistula* occurs when the cystic duct is blocked; it is merely a source of inconvenience, and rarely calls for operative interference.

Biliary fistula, on the other hand, is a distressing condition because of the amount of bile discharged—this reaching to from thirty to fifty ounces in the twenty-four hours. The discharge takes place irregularly, but chiefly during the night and while the patient is fasting. An apparatus must be worn to collect the bile and prevent the clothing becoming soaked. Experience has shown that the loss of bile is not attended with any disturbance of digestion or nutrition. If the fistula proceeds from the gall-bladder and the common duct is patent, only a small amount of bile may escape externally, but if the common duct is obstructed, all the bile escapes. Biliary fistula is met with chiefly after operations in which the gall-bladder has been opened in cases of jaundice associated with obstruction of the common duct, the cause of which is not capable of being removed, such, for example, as cancer of the head of the pancreas or stricture of the common duct. The treatment depends upon the condition giving rise to the fistula. The most satisfactory cases are those in which there is a stone capable of being removed. In malignant disease, the fistula gives relief to the patient by diminishing or getting rid of the jaundice.

Distension of the Gall-Bladder.—The gall-bladder may become distended so as to form a palpable abdominal tumour. The most common cause of such distension is the impaction of a stone in the cystic duct, in which case the gall-bladder contains

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mucus or muco-pus. Less frequently the condition is due to obstruction of the common duct by cancer, impacted stone, adhesions or cicatricial stenosis, and under these circumstances the bladder contains bile. In either case gall-stones may or may not be present.

A distended gall-bladder forms a pear-shaped tumour directed downwards and forwards from the right costal margin towards a point in the middle line just below the umbilicus. In the absence of adhesions it is distinctly felt as a smooth, rounded, tense tumour, the lower extremity of which is freely movable from side to side, while the part towards the liver is more fixed and less defined. In a thin patient the swelling can usually be seen to move up and down with respiration. When there are adhesions, the tumour is less defined and more fixed; and when it is inflamed, it is painful and tender on pressure. In some cases the distended gall-bladder is best felt when the patient is in the genu-pectoral position. The co-existence of jaundice with a distended gall-bladder, and the absence of a history of pain such as is usually present in cases of gall-stones, suggest that the distension is due to malignant disease.

Diagnosis.—A distended gall-bladder is most apt to be mistaken for a floating kidney. Attention should be directed to the following points:—The gall-bladder tumour is continuous above with the liver; its lower extremity alone is movable, and that only from side to side, and it is always found in the same situation at every examination of the patient. It can be pushed backwards into the belly, but always rises again into its former position. The evidence derived from percussion is not reliable. In stout patients and in those with rigid abdominal muscles it may be necessary to examine the patient under a general anæsthetic.

A distended gall-bladder has also to be differentiated from malignant disease of the liver, from hydatids, and from tumours of the pylorus and colon.

The *treatment* depends on the cause of the condition. In the absence of malignant disease it is usual to perform cholecystotomy, and at the same time to remove the obstruction in the cystic or common duct. When the cystic duct is obliterated, it is best to excise the gall-bladder. When there is obstruction in the common duct which is not capable of being removed, cholecyst-enterostomy is the operation of choice.

Primary cancer of the gall-bladder and cystic duct is not uncommon, and is believed to result from the irritation of gall-stones. The walls of the bladder are uniformly infiltrated before

the disease is sufficiently marked to give rise to symptoms. Local extension to the glands of the lesser omentum and to the adjacent substance of the liver takes place, and in the later stages may spread to the pylorus, duodenum, colon, and peritoneum, all of which may become adherent to the gall-bladder. It is most common in women.

The *diagnosis* is always difficult in the early stages, and is often impossible before opening the abdomen. Usually there is a history of biliary colic extending over a lengthened period, followed by progressive deterioration of health, with a sense of discomfort, scarcely amounting to pain, in the region of the gall-bladder. When pain is prominent, it is usually due to an associated empyema of the gall-bladder. As the disease progresses, the pain becomes more marked and more diffuse. With the growth of the local tumour a hard, rounded mass is felt below the costal margin, which differs from a distended gall-bladder in being nodular on the surface, more fixed, and harder. Jaundice and ascites occur in the later stages.

Treatment.—Where the disease is limited to the gall-bladder, cholecystectomy and removal of the adjacent portion of liver and any associated glands afford a fair prospect of cure. Mayo Robson reports a number of successful cases. Where empyema is present, cholecystotomy and drainage give relief.[1]

Primary Cancer of the Hepatic and Common Bile-Ducts.—Malignant disease is most frequently situated at the junction of the hepatic ducts or at the ampulla of Vater. Practically in all cases cancer of the ducts is preceded by gall-stones, and as the symptoms of both diseases are usually present, the diagnosis is difficult. There is progressive jaundice with increase in the size of the liver, and, unless previously contracted and thickened, the gall-bladder becomes distended.

In order to relieve the symptoms cholecystotomy may be performed and a permanent biliary fistula established, or cholecyst-enterostomy may be done.

CHAPTER XXIX.

THE PANCREAS AND SPLEEN.

PANCREAS. — Surgical anatomy — Injuries : *Contusion ; Rupture ; Traumatic cysts*—Pancreatitis : *Varieties: Fat necrosis; Hæmorrhage* —Cysts : *Varieties ; Situations*—Malignant tumours—Pancreatic lithiasis. SPLEEN—Surgical anatomy—Injuries : *rupture, stabs, and gunshot wounds*—Abscess—Hydatids—Primary Sarcoma—Enlargements of the Spleen—Wandering and Dislocated Spleen.

THE PANCREAS.

Surgical Anatomy.—The pancreas is deeply placed at the back of the abdomen, the greater part of the gland lying in the epigastrium behind the stomach, while the tail and adjacent part of the body extend into the left hypochondrium. It is placed behind the peritoneum, the lesser sac of which lies directly in front of the gland. The head is embraced by the concavity of the duodenum, the neck crosses the middle line opposite the disc between the first and second lumbar vertebræ, and the tail touches the spleen. The termination of the main duct of the pancreas curves down to meet the common bile-duct, and the two pierce the wall of the duodenum obliquely and open by a common orifice (Fig. 106).

Functions.—Besides secreting the pancreatic juice, which is poured into the intestine and plays an important part in digestion, the pancreas is believed to furnish to the blood a secretion necessary for the transformation of carbohydrates. If this second secretion be absent as a result of destructive disease of the organ, one form of diabetes ensues. The presence of sugar in the urine, therefore, may afford confirmation of the existence of disease of the pancreas. The presence of fat in the stools is also an occasional accompaniment of pancreatic disease.

Injuries.—The pancreas may be *bruised* or *ruptured* against the vertebral column by violence applied to the abdominal wall, as for example when the body is crushed between buffers. It is impossible to diagnose such lesions at the time of their occurrence. In some cases death takes place from hæmorrhage, in others from fat necrosis. In less severe forms the lesser sac of the peritoneum becomes filled with blood-stained greenish fluid, constituting the so-called traumatic variety of pancreatic cyst.

Wounds implicating the pancreas are usually rapidly fatal from hæmorrhage or from accompanying injuries to adjacent viscera.

Diseases—Pancreatitis.—The essential cause of the various forms of pancreatitis is bacterial infection, and the usual channel of infection is by way of the duct, the organisms passing from the duodenum or from the common bile-duct. Less frequently the infection is derived from the blood—as in pyæmia; or by direct extension from neighbouring organs—as in ulcer of the stomach. Catarrh of the stomach and duodenum, and gall-stones, are common antecedents of pancreatitis.

Fat Necrosis.—In diseases of the pancreas, and especially in acute pancreatitis, a condition known as fat necrosis is met with. It consists in the splitting up of the fat molecules into fatty acids and glycerine: the glycerine, being soluble, is absorbed; the fatty acids are deposited in a crystalline form within the fat cells and cause their necrosis. In time the fatty acids unite with calcium to form lime salts. The change is met with chiefly in the fat around the pancreas, in the mesentery and omentum, and in the retro-peritoneal tissue, and is recognised by the minute opaque white areas scattered through the fat. It appears to be due to the penetration of the fat-splitting ferment of the pancreatic juice into living adipose tissue in the presence of conditions interfering with the passage of the secretion into the intestine.

Pancreatic disease may also be attended with *hæmorrhage*, which takes place into the pancreas itself, or is widely diffused throughout the surrounding tissues. When the hæmorrhage is a marked feature, the condition is known as hæmorrhagic pancreatitis.

The onset of *acute pancreatitis* is sudden and is attended with pain in the epigastrium, nausea and vomiting, which may lead to the condition being mistaken for intestinal obstruction. There is marked tenderness above the umbilicus, and the upper part of the abdomen becomes distended; the temperature may be raised, and the patient be delirious. Death usually supervenes in from two to five days. In the less acute forms the patient survives for a longer period, and *suppuration* usually occurs. The pus may be diffuse throughout the gland, or may be collected into one or more localised abscesses of variable size. The symptoms are similar to those observed in the acute form, but are less severe. Constipation gives place to diarrhœa, the stools are fœtid, and may contain pus and blood. The temperature is very irregular. The patient loses flesh and strength, and presents the features of chronic septic poisoning. The formation

of an abscess may be attended with the appearance of a swelling which comes to the surface above or below the stomach, or the pus may burrow into either loin, forming a perirenal abscess, or pass upwards under the diaphragm and form a subphrenic abscess, or it may follow the psoas muscle into the iliac region. Sometimes the abscess bursts into the stomach or bowel, or into the peritoneal cavity. Death is the usual termination in cases left to nature, but recovery may take place after a tedious and prolonged illness.

Treatment.—In acute cases little can be done to arrest the progress of the disease. Stimulants and nourishment are given by the rectum, and morphin may be required to relieve the pain. Distension of the bowels is to be relieved by calomel followed by salol and bismuth. If a tender and painful swelling is recognised in the situation of the pancreas, operative interference is indicated. A median incision above the umbilicus will enable the operator to palpate the pancreas and locate any collection of pus. The pus is evacuated either through the abdominal wound, or through a posterior incision in the right or left costo-vertebral angle. If a definite abscess form and approach the surface either in front or in the loin, it should be incised and drained.

Chronic Pancreatitis.—This is commoner than either of the preceding forms of inflammation of the pancreas. It usually results from the extension of inflammation associated with the presence of stones in the common bile-duct or in the pancreatic duct, or, apart from lithiasis, from chronic catarrh in the duodenum. The inflammation involves chiefly the head of the pancreas, which becomes enlarged and indurated, and may come to press injuriously on the common duct or on the duodenum.

The *clinical features* may be complicated by those of co-existing affections of the neighbouring structures. The patient loses flesh and strength, and complains of pain in the epigastrium and passing back between the shoulders. The pain may recur in the form of seizures resembling biliary colic, sometimes attended with shivering. If there is tenderness, it is located in the middle line above the umbilicus. The stools are offensive, bulky, soft greasy and pale, and may contain unaltered fat and muscle fibre. If the head of the pancreas is much enlarged it may be felt as a tumour, especially under anæsthesia. It may press unduly on the bile-duct and cause jaundice, at first slight, but later becoming more pronounced and persistent. The gall-bladder commonly becomes distended, and may be felt projecting below the costal margin, and the liver may become enlarged as in other forms of obstructive jaundice. Vomiting and other

symptoms of pyloric obstruction may result from pressure on the duodenum by the enlarged head of the gland.

The condition is to be diagnosed from stone in the common bile-duct, and from cancer of the head of the pancreas. In many cases an exploratory operation is necessary, and even then it may be difficult to differentiate between pancreatitis and cancer. The exploratory incision is made vertically through the right rectus.

The *treatment* consists in getting rid of any condition which may be regarded as causing the pancreatitis. In many cases relief of the symptoms or a complete cure may follow the removal of gall-stones or simple drainage of the gall-bladder. If there are calculi in the pancreatic duct, they must be removed by incising either the duodenum or the substance of the pancreas itself. In cases which are deeply jaundiced there is considerable risk of the operation being followed by hæmorrhage.

Cysts of the Pancreas.—The term pancreatic cyst has been applied not only to a true cyst of the pancreas, but also to an accumulation of fluid in the lesser sac of the peritoneum (Jordan Lloyd). From the fact that a true pancreatic cyst may project into and distend the lesser sac, or may rupture into it, it may be difficult or impossible to differentiate clinically between these conditions.

True pancreatic cysts originate in different ways, and are usually the result of some antecedent disease of the gland. The view formerly held that they are of the nature of retention cysts due to blocking of the main duct has little to support it, although it cannot altogether be excluded. Cyst formation in the pancreas may follow upon inflammatory changes, especially such as involve the smaller ducts, upon necrosis of the glandular tissue, hæmorrhage into its substance, or changes brought about by injury. A small number are of the nature of new growths, chiefly cyst-adenomata.

The true cysts may be uni- or multilocular, and are usually located in the head or in the tail of the gland. They may attain the size of a child's head, but are seldom larger. The contents are usually turbid, often mixed with blood, and occasionally they exhibit certain of the digestive properties of pancreatic juice.

False cysts or accumulations in the lesser sac of the peritoneum usually follow upon a blow or crush of the upper part of the abdomen. They may develop within a few days of the injury, or not until after the lapse of some months. They sometimes

attain a large size, holding several pints of a brown or greenish, turbid, watery fluid, of alkaline reaction, containing albumin and globulin and pigments derived from the blood. In exceptional cases the cystic cavity is of the nature of a localised tuberculous peritonitis.

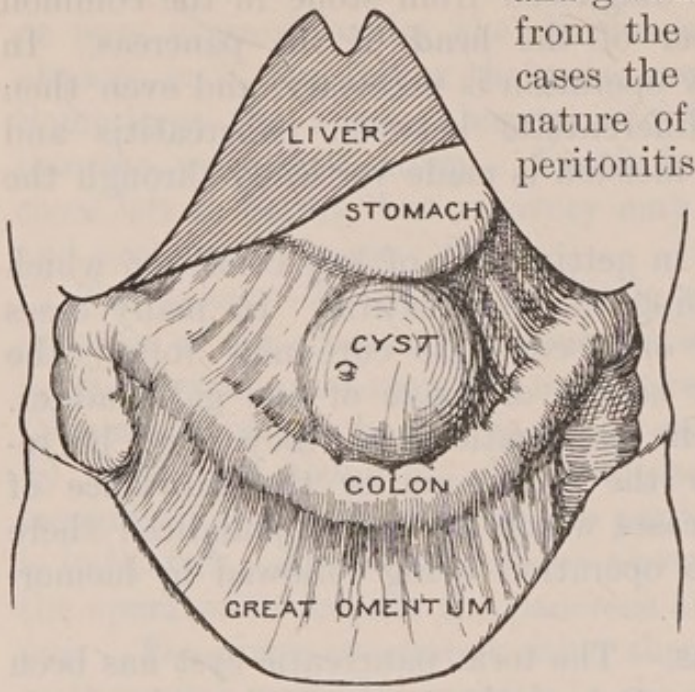


FIG. 108.—Pancreatic Cyst between Stomach and Colon, and covered in front by Gastro-colic Omentum.

Clinical Features.—A pancreatic cyst forms a rounded or oval, fluctuating, and slightly movable abdominal tumour, situated at or above the level of the umbilicus, chiefly to the left of the middle line. The signs on percussion vary with its relation to adjacent organs, but there is usually a central area of dulness surrounded by a tympanitic zone. The cyst may extend forwards, and come into relation with the abdominal wall in one or other of three situations (Körte): (1) It most commonly projects directly forward, filling the lesser sac of the peritoneum, displacing the stomach upwards against the liver, and the transverse colon downwards (Fig. 108). (2) The cyst may project forward between the stomach and liver, pushing in front of it the lesser or gastro-hepatic omentum (Fig. 109). (3) The cyst may insinuate itself between the layers of the transverse mesocolon, so that the colon comes to lie directly in front of the cyst (Fig. 110), or above or below it.

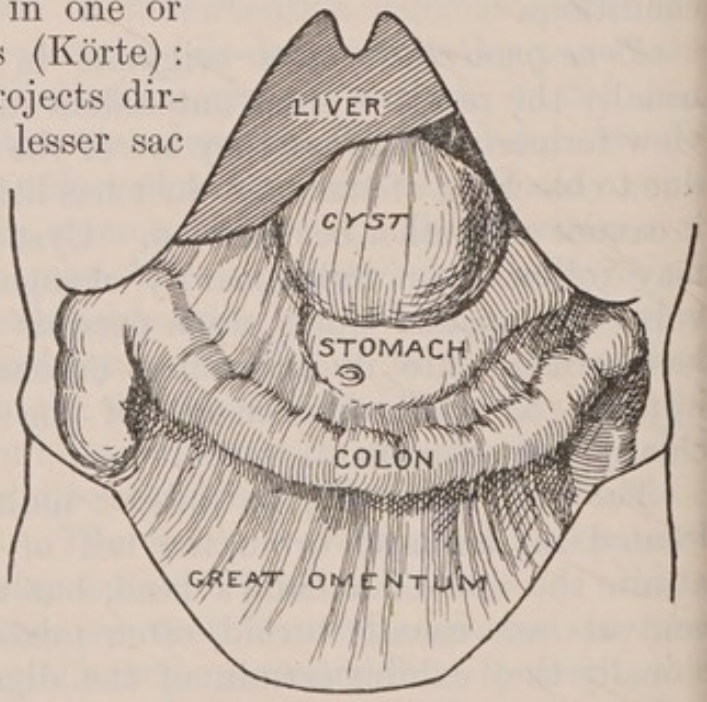


FIG. 109.—Pancreatic Cyst between Liver and Stomach, and covered in front by Gastro-hepatic Omentum.

If the stomach be distended with gas, its relations to the cyst are readily demonstrated.

The symptoms of which the patient complains are mainly the result of pressure. Thus, for example, he may suffer from indigestion and vomiting from pressure on the stomach; breathlessness from pressure on the diaphragm; disturbance of the bowels from pressure on the colon. A cyst in the head of the pancreas may press on the common bile-duct and cause jaundice. In true cysts of the pancreas, loss of flesh is usually a prominent symptom.

Puncture of the cyst for diagnostic purposes should never be practised, as it involves the risk of extravasation or of puncturing the stomach or colon. If the diagnosis is doubtful, an exploratory operation should be performed.

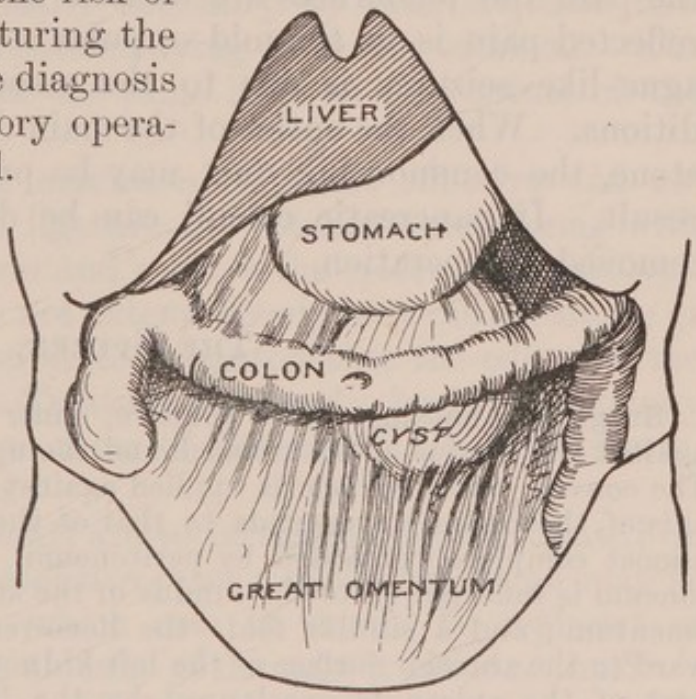


FIG. 110.—Pancreatic Cyst below the Stomach and crossed by Transverse Colon.

Treatment. — The treatment consists in opening and draining the cyst, and this is usually done through an incision in the anterior abdominal wall. After the abdomen has been opened, the relations of the cyst to the stomach and colon are first investigated. When the cyst projects between the stomach and the colon—the commonest situation—its wall is exposed by dividing the gastro-colic omentum. Before the cyst is opened its wall should be sutured to the parietal peritoneum, but if it is so thin as to make this impossible, the peritoneal cavity must be packed off with gauze. The cyst is drained by means of a rubber tube, for which gauze may be substituted when the discharge has diminished in quantity. The surrounding skin should be smeared with ointment in case the fluid draining away from the cyst should possess digestive properties. The filling up of the cavity and the closing of the sinus may take from four to six weeks, or may be delayed considerably longer.

Cysts arising from the tail of the pancreas usually project in the left lumbar region, and may be opened and drained from the loin, behind the peritoneum.

A pancreatic cyst, if pedunculated or definitely circumscribed, may be excised instead of being drained.

Malignant tumours of the pancreas, of which the commonest is cancer of the head of the organ, are only of interest from the point of view of diagnosis, as their removal by operation is very rarely practicable. In certain cases of cancer of the head of the pancreas it may be possible to relieve the jaundice and associated symptoms by cholecystotomy or by cholecyst-enterostomy.

Stones in the ducts of the pancreas are met with chiefly in association with inflammation and suppuration in the gland. They may give rise to symptoms resembling biliary colic, but the pain and tenderness are located in the middle line, and the reflected pain is in the mid-scapular region. The occurrence of ague-like seizures is due to the associated inflammatory conditions. When the outlet of the main duct is blocked by a large stone, the common bile-duct may be pressed upon and jaundice result. If pancreatic calculi can be diagnosed, they should be removed by operation.

The Spleen.

Surgical Anatomy.—The concave, inner surface of the spleen lies against the fundus of the stomach and the upper pole of the left kidney. The convex, outer surface is applied against the diaphragm. The long axis of the organ corresponds to that of the tenth rib. The spleen is almost completely invested by peritoneum. From the hilum the peritoneum is reflected on to the fundus of the stomach as the gastro-splenic omentum; and a similar fold—the lieno-renal ligament—passes backward to the anterior surface of the left kidney. The upper and posterior part of the spleen is overlapped by the left lung, from which it is separated by the peritoneum, the diaphragm and the pleura. The splenic vessels run in the gastro-splenic omentum, which may therefore be regarded as the pedicle of the organ. The splenic artery near its termination breaks up into a series of from five to seven branches, which enter the organ separately, and require to be ligatured individually in removing the organ.

The **functions** of the spleen are imperfectly known, but experience has shown that, while removal of the organ may be followed by temporary enlargement of the lymphatic glands and by anæmia, the general health of the patient is not seriously or permanently impaired.

Injuries.—*Rupture* of the spleen may result from a blow or crush implicating the left hypochondriac region. It may be complicated by fracture of the overlying ribs, or by injury to one or other of the adjacent viscera.

The rupture varies in extent and depth, and is most frequently situated in the region of the hilum, thus implicating the larger blood-vessels. It is well known that the enlarged malarial

spleen may be ruptured by comparatively slight violence, as for example by a stroke with a stick or a blow with the fist.

There is nothing characteristic in the clinical features. In addition to shock and pain the chief symptoms are those which result from hæmorrhage into the abdominal cavity. When the larger vessels are torn, the hæmorrhage may be so abundant as to prove rapidly fatal. If the patient survive, the blood which is poured into the peritoneal cavity gives rise to dulness in the flanks, more especially on the left side. As the blood accumulates the extent of the dulness may be observed to increase.

While it is possible that a rupture of the spleen may be recovered from, it is usually necessary to interfere, and that promptly, to prevent the patient dying from loss of blood. The operation is carried out in the same lines as for rupture of the liver.

Where the rupture is extensive, the most effective and expeditious procedure is to ligature the splenic vessels along with the gastro-splenic omentum and remove the spleen (*splenectomy*). When the laceration does not extend deeply into the substance of the spleen, it may be possible to bring together the edges of the rupture by deep sutures. Treatment must also be directed to any associated injuries, such as those of the ribs or adjacent viscera, and to the bloodless state.

Stabs and gunshot wounds are to be diagnosed and treated on general principles. In extensive open wounds the organ may be protruded externally, in which case it should be replaced or removed according to the amount of damage it has sustained.

Abscess of the Spleen.—Splenic abscess is most frequently met with in relation to endocarditis, pyæmia and typhoid, and is usually the result of septic embolism. More commonly an abscess is formed in the connective tissue around the spleen, as a result of localised suppurative peritonitis, for example, that associated with a perforated gastric ulcer. The abscess may point and burst externally, or it may rupture into the pleural or peritoneal cavity, into the retro-peritoneal tissue, or into one of the adjacent organs. It may give rise to phlebitis in the portal vein, and to secondary abscesses in the liver.

The *clinical features* are rarely characteristic even when the abscess reaches the surface of the organ, or ruptures as above mentioned. The spleen is found to be enlarged and tender, and the patient has rigors, sweats, and loses flesh rapidly. Peritoneal friction may be heard over the swelling, and there may be signs of pleurisy at the base of the left lung.

If the general condition of the patient permit, the area of

suppuration may be opened and drained either by the abdominal or the trans-pleural route.

Hydatid cysts of the spleen are rarely diagnosed during life. The connection of the cyst with the spleen may be recognised by percussion and palpation. They are treated on the same lines as hydatid cysts in other organs.

Primary sarcoma is the commonest form of new growth in the spleen, and is difficult to diagnose without an exploratory operation. The treatment consists in performing splenectomy.

Enlargements of the Spleen.—The splenic enlargement which results from *malaria* may necessitate surgical interference if medical treatment has been found of no avail. The removal of the spleen, while usually followed by great improvement in the general health, does not guarantee the patient against fresh malarial infection. The operation of splenectomy for malarial spleen is attended with a considerable mortality, and should therefore be restricted to carefully selected cases.

Simple hypertrophy of the spleen (splenomegaly) may similarly be subjected to operative interference when medical treatment has failed to bring about relief.

Operative interference is contra-indicated in the splenic enlargement which accompanies *leucocythæmia*. In nearly all the cases in which removal of the organ has been attempted the patient has died of hæmorrhage.

Actinomycosis and **primary tuberculosis** occasionally call for surgical interference.

Wandering or Floating Spleen.—This term is applied to a condition in which the pedicle of the spleen is abnormally long, and the organ is unduly movable, so that it may leave its normal position, and pass to some other part of the abdomen. If it become fixed in its abnormal position by adhesions, it is spoken of as a *dislocated spleen*. Beyond the fact that it is almost exclusively met with in spare women who have borne children, the origin of the condition has as yet received no adequate explanation. In well-marked cases a floating spleen is capable of such wide excursions, that it may be found in any part of the abdomen or pelvis, hence it readily gives rise to errors in diagnosis. When it is displaced, it may drag or press on adjacent viscera, and give rise to symptoms referable to these. By pulling on the stomach, for example, it may kink the duodenum, by becoming adherent to the bowel it may interfere with peristalsis and threaten obstruction, or by pressing upon the uterus it may displace that organ. The pedicle of a wandering spleen may become twisted, and give rise to symptoms

which resemble those of a twisted ovarian cyst. The clinical features tend to merge into those of peritonitis, with or without the symptoms of intestinal obstruction. Partial torsion results in engorgement; complete torsion may terminate fatally, or, if the patient survive, the organ may undergo atrophy.

In diagnosis attention should be directed to the absence of the normal splenic dulness, and to the shape of the prolapsed organ, which is usually freely movable and appears to float on the intestines.

Treatment.—The condition may be palliated by rest in bed, and by the use of a belt when the patient is going about. If the organ is healthy and capable of being replaced in its normal position, it may be fixed there by the operation of *splenopexy*. The method of Rydygier consists in making a new pocket for the organ by incising the parietal peritoneum in the line of the tenth rib, separating the peritoneum from the parietes, and implanting the spleen in the bed thus made for it. If the organ be diseased it is better to remove it. In the majority of the cases in which the pedicle undergoes torsion, the organ should be removed, as this is easier of execution and secures a more rapid recovery than splenopexy.

CHAPTER XXX.

PELVIC SWELLINGS IN THE FEMALE.

Ovarian tumours—Pyosalpinx—Extra-uterine pregnancy—Uterine fibroids.

Ovarian Tumours.—Of the many varieties of tumour met with in relation to the ovary and parovarium, it is only necessary here to refer to the cystic forms, of which the most important are multilocular cyst-adenomata, dermoid and parovarian cysts and papillary tumours. Solid tumours, such as fibromata, myomata, sarcomata and carcinomata, are comparatively rare.

The **multilocular cyst-adenoma** may be taken as the classical form of ovarian cyst. It is due to a proliferation of the glandular elements of the ovary; the glands become distended with secretion and form numerous cysts of different sizes. The condition is usually unilateral, but it may affect both ovaries. In its most common form the tumour is made up of one large cyst, with numerous smaller cysts in relation to it. On section the mass of small cysts presents a honeycomb appearance, delicate fibrous partitions intervening between the different cavities. These partitions tend to give way, so that the cysts come to communicate with one another, and several of the small cysts may open into the large one.

The cysts contain a greyish-yellow fluid, which is peculiarly tenacious, and consists chiefly of the secretion of the cylindrical epithelium lining the cavities. As a result of hæmorrhage into the cyst the fluid is sometimes reddish-brown in colour.

The tumour, which varies in size from an orange to a mass displacing the viscera and filling the abdomen, is rounded or oval in outline, with irregular projections on its surface due to the prominence of individual cysts. The wall is composed of condensed fibrous tissue invested with peritoneum, and is for the most part smooth and glistening. It sometimes presents

calcified areas, and sometimes dark brown patches which indicate the position of previous hæmorrhages. Adhesions to the omentum, the adjacent viscera, and the anterior abdominal wall, frequently follow attacks of localised peritonitis. The pedicle of the tumour is formed by the ovarian ligament, the Fallopian tube and the broad ligament, and as a result of traction it may be stretched till it is several inches in length.

Clinical Features.—The amount of discomfort caused by these tumours varies widely, and bears no constant ratio to the size of the growth. In many cases the patient complains of a heavy, dragging sensation in the abdomen. Attacks of severe pain lasting for a few days usually indicate localised peritonitis. The rate of growth varies, but as a rule is comparatively rapid, and sooner or later pressure symptoms develop. The tumour may, for example, press on or displace the rectum or bladder and interfere with their functions. Sometimes one or both ureters are pressed upon, and dilatation of the ureters or hydronephrosis results. In about 50 per cent. of cases Kelly found albuminuria with tube casts. Indigestion, vomiting and flatulent distension may result from pressure on the stomach and bowels. When the tumour reaches great dimensions it exerts pressure on the diaphragm, producing respiratory and circulatory disturbances. Œdema of the legs, abdomen, and vulva is sometimes present, and the superficial abdominal veins may be greatly distended. Menstruation is disturbed only in about half the cases. The general health suffers and the patient emaciates.

Dermoid cysts are due to inclusion of a portion of the ectoderm in the development of the ovary. During the period of maximum functional activity of the gland, this ectodermic remnant begins to grow erratically, and forms a cyst which contains such tissues as skin, with its accessories, hair, sebaceous and sweat glands, teeth, rudimentary mammary glands, and a thick pultaceous material composed of the inspissated secretion of the sebaceous glands and the debris of the epithelium with which the cyst is lined. In many respects these cysts resemble cyst-adenomata, but they are usually unilocular, occur at an earlier age, grow more slowly, and show a greater tendency to attacks of localised peritonitis.

Parovarian cysts originate in the tubular remnants of the embryonic Wolffian body, in the layers of the mesosalpinx between the Fallopian tube and the ovary. They grow slowly and form smooth, thin-walled, unilocular cysts, over which the Fallopian tube is stretched out in a characteristic way. The

ovary is adherent to the under or anterior aspect of the cyst. The cavity is lined with cylindrical epithelium, which is often ciliated, and contains a clear, limpid fluid.

Papillary tumours form a group intermediate between the cystic and the solid growths met with in the ovary. They are due to a proliferation of the germinal epithelium on the surface of the ovary, or in the Graafian follicles, or in both situations. The tumour may be made up of solid masses of warty or cauliflower-like excrescences springing from the surface of the ovary, and spreading on the adjacent peritoneal surfaces till it fills up and blocks the pelvis; or it may take the form of a large unilocular cyst with papillary growths projecting from its surface as well as into its interior. The rupture of such a cyst is followed by dissemination of the disease over the peritoneum. These growths show a marked tendency to spread by continuity, and are thus locally malignant, but metastasis to distant parts is rare. They are most common in women nearing the menopause, and are sometimes bilateral; they usually grow slowly, and are frequently associated with ascites.

Complications. — Ovarian tumours are liable to various accidents which modify their clinical course. *Inflammation and suppuration*, for example, may occur in the cyst, infection taking place from the Fallopian tube, the vermiform appendix, or the intestine. The swelling becomes painful and tender, general symptoms of septic absorption supervene, and if pus form, it may escape either into the general peritoneal cavity or into an adjacent viscus. If the patient recover, it results in the formation of widespread adhesions.

Rotation of the pedicle is also liable to occur, interfering with the venous return from the tumour, and causing hæmorrhage into the cyst, or even gangrene. This accident is attended with sudden onset of acute pain, pallor and faintness; the tumour rapidly increases in size and becomes tense and tender. The condition closely simulates the onset of acute intestinal obstruction, symptoms of peritonitis ensue, and if suppuration or gangrene occur, the condition is liable to prove fatal unless promptly treated by operation.

Rupture of the cyst may result from gradual thinning of the walls, or from injury or violent contraction of the abdominal walls. In rare cases the rupture implicates a large blood-vessel, leading to serious hæmorrhage. More frequently the fluid merely escapes into the peritoneal cavity and is excreted by the kidneys, the patient for a few days passing large quantities of urine. The cyst collapses and forms adhesions to

adjacent structures. In some cases rupture of the cyst is followed by generalised peritonitis.

Diagnosis.—The presence of a tumour springing from the pelvis can usually be recognised by palpation and percussion of the abdomen, combined with vaginal and rectal examination. In fat women, however, errors are liable to occur, flatulent distension, masses of subcutaneous fat, and so-called "phantom tumours" being mistaken for new growths. On the other hand, in such patients the existence of a small abdominal or pelvic tumour is liable to be overlooked. In doubtful cases the patient should be examined under an anæsthetic.

In the differential diagnosis of ovarian from other forms of abdominal tumour, it is to be borne in mind that an ovarian tumour is dull on percussion over its convexity, that the dulness extends into the pelvis and is surrounded by a zone of resonance above and at the sides. On rectal examination the pedicle of the tumour, formed by the broad ligament, can usually be recognised; and on vaginal examination the tumour is found to have replaced the ovary on the side from which it springs. An ovarian tumour can usually be distinguished from an over-distended bladder by the use of the catheter; from retro-peritoneal tumours by the fact that the rectum lies in front of these growths; from a large cystic kidney by noting the tympanitic area due to the presence of the colon in front of the kidney; and from ascites by the fact that the intestines are floated up on the fluid, and the highest part of the swelling is therefore tympanitic, while the flanks are dull, and the dull area changes with the position of the patient. The ascites which accompanies papillary tumours may be readily mistaken for the ascites resulting from tuberculous disease of the peritoneum. Encysted areas of tuberculous peritonitis are very liable to be mistaken for ovarian cysts. Among the other conditions to be borne in mind may be mentioned mesenteric and pancreatic cysts, tumours of the omentum, mesentery or spleen. The pregnant uterus has also been mistaken for an ovarian tumour. Small ovarian tumours may simulate uterine or tubal growths, or fæcal masses in the rectum.

The chief points of difference between the various forms of ovarian cyst have already been mentioned.

Treatment—Ovariotomy.—On account of the difficulty of distinguishing clinically between benign and malignant growths, it is advisable to remove all ovarian tumours as soon as they are diagnosed, provided the general condition of the patient warrants the operation. Early extirpation is further

indicated in view of the risks attending suppuration, torsion of the pedicle, or rupture, with dissemination of the disease in the case of papillary and malignant growths. Delay also involves the risk of adhesions forming as a result of peritonitis, and so adding to the difficulties of the operation. Neither childhood nor advanced age contra-indicates operation.

The patient is placed in the Trendelenburg position, with the pelvis moderately raised, and a mesial incision is made between the umbilicus and the pubes, exposing the tumour. Care must be taken not to wound the bladder, which may be displaced upwards by the tumour. The cyst is brought to the surface and evacuated by incising it, or with the aid of a suitable trocar and cannula, in either case care being taken that none of the contents enter the peritoneal cavity. As the cyst collapses it is drawn out of the wound until the pedicle lies between the edges of the incision. Any adhesions which may be present must be carefully separated, particularly those between the cyst and the intestines. After the cyst has been isolated, the pedicle is secured by transfixing it with a stout silk ligature, the ovarian and the terminal branches of the uterine vessels, which are usually grouped at its borders, being subsequently enclosed in separate ligatures. All blood and fluid having been removed from the pelvis, the abdomen is closed without drainage.

The results of the operation are usually most satisfactory, but in the papillary tumours, if the growths have extended to the surrounding peritoneum, the condition is very liable to recur, and finally cause death.

Pyosalpinx.—The term pyosalpinx is applied to an accumulation of pus in a Fallopian tube. The affection begins as an inflammation of the lining membrane of the tube—*salpingitis*—which is almost invariably the result of a direct spread of some infective process from the lower parts of the genital tract. In the majority of cases the infective agent is the gonococcus, the tubal inflammation being secondary to an ordinary vaginal gonorrhœa. Less frequently streptococci and staphylococci are present, having spread to the tube from a septic focus in the uterus following abortion, parturition, or some operation on the uterus. When the abscess is in close proximity to the rectum, the bacillus coli may be present. The pus is found to be sterile in abscesses of long standing, the organisms having died out. In a proportion of cases as yet uncertain, the condition is tuberculous.

As a result of the inflammatory process in the tube, the

abdominal ostium becomes occluded, either by peritoneal adhesions gluing together the fimbriæ, or by swelling of the mucous membrane blocking the lumen. The uterine opening of the tube also becomes occluded, and the tube is thus converted into a closed cavity. As the tube distends with inflammatory products, it separates the two layers of the broad ligament and burrows between them, and at the same time it becomes elongated and tortuous, and its walls are thinned out. The inflammatory process spreads to the enveloping peritoneum, and adhesions form binding the distended tube to the ovary, the uterus, the vaginal vault, the rectum, and sometimes to the intestine. The condition may be unilateral, but as a rule both tubes are affected, although to an unequal extent.

The *clinical features* vary widely according to the stage of the disease and the nature of the infection. An *acute stage* is sometimes met with, particularly in cases due to puerperal infection, and in those of gonorrhœal origin. The onset is marked by a chill or rigor, the temperature rises to 102°-103° F., the pulse is small and rapid, and the patient extremely ill. She lies on her back with the legs drawn up, the abdominal muscles are rigid, and there is marked tenderness over the lower part of the abdomen—symptoms indicative of peritonitis. These acute symptoms may last for a week or ten days and then gradually subside, giving place to those which characterise the more chronic type of the disease.

In the majority of cases, and particularly in those of gonorrhœal and tuberculous origin, the disease runs a *chronic* course from the outset. The patient complains of recurrent attacks of pain in the region of the ovaries, pain in the back, and a bearing-down sensation in the pelvis. There may be a slight rise of temperature (99°-101° F.) in the evening, and a corresponding acceleration of the pulse. There is pain on micturition and defecation, and the bowels are markedly constipated. Menstruation is profuse, and there may be a persistent vaginal discharge. These attacks last for a week or ten days, and recur at irregular intervals. In the intervals between the attacks the patient is comparatively well, but she never quite regains the ground lost during the attack, and gradually becomes a confirmed invalid. Her attitude and gait are characteristic; she inclines the body forward, moves very cautiously, and to avoid jarring the pelvic viscera in making any sudden movement she presses firmly on the abdomen with her hands. On vaginal examination the uterus is found to be less movable than normal, and to the sides of the uterus irregular, elongated swellings, which are extremely

tender to the touch, can be palpated. Even when the abscess is of considerable size fluctuation cannot always be detected through the vagina, indeed "a stony hardness of the vaginal vault is one of the most characteristic signs of the presence of pus" (Kelly). In some cases the swelling is best felt by the rectum. In course of time the swelling may become palpable in the abdomen or in the flank, in which case it is liable to be mistaken for an ovarian cyst, a tumour, or the matting of parts around a diseased vermiform appendix.

If left to nature the abscess may burst into the vagina or rectum, and if the opening is large and the drainage free, a speedy cure may thus take place. If, however, the opening is small the symptoms are only temporarily relieved, as all the pus does not escape, and the cavity soon fills again. In other cases the abscess bursts into the bladder, or on to the surface through the abdominal wall, leaving sinuses which show no tendency to heal, and from which pus continues to escape. If the pus bursts into the peritoneal cavity, the symptoms are not unlike those which follow the rupture of an appendicular abscess into the peritoneum. Occasionally the pus becomes encysted and may eventually disappear.

The *diagnosis* is seldom difficult if a clear history of gonorrhœa or of septic endometritis is forthcoming. The conditions from which pyosalpinx is to be differentiated are pelvic cellulitis, appendicular abscess burrowing into the broad ligament, tumours and cysts of the broad ligament, ovarian cysts and uterine fibroids. Retroflexion of the uterus, a kidney displaced into the pelvis, a tumour of the sacrum or innominate bone, cancer of the cæcum, and fæcal accumulation in the rectum, have all been mistaken for pyosalpinx.

Treatment.—In the vast majority of cases operative interference is indicated, but this should not be undertaken during the acute stage or during an exacerbation. To relieve the patient's suffering, rest in bed, purgation, the application of ice-bags over the abdomen, and, if necessary, the administration of opium, are called for.

Vaginal incision and drainage is recommended by Kelly for selected cases in which there is a single, well-defined abscess, and in which fluctuation can be detected through the vault of the vagina. The abscess is evacuated, the cavity irrigated and packed with iodoform gauze. This operation has the advantage of conserving the ovaries and tubes, but is attended with the risk of injuring the rectum, the ureter, or the uterine artery, and of opening into the general peritoneal cavity.

In most cases it is necessary to remove the affected tubes and ovaries through a mesial abdominal incision—*salpingo-oöphorectomy*. After opening the abdomen all adhesions, and particularly adhesions to the intestine, are carefully separated, till the pyosalpinx is clearly defined. The uterine and ovarian arteries are secured, the tube clamped, and the mass removed. Care is taken to avoid infecting the cavity with pus from the tube, and, if this should occur, a drain must be introduced through the vagina, after which the abdominal wound is closed.

Extra-uterine or Ectopic Gestation.—When an impregnated ovum becomes implanted elsewhere than in the cavity of the uterus, the condition is spoken of as an extra-uterine or ectopic gestation. It is only necessary here to refer to that variety in which the site of implantation is the Fallopian tube—*tubal gestation*—as the abdominal and ovarian forms are extremely rare. The middle or ampullary portion of the tube is the most common situation in which the ovum becomes arrested.

The ovum becomes embedded in the mucous membrane, and at first the walls of the tube are swollen, vascular, and turgid, but after the sixth week they gradually become thinned out until the affected portion of the tube is represented by a delicate, transparent sac. The fœtal membranes develop at the site of implantation in very much the same way as in an ordinary intra-uterine pregnancy. The uterus increases in size, and a thick, soft, decidual membrane develops in its interior. The ovum is liable to various accidents during the process of its development. If situated towards the fimbriated end of the tube, it may be extruded into the peritoneal cavity—*tubal abortion*—and this may be accompanied by severe and even fatal hæmorrhage. The ovum may die in the tube and persist as a *tubal mole*, which consists of a small amniotic cavity, in which the fœtus lies surrounded by blood-clot enclosed within the chorion. The presence of a tubal mole is associated with repeated slight hæmorrhages into the peritoneal cavity, leading to the formation of an intra-peritoneal hæmatocele. Another common accident is *rupture* of the gestation sac. This may take place directly into the peritoneal cavity and lead to rapidly fatal hæmorrhage, or into the connective tissue between the layers of the broad ligament, in which case the hæmorrhage is less copious.

The fœtus usually perishes when rupture occurs, and it may escape into the peritoneal cavity or remain embedded in the substance of the broad ligament. It may ultimately be absorbed and give rise to no trouble, or it may become mummified. In

some cases the soft tissues are impregnated with lime salts (*lithopœdion*), in others they become converted into adipocere (*lipopœdion*). The introduction of septic infection leads to the formation of a pelvic abscess, which may burst externally, or into any of the adjacent viscera—bladder, rectum, uterus or vagina, the discharge containing fragments of fœtal bones.

Less frequently the fœtus survives, and the pregnancy goes on, sometimes even to full term.

Clinical Features.—Ectopic gestation may occur at any time during the childbearing period, and it is usually the case that several years have elapsed since the last normal pregnancy. There is often a history of previous tubal disease, although this is usually quiescent, and the patient is apparently in good health at the time the abnormal impregnation occurs. In some cases the ordinary general symptoms of pregnancy are present, but in others the patient is not aware that she is pregnant. It often happens that the patient misses one or two periods, and then suffers from irregular, intermittent hæmorrhages, the blood being thick, dark in colour, and moderate in amount, although floodings are not uncommon (Halliday Croom). The uterine decidual membrane may be thrown off during the early weeks, either in the form of a complete cast of the interior of the uterus or in shreds mixed with the blood. This, when present, is a valuable diagnostic sign. The external genitalia present the ordinary signs of pregnancy; the uterus is enlarged to about the size of a two months' pregnancy, soft and globular, and appears to be displaced slightly to one side by a tense, elastic, and fluctuating swelling in which pulsating vessels may be felt. This swelling, which is the gestation sac, is ovoid, and is situated to one side of the uterus, and as it increases in size becomes fixed and very tender on palpation, and the seat of a dull, aching pain. If the pregnancy continues to develop, the abdomen increases in size, the fœtus can be distinctly felt through the parietes, and fœtal heart sounds may be heard.

Before the occurrence of rupture the *differential diagnosis* is often extremely difficult, and in considering it the following conditions are to be borne in mind:—Pregnancy in the rudimentary horn of a bicornate uterus, retroflexion or anteflexion of a gravid uterus, ovarian or fibroid tumours complicating ordinary intra-uterine pregnancy, pyosalpinx, and tumours of the broad ligament. An ordinary intra-uterine pregnancy or abortion may be mistaken for an ectopic gestation, and it is to be remembered that the two conditions may coexist. The diagnosis is often aided by the administration of a general

anæsthetic, but in some cases can only be cleared up by an exploratory operation. Microscopic examination of the decidual membrane cast off from the uterus is also of value in diagnosis.

Rupture of the Sac.—Primary rupture may take place at any period, and is seldom delayed beyond the twelfth week. It may be determined by some slight injury, by jumping from a chair, or by straining, for example in vomiting, or it may occur while the patient is at rest in bed. The severity of the symptoms varies according as the rupture is intra- or extra-peritoneal.

In *intra-peritoneal* rupture the patient is suddenly seized with intense abdominal pain, and a feeling as if "something had given way." She becomes collapsed and extremely pale, with low temperature, a small, rapid, feeble and thready pulse, sighing respiration, and other signs of the bloodless state. There is usually some bleeding from the vagina, the blood being mixed with shreds of decidua. On vaginal examination the pouch of Douglas is found distended with fluid, and on withdrawal the examining fingers are stained with blood. The abdomen may become distended with blood. Vomiting and diarrhœa are not uncommon. The condition may prove fatal in a few hours, or the hæmorrhage may cease and the patient slowly rally.

In *extra-peritoneal rupture* also the onset is sudden and attended with severe pain, but the patient is less collapsed and soon rallies, and the evidence of profuse hæmorrhage is not so prominent.

Rupture of an ectopic gestation is to be *diagnosed from* perforation of a gastric or duodenal ulcer, perforation of the intestine or of the vermiform appendix, acute intestinal obstruction, rupture of an ovarian cyst or torsion of its pedicle, rupture of a pyosalpinx, and renal or biliary colic. Reliance is placed chiefly on the history of pregnancy, the occurrence of bleeding from the vagina, microscopic examination of the decidual shreds, and the extreme pallor and other signs of internal hæmorrhage.

Treatment.—If the condition be diagnosed before rupture take place, the abdomen should be opened and the affected tube removed. The majority of cases only come under observation when rupture has occurred and the patient's life is in danger from hæmorrhage. In such cases laparotomy should be performed at once, the clots cleared out, the ovarian and uterine arteries secured with forceps, and the tube removed entire. The peritoneal cavity is then cleared of clots and the abdomen closed without drainage. The bloodless state is counteracted by infusion of saline fluid into the veins or peritoneal cavity, and by large saline enemata. If the patient is not seen until some time

after rupture has occurred, and if there is reason to believe that the rupture has taken place extra-peritoneally, and that the fœtus is dead, operative interference may be delayed in the hope that absorption will take place; but if the fœtus be alive, and the gestation sac increasing in size, it is safer to operate and remove the tube. The chief difficulty in the operation lies in controlling the bleeding from the placenta. Operation is also indicated for the removal of a disintegrating or decomposing fœtus to avoid the risks of septic infection and of abscesses and fistulæ. The practice of allowing the gestation to go on to term in the hope of saving the life of the fœtus is attended with too grave risk to the mother to be justifiable, particularly as the fœtus is usually imperfectly developed and is seldom viable.

Uterine Fibroids.—This clinical term is applied to myomata and fibro-myomata of the uterus—tumours which are composed of irregularly interlacing bundles of muscular and fibrous connective tissue. They usually spring from the body of the uterus, less frequently from the cervix, as well-defined globular, or irregularly nodular growths, which are more or less completely encapsulated. They vary in size from a hazel-nut to a mass which occupies the greater part of the abdominal cavity. There may only be one tumour, but as a rule there are several.

The tumour may develop under the uterine mucosa—*the submucous variety*—projecting towards the cavity of the uterus, and showing a marked tendency to become pedunculated. The uterine cavity is enlarged, and the pedicle may become so attenuated that the fibroid is separated and cast off through the vagina. The *interstitial or intra-mural* variety forms in the muscular wall of the uterus, and is surrounded by normal muscular fibres. These tumours, having a more copious blood-supply, grow more rapidly than the other forms, and in their growth they tend to project towards the abdominal cavity rather than towards the uterus. The *subserous or subperitoneal varieties* grow from the outer surface of the uterus under the peritoneal covering of the organ, and extend towards the abdominal cavity. They tend to become pedunculated, and to form adhesions with the abdominal walls, the omentum and the intestine. All varieties are liable to undergo degenerative changes, such as calcification or myxomatous degeneration, and to become the seat of cyst formation.

Clinical Features.—In many cases these tumours attain a considerable size without giving rise to any symptoms which lead the patient to seek advice. While fibro-myomata are probably present in early life, they seldom cause discomfort till

some years after menstruation has been established, and in the majority of cases the symptoms only become prominent when the patient is between thirty-five and forty-five years of age. The earliest symptoms are painful menstruation and an excessive flow during the period. As the tumour increases the menstrual periods become prolonged, lasting for a week or ten days, and they recur every three or even every two weeks. The patient, therefore, loses a great quantity of blood and becomes markedly anæmic. She loses strength, and suffers from dyspnœa and palpitation. Pain is not a prominent symptom, and in many cases is entirely absent. It is most marked when there are numerous small nodules in the substance of the uterine wall, in which case the patient may complain of grinding, bearing-down sensations, like severe and prolonged labour pains. Women who suffer from fibroids are usually sterile, or are subject to repeated early miscarriages.

Pressure symptoms seldom ensue until the tumour blocks the pelvis. Then there is frequency and pain on micturition from the bladder being pushed up behind the pubes towards the abdominal cavity. The ureters also are pressed upon and become dilated, and hydronephrosis not infrequently ensues. Pressure on the rectum seldom results in obstruction of the bowels, but may cause difficulty in defecation and tenesmus, and sometimes leads to the development of hæmorrhoids. Pain may result from pressure on the pelvic nerves.

Fibroid tumours grow very slowly, in some cases taking ten, fifteen, or even twenty years to reach the size of a uterus at term. They usually cease to grow after the menopause, and either remain quiescent or undergo atrophy. They may be associated with disease in the ovaries and tubes, or with uterine cancer, and they may complicate pregnancy and parturition.

The *diagnosis* is made by a consideration of the history, and by local examination under anæsthesia. The uterus is pulled down by means of tenaculum forceps grasping the cervix, and examined both by the vagina and through the rectum. When the tumour reaches into the abdominal cavity the abdomen has an irregular, nodulated appearance, and on palpation the growth feels densely hard and unyielding. The relation of the tumour to the uterine wall can usually be recognised on vaginal examination. Except when the tumour is subserous and pedunculated, the cavity of the uterus is enlarged, as may be detected by passing a sound.

Treatment.—The majority of uterine fibroids, as they give rise to little discomfort and involve no risk to the life of the

patient, do not call for any treatment. Palliative measures are indicated in cases attended with hæmorrhage and pressure symptoms, particularly when the tumour is rapidly increasing in size. Of these may be mentioned packing the uterus or vagina, the use of pessaries to raise the tumour into the abdomen, curettage of the uterus, and the application of the galvanic electric current, by introducing the positive pole into the uterine cavity, and placing the negative pole over the anterior abdominal wall. The electrical treatment not only stops the bleeding, but may also arrest the growth of the tumour, or even bring about a permanent diminution in its size.

Operative treatment is called for when the tumour is impacted in the pelvis and is causing pressure on the bladder, ureters, and rectum, or when it has passed into the abdomen and has reached the size of a seven months' pregnancy, and is still growing. Profuse hæmorrhage, pain, and interference with the general health, so that the patient becomes a chronic invalid, may also necessitate operation.

The ideal operation is *myomectomy*, which consists in enucleating the tumour without sacrificing any material portion of the uterine wall. This procedure is specially indicated in young women, and in isolated and pedunculated growths of the subserous and interstitial varieties, which can be shelled out of their bed in the uterus. The tumour should be freely exposed through a mesial abdominal incision, isolated, and, if possible, brought out through the wound. An incision is made round the pedicle or into the capsule, and the growth is enucleated. Hæmorrhage must be completely controlled by securing the main vessels of supply, and by clamping and ligaturing all the bleeding points. The gap in the uterus is accurately closed by a series of interrupted sutures so as to leave the organ functionally intact. Several growths may be removed from the uterus in this way. The abdominal wound is closed without drainage.

When it is impossible to enucleate the tumours, the body of the uterus may be removed with the growths, the cervix being preserved—*hystero-myomectomy* or *supra-vaginal hysterectomy*. In some cases it is necessary to remove the entire uterus and its appendages—*pan-hysterectomy*.

When fibroids complicate pregnancy and give rise to urgent symptoms, it may be necessary to terminate the pregnancy by inducing abortion, and to perform myomectomy or hysterectomy according to circumstances.

CHAPTER XXXI.

THE RECTUM AND ANUS.

Surgical anatomy—Examination—Congenital malformations—Injuries—Foreign bodies—Inflammatory affections and their results: *Proctitis; Periproctitis; Ulceration; Cicatricial stricture; Abscesses in the region of the rectum and anus; Fistula-in-ano*—Anal fissure—Hæmorrhoids or piles—Tumours: *Rectal polypi; Carcinoma; Sarcoma*—Epithelioma of anus—Prolapse of rectum.

Surgical Anatomy.—The lower portion of the intestinal tract is, for practical purposes, best divided into the *anal canal* which extends upwards from the margin of the true skin for a distance of about an inch, and the *rectum proper*, extending from the upper limit of the anal canal to the level at which the peritoneum is reflected from the bowel, which is usually opposite the body of the third sacral vertebra. Above this level the bowel constitutes the pelvic colon or sigmoid flexure.

The *anal canal* is lined by a smooth, glossy, muco-cutaneous membrane, which at its lower part has the characters of stratified squamous epithelium, and as it ascends is gradually transformed into the columnar epithelium characteristic of the rectum proper. The skin around the anal orifice is slightly pigmented, and is thrown into folds by the contraction of the external sphincter muscle. It contains numerous sudoriparous and sebaceous glands, and hair follicles. About half-way up the canal may sometimes be seen a pale ring running round the bowel—the *white line of Hilton*—which indicates the junction of the external and internal sphincters. The *external sphincter*, composed of voluntary striped muscle, surrounds the anal canal, and is attached posteriorly to the coccyx and anteriorly to the central point of the perineum. It is supplied by nerve filaments derived from several of the sacral nerves.

The *rectum proper* is lined by a thick, vascular mucous membrane, covered by columnar epithelium, and containing numerous tubular mucin-secreting glands and follicles of lymphoid tissue. In the upper part of the rectum the mucous membrane is arranged in horizontal folds. Three or four of these are specially well marked, and as they contain a quantity of submucous and muscular tissue at their bases they constitute distinct and permanent valves—the *valves of Houston*. In the lower part of the bowel the folds are longitudinal, and form the *columns of Morgagni*. Between these columns stretch a series of short semilunar valves, behind which are small crypts—the *valves and crypts*

of Morgagni. This line of valves marks the junction of the anal canal and rectum proper.

The submucous connective tissue is specially loose and lax, and in it run the blood-vessels, lymphatics and nerves of the bowel. The muscular coat is made up of an outer series of longitudinal fibres, the downward continuation of the three longitudinal bands of the colon, and an inner series of circular fibres. At the lower end of the rectum, for about an inch of its length, the circular fibres are larger and more numerous, and constitute the *internal sphincter*, the terminal fibres of which interlace with those of the levator ani and external sphincter muscles. The nerve-supply of the muscular tunic, including the internal sphincter, is derived from the pelvic sympathetic plexuses.

The rectum is supplied with blood by the superior, middle, and inferior hæmorrhoidal, and the middle sacral arteries.

The veins begin as small, bulbous sacs, situated along the line of the ano-rectal junction, just above the crypts of Morgagni. The blood entering the superior hæmorrhoidal veins is carried through the inferior mesenteric vein into the portal circulation, while that collected by the middle and inferior hæmorrhoid and middle sacral veins enters the general circulation through the vena cava.

The lymphatics of the upper part of the bowel enter the sacral and lumbar glands, while those from the anal and perianal region pass to the inguinal glands.

Examination.—A digital and visual examination should be made in all cases in which the patient complains of symptoms referable to the rectum, and the lower bowel should first be washed out by an enema. The examination may be carried out with the patient lying on the left side, in the lithotomy position, or in the knee-elbow position. In many cases it is most satisfactorily made with the patient bending over the back of a chair. Rubber gloves or a finger-stall should be worn, and the finger lubricated with sterilised vaseline from a collapsible tube. In making the examination the surgeon should note in turn the state of parts around the anus, the condition of the sphincters, the mucous membrane of the anal canal and of the rectum beyond the internal sphincter, with special reference to ulceration, swelling, and the presence of sinuses. The condition of the prostate, seminal vesicles, and coccyx should also be noted. On the finger being withdrawn the presence of discharge or blood should be observed. It is possible in this way to explore the lower four inches of the bowel. When a higher examination is called for a general anæsthetic should be administered and the sphincters gently stretched.

To inspect the anal canal an ordinary rectal speculum is employed, but when it is necessary to investigate the rectum and pelvic colon, a speculum such as that devised by Kelly, is necessary.

CONGENITAL MALFORMATIONS.—**Development.**—The rectum and anal canal are developed independently of one another. The *rectum* is developed from the posterior part of the hind gut, partly from the hypoblast, and partly from the mesoblast. In the early embryo the hind gut is represented by a *cul-de-sac*, named the *cloaca*, into which open the genito-urinary ducts. During the second month of intra-uterine life the cloaca becomes divided into two compartments by the growth of a

longitudinal septum. In relation to the anterior of these compartments the genito-urinary organs are developed, while the posterior compartment becomes the rectum. Abnormal communications between the rectum and the genito-urinary passage are due to imperfect development of the longitudinal septum.

Coincidently with the formation of the rectum the *anal canal* undergoes development by the formation in the epiblast of a depression, named the *proctodæum*, which lies in line with the rectum, but is separated from it by a strand of epiblast known as the *cloacal membrane*. About the third month this membrane disappears, and the continuity of the rectum and anal canal is thereby established.

Malformations.—These vary according to the period at which the development is arrested, and according to the layers of the blastoderm involved. Interference with the evolution of the hypoblastic and mesoblastic layers leads to malformations of the rectum proper, while errors in the development of the epiblast cause deformities of the anal canal. In certain varieties the escape of meconium and fæces is completely obstructed, in others the obstruction is only partial, and in some the outlet of the alimentary canal, although patent, is abnormally placed.

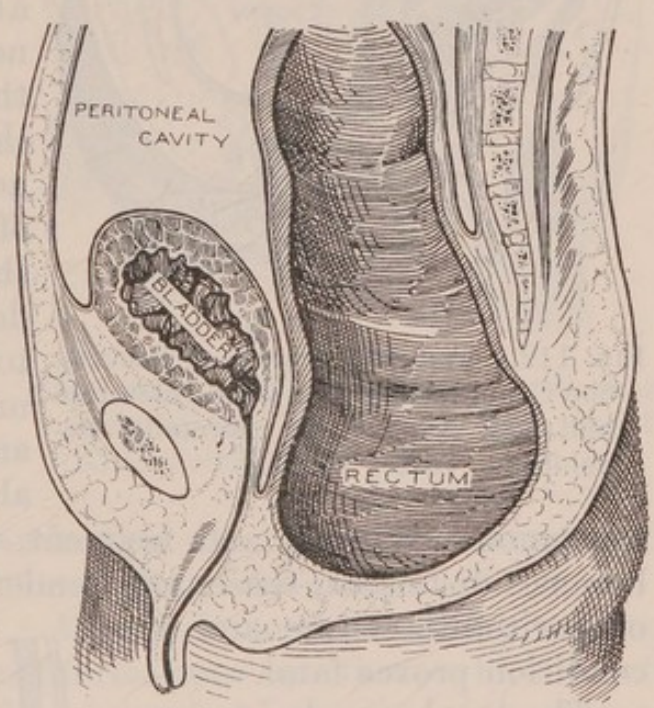


FIG. 111.—Complete absence of the Anus. (After Tuttle.) [1]

The most common deformity of the *anus* is its occlusion by a thin fibrous membrane which stretches from the centre of the perineum to the region of the coccyx. The meconium bulges this membrane, and forms a dark bluish swelling in the perineum which becomes tense when the infant cries or strains. In some cases the membrane is incomplete, and meconium escapes at its edges. As a rule the canal is perfectly developed in other respects.

Occasionally the anal canal is completely absent (Fig. 111), the position of the orifice being indicated merely by a slight pigmentation and corrugation of the integument. More

[1] *Diseases of the Anus, Rectum, and Pelvic Colon*, by Jas. P. Tuttle, 1903.

frequently the canal is represented by a depression which admits the tip of the little finger, but does not communicate with the rectum (Fig. 113). In some cases the cavities are only separated by a thin septum—the remains of the cloacal membrane; in others, a bridge of fibrous tissue, varying in thickness, intervenes between them.

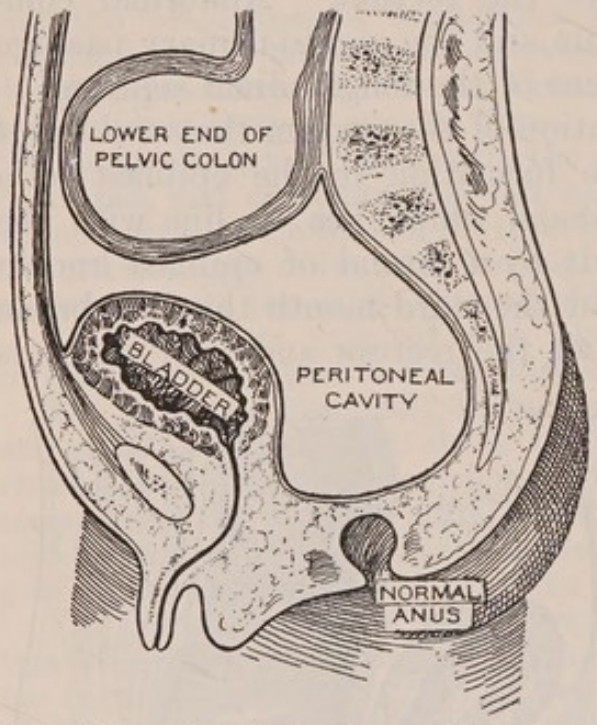


FIG. 112.—Complete absence of Rectum, the Colon ending in a large Dilatation and the Anus being normally developed. (After Tuttle.)

Clinical Features.—These abnormalities may escape notice until the attention of the nurse is drawn to the fact that the infant's bowels have not moved. An examination of the perineum then reveals the deformity. If nothing is done to permit the meconium to escape the infant becomes unduly restless and irritable, and appears to suffer from abdominal pain. There is continuous straining and frequent vomiting, and the abdomen becomes distended, tense, and tender. If unrelieved, symptoms of peritonitis ensue and the condition proves fatal.

The anal canal is sometimes abnormally narrow, although otherwise fully developed. The meconium and fluid fæces escape quite freely, but constipation results if the motions become solid.

The *rectum proper* may be entirely absent, the colon ending in the pelvis as a *cul-de-sac* (Fig. 112). In some cases the anal canal is also absent; in others it is fully developed, but is separated from the colon by a thick bridge of fibrous tissue.

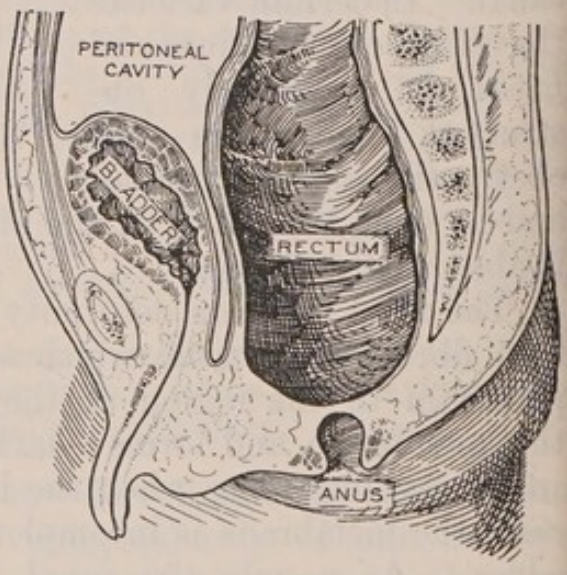


FIG. 113.—Imperforate Anus due to persistence of the Cloacal Membrane. (After Tuttle.)

A more common deformity is that in which the rectum, although fully formed, does not communicate with the anal canal

(Fig. 113). The two cavities are separated by a septum which varies in thickness, in some cases being so thin that the meconium causes it to bulge towards the anal canal, in others being so thick that even on bi-manual palpation no trace of the rectal tube can be detected. In a certain number of cases a pouch of peritoneum intervenes between the two cavities —an arrangement which renders it dangerous to attempt to establish a communication by means of a trocar and cannula.

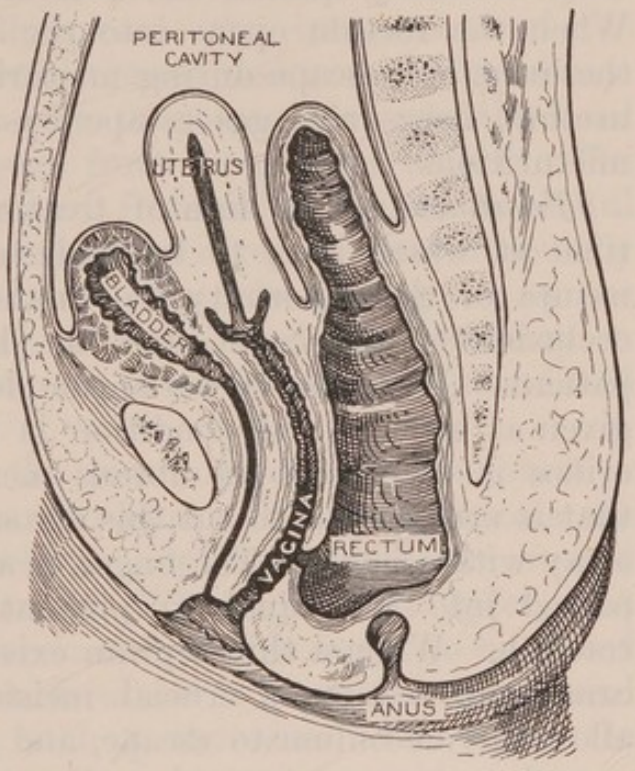


FIG. 114.—Imperforate Anus; the Rectum opens into the Vagina close to its outlet. (After Tuttle.)

In these conditions, the meconium being retained, the *clinical features* are those of intestinal obstruction. It is seldom possible to determine by physical examination the precise nature and extent of the deformity.

FIG. 115.—Congenital Communication between the Rectum and Urethra in a Male Infant, causing death at the age of six months.

More common than the preceding malformations are those which result from imperfect formation of the septum which divides the primitive cloaca into its genito-urinary and rectal compartments. The rectum may then communicate with the vagina, the bladder, or the urethra. In such cases the anal canal may be fully developed, or it also may present abnormalities. In about 50 per cent. of all cases the abnormal opening is into the vagina close to its outlet (Fig. 114), and the condition may give rise to so little disturbance that it is for long entirely overlooked, and only attracts attention in adult life. Communications with the bladder and urethra are less common, and occur usually in males (Fig. 115). The opening is generally so small

as only to admit of the passage of meconium and fluid fæces. Obstructive symptoms ensue if the stools become semi-solid. When the rectum opens into the bladder, the fæces mix with the urine and escape during micturition; when it opens into the urethra, fæces and gas escape by the meatus independently of micturition.

Treatment.—The line of treatment to be adopted, and the time at which it is to be undertaken, vary according to the nature of the deformity, to whether or not there is complete occlusion of the canal, and to the general condition of the patient. When the bowel is completely occluded, relief must be given as soon as the condition is recognised. When the anal orifice is occluded by a fibrous membrane stretched over it, all that is necessary is to cut this across at its two ends and snip it away with scissors. The finger or a bougie should frequently be passed into the canal to prevent subsequent cicatricial contraction. When a thin septum exists at the junction of the anal canal and rectum, a crucial incision should be made in it to allow the meconium to escape, and graduated bougies should be passed to prevent stenosis. Congenital stenosis is treated by the systematic use of bougies.

In cases where the anal canal and rectum are undeveloped, or are separated from one another by a considerable thickness of fibrous tissue, and in cases where the rectum opens into the bladder and urethra, it is necessary to establish an exit for the meconium either by exposing the end of the alimentary canal by dissection through the perineum, or by performing inguinal colotomy. The infant is placed in the lithotomy position, and an incision made in the middle line of the perineum with its centre in the normal position of the anus, in order to conserve such sphincteric fibres as may be present. The dissection is carried down, keeping close to the hollow of the sacrum, until the lower end of the gut is exposed; the latter may be made more evident by pressing down from above. In weakly patients colotomy should be performed. If the patient survive, an attempt may be made later to expose the rectum from the perineum.

When the rectum opens into the vagina there is seldom any urgency in operating, as the intestinal contents escape freely. When the child is old enough to stand the operation, the fistulous opening should be closed by dissecting down between the vagina and the rectum, separating them from one another, and closing the opening in each after the method employed in other fistulæ.

Injuries.—The most common cause of injury of the rectum

is the patient falling on a pointed, projecting object, such as a spike or broom-stick, or a fragment of broken glass or china. The impinging object usually pierces the integument of the perineum, lacerates the perirectal tissues, and wounds the rectum from without. Less frequently it passes through the anal orifice and perforates the bowel from its mucous aspect. The rectal wall may also be damaged from within by the unskilful use of a rectal bougie or an enema syringe, or from without by a urethral instrument which has made a false passage, or by the surgeon's knife during the operation of perineal lithotomy or prostatectomy. It has been ruptured by objects introduced intentionally by the patient.

The lesion is usually of the nature of a large puncture or tear with contused and lacerated edges. In most instances the whole thickness of the bowel is implicated, and the wound extends into the perirectal tissues. When a pointed object, such as a spike, passes through the anal orifice, it is apt to be forced through the wall of the rectum where it joins the colon, and enter the peritoneal cavity, and at the same time injure the bladder or urethra.

The most prominent immediate *symptoms* are shock, pelvic pain, and hæmorrhage. The blood escapes externally, but may also enter the peritoneal cavity. Inflammation of the wall of the bowel, perirectal cellulitis and abscess, and septic peritonitis may ensue.

The nature and extent of the injury must be determined by careful examination, and this usually calls for the use of a general anæsthetic. In the case of injury to the rectum the sphincters must be stretched to give the required access.

If the peritoneum is found to have been opened, laparotomy should be performed to permit of the pelvic cavity being purified, and if the wound can be reached it should be closed. The suturing will be facilitated by placing the patient in the Trendelenburg position. In some cases colostomy should be performed to prevent the fæces traversing the rectum while the wound is healing.

Foreign Bodies.—Foreign bodies may become impacted in the rectum and give rise to symptoms, either by obstructing the canal, or by injuring the wall of the bowel and causing inflammatory complications. Three varieties of foreign bodies are met with: (1) those which are swallowed and pass along the alimentary canal, for example, tooth plates, game and fish bones, pins, buttons, nails, etc.; (2) those which form in the alimentary canal or its associated glands, such as enteroliths

or gall-stones; and (3) bodies introduced through the anus by lunatics, criminals, and others, of which an endless variety might be named.

When the body lodges in the rectum, the patient complains of a constant feeling of discomfort and desire to empty the bowel, and, it may be, of tenesmus and the passage of mucus tinged with blood. The mass may press upon the bladder and cause frequency of micturition, or upon the cords of the sacral plexus, and cause shooting pains in the lower extremities simulating those of sciatica. Sharp or irregular bodies, such as fish bones, pins, or tooth plates, which become impacted in the rectal wall, cause extreme pain, particularly during and after defecation. The mucous membrane may become ulcerated, and give rise to a muco-purulent discharge and bleeding. An abscess may form in the submucous or perirectal connective tissue.

A digital examination of the rectum should be made in all cases where these symptoms are present, and if this fail to reveal the cause of the patient's suffering, an examination should be made with the speculum.

Treatment.—In the case of small bodies, such as fish bones, their removal is facilitated by the application to the mucous membrane of a 5 per cent. cocain ointment. In the case of larger bodies a general anæsthetic is required, and great gentleness is called for because of the risk of tearing the bowel. It may be necessary to lay open the anal canal by cutting backwards towards the coccyx.

Inflammatory Affections.—**Inflammation of the Rectum—Proctitis.**—The rectum is subject to the same forms of inflammation as the colon, and it is not uncommon for proctitis and colitis to occur together. The rectal mucosa is specially exposed to bacterial infection from the nature of the contents of the gut, the folds and glandular recesses in the mucous membrane, and the frequency with which it is subjected to minor forms of trauma. Infection may be further aided by conditions causing congestion of the walls of the gut or lowering its vitality, such as the irritation produced by the presence of scybalous masses, foreign bodies, or intestinal parasites, or by the use of drastic purgatives or enemata. Sitting on cold stones or damp seats may determine an attack of proctitis by lowering the vitality of the parts. Dysenteric proctitis is usually an extension of a similar inflammation from the colon. Gonorrhœal infection of the rectum is met with chiefly in women, and is due to the discharge passing backwards from the vulva or to unnatural sexual practices.

Clinical Features.—The patient complains of a persistent feeling of weight and heat in the bowel, and of pains radiating to the loins and down the legs. A sensation as of a foreign body in the rectum induces a constant desire to empty the bowel, and the attempt is attended with severe tenesmus and bearing down. The motions passed are thin, watery and acrid, and contain much mucus, which may be tinged with blood. The rectal mucous membrane is injected and swollen, and, on digital examination, is found to be hot and tender. The skin around the anus is irritated by the discharge from the bowel, and may become excoriated and painful. There may be increased frequency of micturition from reflex irritation of the bladder. There is more or less constitutional disturbance, according to the extent and severity of the inflammation.

The *treatment* consists in removing the cause of the inflammation when this is possible, in confining the patient to bed, and giving a bland fluid diet. Locally injections of ice-cold water, or of water as hot as the patient can bear it, give relief. A few drops of laudanum may be added to the fluid injected, or a morphin suppository may be introduced after the injection. Hot hip baths are also useful. The bowels should be moved regularly by the aid of mild laxatives.

Periproctitis, or inflammation of the cellular tissue around the rectum, may be due to the spread of an inflammatory or ulcerative process from the bowel, or it may commence as a cellulitis. It usually ends in suppuration and perirectal abscess.

Ulceration.—Non-malignant ulceration of the rectum may be due to a great variety of pathological conditions. It may, for example, follow on one or other of the varieties of proctitis, or it may be due to the downward spread of an infective colitis. In addition to those forms which may be traced to injury of the rectal mucous membrane—for example, by foreign bodies, impacted fæcal masses, or the pressure of the fœtal head during parturition—and those associated with the presence of piles, polypus or stricture, it is necessary to refer more particularly to the dysenteric, the tuberculous, and the syphilitic varieties. All forms of ulceration are most common in middle life, and are more frequently met with in females than in males.

Dysenteric ulceration often affects the pelvic colon and the rectum simultaneously. The mucous membrane becomes infiltrated here and there with a fibrinous exudation, which raises the epithelium, and causes it to give way, leaving a series of small superficial ulcers. These tend to spread and to run

together, and patches of the mucous membrane may undergo necrosis and leave a large irregular ulcer extending over a considerable area of the rectal wall. It is characteristic of the dysenteric ulcer that the mucous membrane surrounding it is more or less inflamed and swollen. Although perforation seldom occurs, perirectal abscesses and fistulæ are not uncommon. The contraction which accompanies the healing of such ulcers may give rise to stenosis of the bowel—*dysenteric stricture.*

Tuberculous ulceration of the rectum is usually met with in patients who suffer from other tuberculous affections, notably pulmonary phthisis, and the organisms may reach the rectum either by being swallowed in the sputum, or by way of the blood-stream. The ulcer is formed by the coalescence and breaking down of tubercle nodules which have developed in the submucous tissue. It is irregular in outline, its edges are thin and undermined, and its base grey and glazed. A characteristic feature is the presence of firm nodules in the mucous membrane surrounding the ulcer. The ulcerative process may lead to perforation of the bowel and the formation of tuberculous perirectal abscesses and fistulæ. As a rule the disease tends to persist, but if healing take place, it results in the formation of an irregular stricture of the bowel.

Syphilitic Ulceration.—The most common form of syphilitic ulceration is that which results from the breaking down of a gumma originating in the submucous tissue — the so-called *ano-rectal syphiloma.* The ulcers are circular or serpiginous in outline, and have the punched-out appearance which is characteristic of syphilitic ulcers in other situations. The edges are hard and sharply defined, and the base is covered with a greyish-yellow slough or discharge. These ulcers are usually situated just within the anus, and the surrounding mucous membrane is dense and indurated. Perforation may take place, and perirectal abscesses and fistulæ develop. Stenosis is a common sequel to the cicatrisation of a syphilitic ulcer.

A less common form of ulceration results from the extension to the rectal mucous membrane of perianal cracks and sores.

It is seldom justifiable to diagnose an ulcer as syphilitic in the absence of a clear history of infection, of other specific manifestations, or of definite improvement under antisyphilitic treatment.

Clinical Features.—The clinical features of these different forms of ulceration vary so little that it is often impossible, apart from the history of the condition, to distinguish between them. The symptoms produced by a given ulcer depend more

upon its situation than its size and nature. A small ulcer, for example, situated in the region of the sphincters may give rise to severe pain, tenesmus, and reflex nervous disturbances, while a much larger ulcer higher up in the bowel causes comparatively little discomfort. Morning diarrhœa is one of the earliest and most constant symptoms. The patient is urgently called to stool as soon as he gets up in the morning, but only passes a quantity of thin, muco-purulent, or "coffee-ground" matter. This does not give him relief, and he may have severe tenesmus, which necessitates repeated efforts to empty the bowel. At last a solid motion is passed, and he remains comfortable for the rest of the day. As the ulceration progresses, there is a constant dull, aching pain, and the desire to empty the bowel becomes more frequent. There may be griping pain in the lower part of the abdomen and flatulent distension. Later he may suffer from alternating constipation and diarrhœa. On examination with the finger or speculum the ulcer is detected, and is usually found to be within an inch and a half or two inches of the anus. In many cases there are several characteristically club-shaped tags of skin around the anal margin. The symptoms of ulceration often gradually merge into those of stricture.

Treatment.—The general and constitutional treatment should be directed to the cause of the ulceration. The patient is usually most comfortable in the recumbent position, with the foot of the bed raised on blocks to diminish congestion of the pelvis. The bowels must be carefully regulated by mild laxatives and enemata. The ulcer may be treated by stimulant, sedative, or astringent applications according to its condition. The operative measure which gives most relief is division or stretching of the external sphincter. The rest afforded to the sore by this measure also favours healing. In some cases the ulcer may be scraped and sponged over with pure carbolic acid. Insufflation of iodoform or of orthoform is often useful. When pain is severe morphin or cocain suppositories are indicated. In otherwise intractable cases the ulcer may be excised. A temporary colostomy may be of service by affording complete rest to the rectum, thus placing the ulcer under the most favourable conditions for healing.

Cicatricial Stricture.—Cicatricial, fibrous, or non-malignant stricture of the rectum may follow on any form of inflammation or ulceration which implicates the submucous and muscular coats of the bowel. It is perhaps most common after syphilitic, dysenteric or tuberculous ulceration. Stenosis may also ensue after any operation which involves removal of a considerable

portion of the rectal wall, for example, the excision of a malignant growth or the operation for prolapse; or in which extensive and irregular incisions are made in the bowel, as in the treatment of complicated fistulæ.

The proportion of syphilitic cases has probably been exaggerated on account of the tendency to attribute to syphilis all strictures in which no other definite cause can be discovered. Tuberculous stricture is less common than the syphilitic form, as patients who suffer from tuberculous ulceration of the rectum are usually the subjects of advanced pulmonary phthisis, and succumb to this disease before cicatrisation of the ulcer takes place. It is to be borne in mind, however, that cicatricial contraction resulting in stenosis may take place although healing of the ulcer has not occurred.

Stricture may affect any portion of the rectum, but in the great majority of cases is within two or three inches of the anal orifice. The shape and extent of the constriction vary with the cause. When due to diffuse inflammation of the whole thickness of the bowel, for example, it is usually tubular, and implicates several inches of the lumen; when due to a simple or syphilitic ulcer, it is annular; while in tuberculous cases it tends to be irregular. The bowel above the stricture is dilated, its muscular coat hypertrophied, its mucous membrane the seat of chronic catarrh and ulceration, and perirectal abscess and fistulæ may develop. In strictures high up the rectum is distended or "ballooned" below the stricture, owing to paralysis of the muscular coat and distension of the bowel by gas and fæces. If the constriction is low down, the tone of the sphincters is lost, and the anus becomes patulous, admitting of prolapse of the mucous membrane.

Clinical Features.—Non-malignant stricture is most commonly met with in females between the ages of twenty and forty. There is usually a history of some inflammatory or ulcerative condition, followed by a varying interval during which the patient is free of rectal trouble. Later, there is a gradually increasing difficulty in getting the bowels to move, and unless recourse is had to drugs or enemata, they may be constipated for days or even weeks. The diameter of solid motions is often greatly reduced. When hard scybalous masses collect above the stricture and irritate the bowel, attacks of diarrhœa supervene, the patient passing quantities of fluid fæces and mucus, but never completely emptying the bowel. Loss of control is a common complaint on the part of the patient. There is frequently a discharge of blood-stained, muco-purulent material, which escapes

apart from the stools. As the obstruction increases, the abdomen becomes distended with flatus, the patient loses appetite, and becomes greatly emaciated. The stricture seldom completely occludes the lumen of the gut, but symptoms of acute obstruction may suddenly supervene if a mass of hardened fæces becomes impacted and blocks the passage.

The *diagnosis* is made by digital examination, by the use of the rectal speculum, or by the passage of bougies.

Treatment.—In all cases of rectal stricture the diet should be restricted to fluids to diminish the amount of fæces, and the bowels regulated by mild laxatives and the use of enemata. The operative treatment to be adopted in a given case depends upon the site and nature of the stricture. In moderately tight and short annular, or tubular strictures low down in the bowel, the frequent passage of *graduated bougies* may suffice to keep the patient comfortable. *Internal proctotomy*, which consists in dividing the stricture at one or more points from within the bowel, and then passing large bougies, is only suitable when the stricture is near the anal orifice. It is liable to be followed by septic complications in the perirectal tissues. *External* or *linear proctotomy* is employed in long tubular strictures. It consists in carrying an incision through the posterior aspect of the whole length of the stricture or lower part of the bowel, including the sphincters. This ensures complete relief to the obstruction and perfect drainage. During the healing process bougies should be passed from time to time to prevent recontraction. *Excision*, as for malignant disease of the rectum, with end to end suture, may be performed if the stricture is annular and situated low down. Unless primary union takes place it is apt, however, to be followed by the formation of a fresh cicatrix. *Inguinal colostomy* may be an essential preliminary in advanced and neglected cases complicated with periproctitis and fistulæ; the local conditions improve as soon as the rectum is afforded absolute rest and becomes amenable to local measures.

Abscesses in the Region of the Rectum and Anus.—Suppuration is comparatively common in the region of the rectum and anus, and several varieties of abscess are recognised. In the majority of cases the suppurative process is circumscribed and a localised abscess forms, but in others the pus is diffused throughout the cellular tissue, and burrows all round the rectum, and even into the pelvis. The pus, wherever it is formed, tends to spread along the lines of least resistance, and usually finds its way towards the nearest cutaneous or mucous surface, producing irregular and tortuous sinuses and fistulæ.

The organisms most frequently present in these abscesses are the colon bacillus, the tubercle bacillus, the streptococcus, and the staphylococcus aureus. The colon bacillus is usually associated with the ordinary pyogenic cocci. The tubercle bacillus is frequently found alone. The determining cause of the abscess may be an injury of the rectum, for example, by a foreign body, such as a fish bone impacted in the mucous membrane, a blow or kick over the perineum, or the pressure of an ill-fitting bicycle saddle. In other cases suppuration follows an attack of proctitis, an ulcer of the rectum, or is associated with polypus, piles, or stricture. Exposure to cold or wet, by lowering the vitality of the tissues, probably predisposes to suppuration.

Abscesses may occur in the vicinity of the rectum at any age, but are most common above the age of thirty. Males suffer much more frequently than females.

Varieties.—The *subcutaneous or* **perianal abscess** may originate either in a sebaceous follicle, or in relation to a thrombosed external pile or a fissure. It is situated in the subcutaneous tissue close to the anal margin. The *follicular* abscess—which is practically a boil—may be simple or multiple, and it is not uncommon for several to form one after another, and for these to coalesce and lead to considerable burrowing under the skin. The burrowing usually takes place in a direction away from the bowel, with the result that a fistula seldom forms. When associated with a fissure or pile the abscess (*marginal abscess*) is usually single, and tends to burrow towards the mucous membrane, forming a short, superficial fistula (Fig. 119*a*).

These abscesses give rise to itching around the anus and constant throbbing pain, which is aggravated by sitting or walking, and during defecation. Locally there is a small, red, fluctuating swelling, surrounded by an area of induration and œdema. The parts are tender to touch and on rectal examination.

Treatment.—The abscess should be opened as early as possible to prevent burrowing, and to avoid the formation of a fistula. A crucial or T-shaped incision extending well beyond the indurated area ensures gaping of the wound, and permits of better drainage than a single straight cut. Care should be taken not to divide the external sphincter. Any septa in the abscess should be broken down, and the cavity packed with iodoform worsted.

The *after-treatment* of this, and of other varieties of rectal abscess, calls for much attention to prevent the formation of a fistula. The wound should be dressed twice a day, the packing being carefully adjusted to ensure that healing takes place from the bottom. Hot sitz baths at the time the dressing is changed

are useful in promoting discharge and ensuring cleanliness. Purgatives are to be avoided. An easy movement of the bowels may be ensured by injecting an ounce or two of warm olive oil into the rectum each night. In some cases the introduction of a rectal flatus-tube, or dilatation of the sphincter after the abscess has been opened, is useful in allaying spasm of the sphincters and preventing distension of the bowel by flatus (Tuttle).

Ischio-rectal Abscess.—(Fig. 116).—This form of abscess begins in the loose cellular tissue of the ischio-rectal space as a septic cellulitis, which, in the course of a few days, ends in suppuration. At first the pus is scattered throughout the meshes of the cellular tissue, but it soon comes to fill the space and to bulge it in every direction. The weakest part of the abscess wall is situated towards the back of the rectum, where the posterior

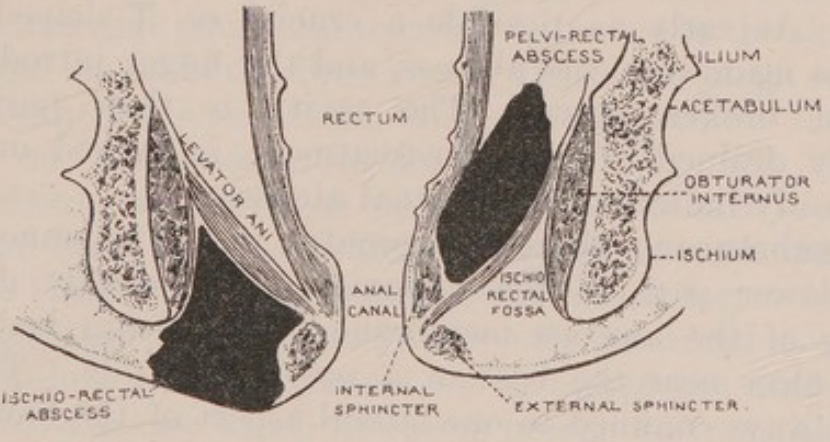


FIG. 116.—Diagram of Ischio-rectal and Pelvi-rectal Abscesses.

edges of the levatores ani blend with the ano-coccygeal ligaments, and at this point the pus usually burrows into the rectum, passing between the external and the internal sphincters. In some cases it finds its way across the middle line, and so comes to invade the ischio-rectal fossa of the opposite side, forming what is known as a "dumb-bell" or "horse-shoe abscess." Either before or after bursting into the rectum, the pus also finds an exit through the skin, and in this way a complete fistula is formed.

Clinical Features.—The condition usually develops somewhat acutely, and is ushered in by a rigor and general feeling of malaise. There is at first a dull, aching pain in the ischio-rectal fossa, which later assumes a throbbing character. The patient is unable to sit or to walk with comfort, and there is intense pain during defecation. Frequently there is retention of urine. A hot, red, and tender swelling develops in the perineum to one side of the anus, and the surrounding integu-

ment becomes indurated and œdematous. On rectal examination a tense, elastic swelling, which does not encroach much on the bowel, can be detected in the ischio-rectal fossa. The symptoms may suddenly abate if the abscess bursts either into the rectum or on to the surface, but the opening being small is liable to become blocked and the symptoms reappear. In some cases the recurrence of symptoms is due to the formation of an abscess in the ischio-rectal fossa of the opposite side. The pus which escapes may be yellow and creamy, or dark brown and grumous from admixture with broken-down blood-clot. It is always extremely fœtid, and often contains putrefactive gases. When the abscess is tuberculous it runs a more chronic course.

Treatment.—No time should be wasted by applying poultices, ice-bags, or other local applications, in the hope of aborting the abscess. As early as possible a crucial or T-shaped incision should be made into the abscess, and the finger introduced and all septa broken down. The cavity is then purified and efficiently drained. The after-treatment is carried out on the lines already indicated for perianal abscess.

The **submucous abscess** originates in the submucous tissue of the lower part of the rectum, and is usually due either to injury of the mucous membrane by a foreign body, or to a tear or ulcer near the base of a polypus or pile. The pus is almost always confined to one lateral aspect of the bowel, and it tends to burrow towards the anus, and to burst close to the anal margin, forming a short and shallow blind internal fistula (Fig. 120*a*).

The *symptoms* resemble those of an ischio-rectal abscess, but there is no external swelling. Digital examination causes much more intense pain, and a soft, fluctuating swelling can be felt bulging towards the bowel. If the abscess is not burst by the introduction of the finger into the rectum it should be incised at its lowest part and drained.

The **pelvi-rectal abscess** (Fig. 116) is situated between the rectum and the levator ani muscle, in the loose connective tissue which is continuous above with the various cellular planes of the pelvis. It differs from the other varieties in that it is comparatively seldom due to disease or injury of the rectum itself, in the majority of cases originating in the pelvis in relation to the base of the bladder, the prostate, the uterus, or the broad ligament. Sometimes the pus from a psoas or an appendicitic abscess, or from a focus of disease in the pelvic bones, finds its way into the pelvi-rectal space. Very frequently

the pus burrows through the substance of the levator ani and invades the ischio-rectal fossa.

The *clinical features* vary with the nature and seat of origin of the abscess. In most cases they are those of an ordinary pelvic cellulitis, followed by the development of a localised abscess in the vicinity of the rectum. In other cases they resemble those of an ischio-rectal abscess. On digital examination of the rectum, a swelling is found bulging towards the bowel above the level of the internal sphincter, and, it may be, extending beyond the reach of the finger.

The *treatment* consists in opening the abscess at its accessible part, establishing efficient drainage, and dealing with the lesion from which it originated.

Ano-Rectal Fistulæ.—The term *fistula-in-ano* is applied to any abnormal channel passing through the tissues in the vicinity of the rectum and anus, and opening either on to the skin or into the rectum, or in both directions. Three varieties are recognised: (1) the *complete* fistula, which opens both on the cutaneous and on the mucous surfaces (Fig. 117); (2) the *blind external* fistula, which opens only towards the skin (Fig. 119); and (3) the *blind internal*, which opens only towards the mucous membrane (Fig. 120). Inasmuch as the blind forms have only one opening they would be more correctly described as sinuses.

The fistulous track represents the shrunken but unobliterated cavity of an abscess, which has been prevented from healing by various causes, the most important of which are imperfect drainage and constant reinfection of the raw surfaces. Other factors which favour the formation and persistence of fistula are the passage of fæces and flatus along the channel, the constant movement of the parts, caused by the contraction of the sphincters and other muscles, and the irregularity of the abscess cavity. It is most common in males beyond the age of thirty.

The **complete fistula** is the form most frequently met with, about 70 per cent. of all cases being of this variety. It is usually due to an ischio-rectal or a pelvi-rectal abscess having burst both towards the bowel and towards the skin. There are usually two or more external openings situated within an inch or an inch and a half of the anus. The internal opening, which is almost always single, is most commonly found exactly opposite the space between the external and internal sphincters (Fig. 117*a*). Sometimes, however, the pus burrows upwards under the mucous membrane and opens at a higher level (Fig. 117*b*). The track of the fistula is irregular and tortuous, with one or more dilatations in its course. On rectal examination it is recognised by

the induration of the tissues around it. It is not always easy to pass a probe from one opening to the other on account of the irregular diverticula in the track of the channel. When the fistula follows a bilateral or "horse-shoe" abscess the channel may surround the rectum, and openings form on both sides—"horse-shoe fistula." As a rule the burrowing is most marked towards the posterior aspect of the rectum (Fig. 118). There is always more or less pain and spasmodic contraction of the sphincters. The bowels are usually loose, and thin fæces and flatus may escape from the opening, soiling the linen, and causing an offensive odour. The patient is unable to associate with others, and is liable to become mentally depressed or even melancholic.

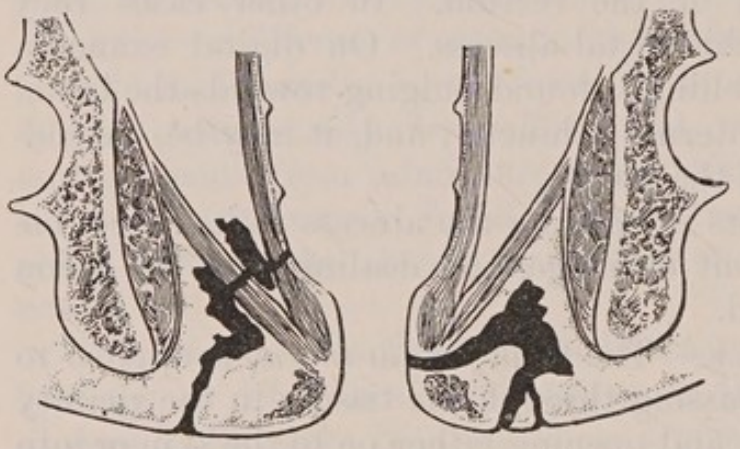


FIG. 117.—Diagram of complete Fistulæ.

Blind external Fistula.—About 20 per cent. of rectal fistulæ belong to this variety. The fistula may result from the bursting of a perianal abscess, in which case the channel is comparatively short and entirely subcutaneous, and the opening lies close to the anal margin (Fig. 119 *a*). In other cases it follows an ischio-rectal abscess, the sinus being deeper, and the opening farther away from the anus (Fig. 119 *b*). After the symptoms referable to the abscess subside, the sinus discharges a small amount of thin sero-pus. The opening frequently closes up, and the discharge is retained for a day or two, but it soon bursts out again. In some cases fresh external openings form in the anal region, and in others the pus burrows into the rectum, and the fistula becomes complete. In cases of blind external fistula there is comparatively little pain on defecation, and there is no

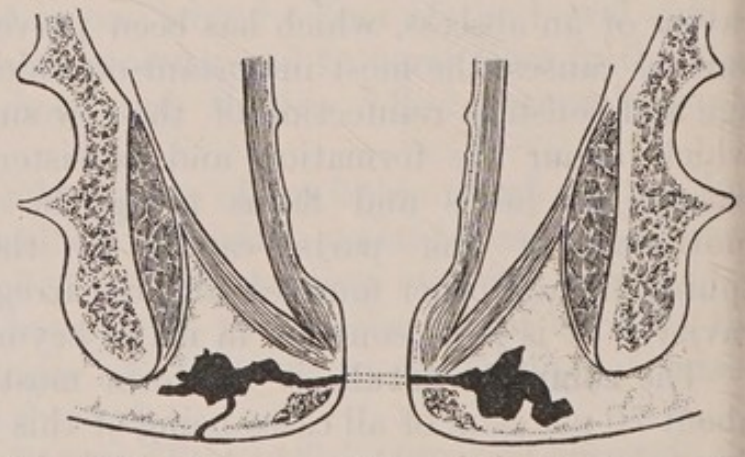
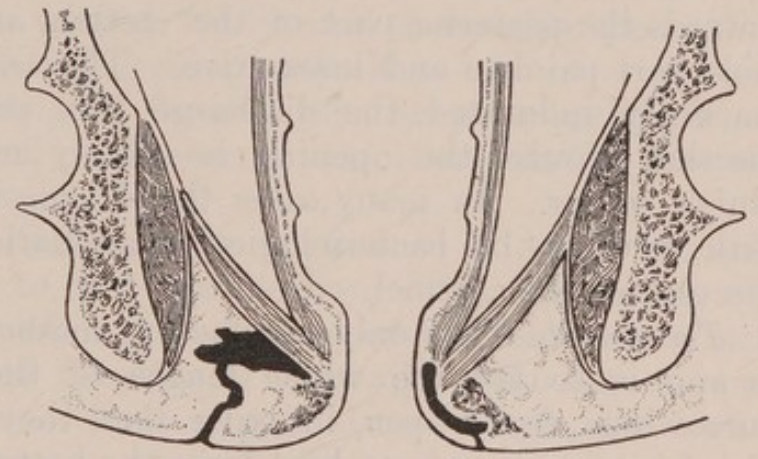


FIG. 118.—Diagram of Horse-Shoe Fistula resulting from bilateral ischio-rectal abscess.

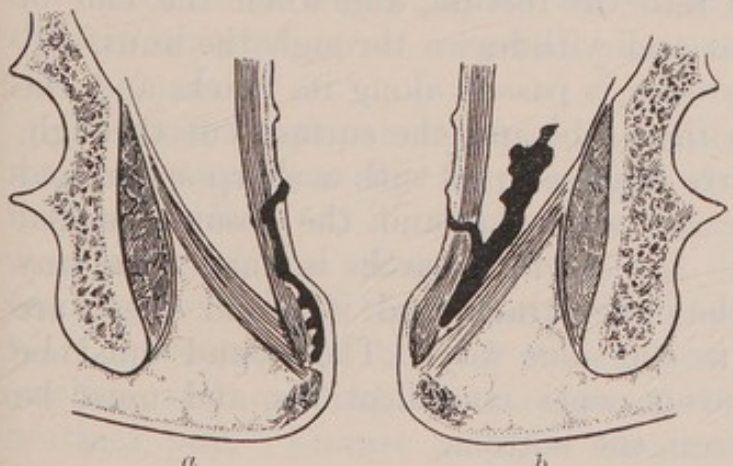
spasm of the sphincters. Beyond slight staining of the linen the patient has little discomfort.

Blind internal fistula is the least common form, only about 10 per cent. of all cases being of this variety. There is usually a history of an abscess having burst into the rectum, and of pus and blood having escaped from the bowel. When the abscess is of the submucous variety the fistula is comparatively short, and runs immediately under the mucous membrane, opening usually near the anal margin (Fig. 120). When the fistula follows a pelvi-rectal abscess it is longer, more tortuous, and opens usually above the sphincters (Fig. 120*b*). A characteristic feature of the blind internal fistula is the way in which it repeatedly closes for a time and reopens again. There is tenesmus and pain on defecation. On digital examination the track of the fistula may be recognised as an indurated cord in the perirectal tissues, and the opening is felt as a small pit or depression with thickened edges. The opening is usually single, and is most frequently situated towards the posterior part of the rectum.



b *a*

FIG. 119.—Diagram of Blind External Fistulæ, resulting from (*a*) perianal abscess, and (*b*) ischio-rectal abscess.



a *b*

FIG. 120.—Diagram of Blind Internal Fistulæ : *a*, following submucous abscess ; *b*, following pelvi-rectal abscess.

Tuberculous Fistula.—A considerable number of cases of fistula-in-ano are tuberculous in character. Great difference of opinion exists as to the relative frequency of such cases, and as to the precise rôle played by the tubercle bacillus. Some authorities believe that the ano-rectal condition is frequently a primary manifestation of tuberculosis, while others hold that the

fistulous track is infected secondarily. Statistics seem to show that while fistula is by no means common in phthisical patients, a considerable number of those who suffer from fistula subsequently develop tuberculosis. The complete form is that most frequently met with. It differs from the ordinary pyogenic fistula, chiefly in being situated towards the anterior, rather than towards the posterior part of the rectum, and in being for the most part painless and insensitive. The track of the fistula is markedly indurated, the discharge thin, pale, and watery, and the skin around the opening is usually undermined and of a bluish colour. In many cases the diagnosis can only be made with certainty by bacteriological examination of a scraping of the wall of the channel.

Treatment.—The only satisfactory method of treating fistula-in-ano is to lay the whole length of the track, and all its burrowings, freely open, in order that they may be thoroughly disinfected and made to heal from the bottom. In doing so the internal sphincter should be injured as little as possible to avoid the risk of incontinence. If it be necessary to divide the external sphincter, the muscular fibres should be cut straight across, and not obliquely, and they should not be cut at more than one place. To ensure sound healing it is essential that the internal opening of the fistula be found and laid open.

In a *complete fistula* a flexible probe or director is passed along the track from the external to the internal opening. A finger is then introduced into the rectum, and when the end of the probe is felt it is bent and withdrawn through the anus. A curved probe-pointed bistoury is passed along its track, and the bridge of tissue between the probe and the surface cut through. The walls of the fistula are then scraped with a sharp spoon and sponged over with pure carbolic acid, and the wound packed with iodoform worsted. A careful search is made for any lateral offshoots from the main track, and if found these are opened up and treated in the same way. The wound must be dressed frequently to prevent septic complications, and must be packed so that it heals from the bottom.

A *blind external* fistula, when superficial to the internal sphincter, should be converted into a complete fistula by passing a probe along its track, and forcing it through the mucous membrane at the upper end. The track is then laid freely open and treated in the manner above described. If the fistula passes deeply into the ischio-rectal fossa, and approaches the rectum above and outside the internal sphincter, it should not be opened into the rectum, as this would necessitate dividing

the internal sphincter. The external sinus should be freely enlarged, purified, and packed.

A *blind internal* fistula, if submucous and below the internal sphincter, is rendered complete and slit up. If the internal opening passes through or above the internal sphincter the fistula should be rendered complete, but should not be slit up. The external part is opened freely and thoroughly packed in the hope that the internal opening may close.

Tuberculous fistulæ are treated on the same principle as other forms, provided the general condition of the patient warrants operation.

Anal Fissure.—This term is applied to a small irritable ulcer situated close to the anal orifice. The sore is usually elliptical or pear-shaped, and lies in one of the folds into which the integument around the anus is thrown by the contraction of the external sphincter. It is almost always single, and varies in length from a quarter to one inch, its narrow upper end being situated on the mucous membrane, reaching to the lower border of the internal sphincter; while its broader, lower end may extend on to the skin and overlie the external sphincter. In depth the sore varies from a superficial abrasion of the mucous membrane to an ulcer which exposes, or may even invade, the muscular fibres of the external sphincter. The edges are usually inflamed and elevated, and curl in over the feeble granulations which cover the base of the ulcer. At the lower end of the fissure there is frequently an œdematous or hypertrophied tag of skin simulating an external pile, and named by Brodie the *sentinel pile*.

The most common cause of these ulcers is laceration of the mucous membrane by the passage of hard fæcal masses or foreign bodies, or, in women, over-stretching of the mucous membrane of the anterior rectal wall during parturition. According to Ball, in the majority of cases the initial lesion is a tear or rupture of one of the crypts of Morgagni, and the swollen and œdematous margins of the valve constitute the sentinel pile. Fissure may be associated with piles, polypus, fistula, or other rectal affections.

Clinical Features.—Fissure is usually met with in adult life, and is, on the whole, more common in women than in men. When it occurs in childhood it is usually a result of inherited syphilis. The most characteristic symptoms are intense pain during and after defecation, and spasmodic contraction of the sphincters and levator ani muscles. In the early stages, while the ulcer is comparatively superficial, the pain is of an

acute tearing or cutting nature, and lasts only for a few minutes. Later it becomes burning, and is accompanied by spasm of the sphincters and bearing-down sensations, which may last for an hour or two. When the ulceration exposes the fibres of the external sphincter the pain is of a dull, aching, or throbbing character, and is more or less continuous. In addition to the local pain the patient may suffer from reflex pains radiating to the back, the pelvic organs, and down the legs. In some cases there is pain and difficulty in micturition. The motions may be altered in shape, and are sometimes streaked with blood.

On separating the buttocks the small ulcer and its sentinel pile, if present, may be seen. It is most frequently situated towards the posterior margin of the anus, particularly in men. In women, when due to tearing of the mucous membrane during parturition, it occurs on the anterior wall. The sore is extremely sensitive when touched or stretched, or when the patient attempts to strain. The sphincter and levator muscles are firmly contracted. To the finger the fissure feels like the edges of a buttonhole. The occurrence of bleeding in cases of fissure suggests the presence of piles or polypus, and purulent discharge is usually due to an associated fistula. A digital examination of the rectum should always be made to discover if there is any other affection present, such as polypus, piles or fistula, and in making the examination the finger should be pressed against the side of the anus opposite to that on which the fissure is situated.

Treatment.—In slight and early cases careful regulation of the bowels, scrupulous attention to cleanliness, and the use of soothing antiseptic applications, such as orthoform, ichthyol, mercurial ointment, or iodoform and cocain suppositories give relief, and may even effect a cure. In more severe and persistent cases it is necessary to paralyse the external sphincter for a sufficiently long time to enable the sore to heal. This may be done by carrying an incision through the base of the fissure, and so dividing the fibres of the external sphincter. When the edges of the fissure are indurated they should be snipped away with scissors. A simple antiseptic dressing is applied, and the bowels kept at rest for a few days. The sphincter usually regains its power in about a fortnight. Another method of treatment consists in forcibly stretching the sphincter, so that its power of contracting is temporarily arrested. When the fissure is associated with polypus, piles, or other disease of the rectum, it is necessary to treat these conditions.

Hæmorrhoids or Piles.—The term hæmorrhoids or piles is

applied to a varicose and hypertrophied condition of the veins at the lower end of the rectum and anal canal. Two varieties are recognised: *internal piles*, which originate inside the anal orifice, and implicate the terminal branches of the superior hæmorrhoidal vessels; and *external piles*, which lie outside the external sphincter and implicate the branches of the inferior hæmorrhoidals. When both varieties co-exist, as is frequently the case, the piles are spoken of as *mixed*.

Internal Piles.—The internal is the more common and more important variety. Each pile consists of a central arterial twig, surrounded by a bunch of varicose and sacculated veins, and a varying quantity of condensed connective tissue—the whole forming an elongated, pear-shaped swelling over which is stretched the rectal mucous membrane. There may be only one pile present, in which case it usually lies in the right anterior quadrant of the rectum, or there may be several scattered round the bowel, the rounded ends of the piles reaching down to the muco-cutaneous junction. Phlebitis and periphlebitis frequently occur in relation to piles, and phleboliths may form in thrombosed veins.

Piles may occur at any period of life, but are rarely met with before puberty, and are most common between the ages of forty and sixty. The two sexes seem to suffer with about equal frequency, but men apply for treatment much oftener than do women. Many factors contribute to the production of piles, the most important of which are habitual constipation, and repeated and prolonged causes of straining, for example, enlarged prostate, urethral stricture, or stone in the bladder. Increased backward pressure in the venous circulation, such as occurs, for example, in cirrhosis of the liver and in heart disease, also tends to induce piles. The pressure of the enlarged uterus during pregnancy, or of abdominal or pelvic tumours, is another cause. In many cases there is a distinct hereditary tendency towards the development of piles, as there is in other forms of varix.

Clinical Features.—Three degrees or stages may be recognised. In the first degree the piles remain inside the anal orifice, and are not protruded during defecation or on straining. The veins are varicose, but do not form distinct masses. In the second degree the vessels are dilated and sacculated, and form fleshy masses which are protruded during defecation, but return spontaneously after the act, or can be readily returned by the patient. In the third degree the piles remain protruded and can only be returned by the patient with difficulty, if at all,

and there is frequently also some prolapse of the mucous membrane.

In addition to the protrusion of the pile mass from the anus the most important symptoms are hæmorrhage, pain, and discharge of mucus.

In piles of the *first degree* the bleeding is usually slight, in some cases amounting only to a streaking of the motion, or to the loss of a few drops of blood at each act of defecation. It only occurs while the bowels are moving, and is most marked when the motions are hard and the bowels constipated. If the bowels are kept regular and the motions soft, there may be no bleeding.

It is in piles of the *second degree* that bleeding becomes a prominent and serious symptom. As a rule the blood escapes from the piles after they have been protruded, and continues to flow as long as they remain down, the bleeding being due to interference with the venous return caused by constriction of the neck of the piles by the spasmodically contracted external sphincter. In such cases the blood is venous in character, and escapes from the surface of the pile mass in a steady ooze, and the bleeding stops whenever the piles are returned within the bowel. In other cases bright arterial blood comes in jets from a single ulcer on a protruded pile, and the bleeding may continue after the piles have been returned, with the result that a considerable quantity of blood collects in the rectum, and is passed, either in a fluid or coagulated state, some time after defecation. From piles of the second degree the patient may lose from several drams to several ounces of blood each time the bowels move, and as a consequence he becomes weak and anæmic, and exhibits a characteristic clay-like pallor. Such patients also tend to become unduly irritable, anxious, or mentally depressed.

In piles of the *third degree* there is seldom much bleeding, as the mucous membrane becomes thickened, and the normal columnar epithelium covering it is replaced by stratified squamous epithelium.

Pain localised to the lower part of the bowel is seldom severe in uncomplicated cases of piles, except while they are actually protruded and constricted by the sphincter, and it ceases soon after the piles are returned. If pain persists for any length of time after reduction, the presence of a fissure should be suspected. On the other hand pains referred to the sacral and lumbar regions are common to all forms and degrees of piles.

It is only in piles of the third degree that a profuse discharge

of mucus takes place, and in some cases this gives rise to considerable irritation and pruritis of the skin around the anus.

Diagnosis.—A local examination should always be made on a patient who complains of "piles," as this term is applied by the laity to all conditions affecting the lower bowel, and it is necessary to exclude such affections as condylomata, fistula, and cancer. In cases of piles it is usually found that the skin around the anus is loose and lax, and that the normal folds or rugæ are markedly redundant and often œdematous. If the piles are of long standing and are uncomplicated by fissure or ulceration, the sphincters are usually relaxed, and the piles can be brought into view by the patient straining slightly. When a fissure or ulcer is present the sphincters are spasmodically contracted, and the piles cannot be brought down by straining. The piles may be seen with the speculum, but a digital examination does not always reveal their presence, in many cases nothing more than a series of ridges on the mucous membrane close to the anal orifice being recognisable. In the majority of cases the upper part of the rectum contains fæces even although there has been a recent action of the bowels.

Inflammation and Strangulation of Internal Piles.—In some cases internal piles periodically become the seat of acute inflammation—phlebitis and periphlebitis—attended with pain, tenesmus, and bleeding, while the skin around the anal margin is swollen and œdematous. This condition, which is spoken of as "an attack of the piles," lasts for a few days, and then gradually subsides.

It frequently happens also that piles of the second degree, after becoming prolapsed, are so tightly grasped by the sphincter that the circulation through them is completely obstructed. The extruded mass becomes swollen and œdematous, blood escapes from the distended vessels into the surrounding connective tissue, and in some cases gangrene of the piles takes place. This occurrence is accompanied by severe local pain and some constitutional disturbance. When the slough separates the stump of the pile returns to the bowel, and the patient obtains relief. Piles of the third degree also may become engorged from various causes, notably septic infection, and be so tightly constricted that they slough off.

Pyæmia has been known to follow septic thrombosis of piles.

Treatment.—All cases of piles of the first degree, and mild cases of the second degree, should be treated by *palliative measures* in the first instance. As constipation is usually present the bowels should be carefully regulated by the

administration of such drugs as cascara, sulphur, castor oil, or one or other of the natural mineral waters, or by suitable dietary, so that the patient has a soft, easy motion at least once a day. Drastic purgatives, and especially such as contain aloes, are to be avoided, as excessive action of the bowels aggravates the hæmorrhoidal condition. Alcohol, too, should be avoided. Any cause for straining that may be present—such, for example, as stricture, prostatic enlargement, or vesical calculus—should also be remedied. If hæmorrhage occurs with defecation the injection of an ounce of olive oil before the act lubricates the passage and may prevent bleeding. After defecation the injection of a few ounces of cold water into the rectum and cold sponging of the perineum are useful in toning up the rectal muscles. Local styptics, applied in the form of ointments, or as suppositories containing adrenalin, hazeline, gallic or tannic acid, may be used, but are not always efficacious.

Inasmuch as an "attack of the piles" may lead to cure of the condition by thrombosis or sloughing of the affected veins, it is sometimes advisable to palliate the symptoms during the attack by soothing anodyne applications. In most cases, however, it is better to give the patient a general anæsthetic and remove the piles.

Operative Treatment.—It is only necessary to refer particularly to three of the many operative procedures which have been suggested for the treatment of internal piles: ligature, excision, and clamp and cautery. The bowels should be freely opened for two or three days before operation, a copious enema being administered each night, and about three hours before operation an enema of boracic lotion should be given.

Ligature.—This is the most simple and the most generally applicable method of treatment. Under general anæsthesia the anus is dilated by stretching the sphincters and the piles are thus brought into view. Each pile is grasped separately by suitable forceps, and, after the mucous membrane around its base has been snipped through with scissors, is transfixed with a blunt needle carrying strong silk or pile-twine. The ligature is then tied as tightly as possible, and the part of the pile beyond it cut off. If the ligature is applied as a Staffordshire knot there is no risk of it slipping off the stump. Redundant folds of skin around the anus should be snipped off with scissors, and any hæmorrhage arrested by pressure or ligature.

Excision.—A simple and safe method suggested by Mitchell of Belfast consists in clamping the base of each pile with a pair of Kocher's artery forceps applied in the long axis of the bowel,

and, after cutting off the redundant portion of the pile, introducing a continuous catgut suture which includes the clamp and the tissues around the base of the pile. Just before tightening up the suture the clamp is removed. The suture not only arrests all bleeding, but also closes the wound, so that healing takes place more rapidly, and no raw surface being left, the bowels may be encouraged to move from the third day. Whitehead's method, which consists in excising the whole of the pile-bearing area of mucous membrane, has been almost entirely abandoned, as being needlessly severe for the majority of cases and on account of the bleeding which accompanies it.

Clamp and Cautery.—In this method the base of each pile is seized with a specially constructed clamp, applied in a direction radiating from the anus, and after the projecting portion has been cut off with scissors, the stump is seared with an actual or a thermo-cautery. It is of special service in friable or ulcerated piles.

After-treatment.—A morphin suppository ($\frac{1}{4}$ to $\frac{1}{2}$ a grain) is introduced into the rectum, and a dressing applied and retained in position by a T-shaped bandage The dressing should be changed daily. Many patients have difficulty in passing water after the operation. The catheter, however, should not be used unless absolutely necessary, as, if once used, it may not be dispensed with for some days, and there is a risk of setting up cystitis. The patient is kept on a fluid diet until the bowels are moved on the third or fourth day; a dose of castor oil at night, followed by the injection of about half a pint of warm olive oil in the morning, ensures a soft and easy evacuation. The patient should be confined to bed for about a week or ten days.

External Piles.—These may occur either alone or in association with internal piles. Several different conditions are included under the term "external piles." The variety which most frequently coexists with internal piles consists in a dilatation and slight varicosity of the subcutaneous veins around the anal orifice. The turgescence of the vessels is only evident when the patient strains, and then the perianal skin, which is usually loose and redundant, is raised as a bluish cushion-like ring, which completely surrounds the orifice. When the patient ceases to strain the swelling disappears. This condition is common in patients who are habitually constipated, or who follow a sedentary occupation. It gives rise to no trouble beyond a slight feeling of fulness at the anus during and immediately after defecation, and a sensation as if the bowel

had not been completely emptied. This causes excessive straining which aggravates the condition, and the external sphincter becomes hypertrophied and indurated. When internal piles coexist, bleeding and pain are usually present. The *treatment* of this variety consists in removing the piles.

The term *venous or thrombotic pile* is applied to a condition in which an extravasation of blood takes place around one of the perianal veins which has been ruptured by violent straining of any kind, for example, during defecation or in making some severe muscular effort. The effused blood forms a small, rounded, tense, bluish swelling just beneath the skin or mucocutaneous surface. At first the swelling is soft, but later, when the blood coagulates and the connective tissue around it becomes condensed, it becomes firm. This condition is sometimes supposed to be due to thrombosis occurring in a varicose vein, but this is seldom the true explanation.

At the moment of rupture the patient experiences a sharp, pricking pain, as if something had given way in the vicinity of the anus. This is immediately followed by the appearance of a swelling, which is painful and tender. The acute pain soon subsides and gives place to a dull feeling of tension, which in the course of a week or ten days disappears. In some cases the swelling also disappears, in some a fibrous nodule remains, and in others infection of the clot takes place and a perianal abscess forms.

The *treatment* consists in making an incision over the swelling and turning out the clot. The wound usually heals in two or three days.

A third condition, sometimes, but erroneously called the "connective-tissue external pile," is met with in the vicinity of the anus. It consists merely in an hypertrophied tag of perianal skin—the so-called "dog-ear pile." It does not contain any varicose vein, and is, strictly speaking, not a pile at all. The swelling causes itching and irritation around the anus, and may become infected and give rise to a perianal abscess. Such swellings are frequently found at the lower end of a fissure, and constitute the so-called sentinel pile.

These tags of skin should be snipped off with scissors, the bleeding being arrested by forceps and a ligature or suture. Under an antiseptic dressing the wound rapidly heals.

Tumours. — Tumours of the rectum may be simple or malignant, and transitional forms are met with which it is impossible to place definitely in either class.

Innocent Tumours.—From the fact that the majority of

innocent rectal tumours tend to become pedunculated, they are sometimes spoken of generically as *rectal polypi*. The term polypus, however, only denotes that a growth is attached to the rectal wall by a longer or shorter pedicle, and conveys no indication of its histological structure. The pedicle is composed of a varying quantity of submucous connective tissue covered by mucous membrane, and in it run the vessels which supply the growth. The traction exerted on the tumour by the muscular efforts of the bowel in attempting to expel it tends gradually to lengthen the pedicle. As a rule the tumour is single, but in some cases there are several independent growths present. In rare cases the whole of the rectal mucous membrane is infiltrated with small tumours—*disseminated polypi*. The most common varieties of polypi are the adenoma and the fibroma.

The *adenoma* is usually met with in children, and originates in one of the glands of the rectal mucosa, forming a soft, vascular tumour varying in size from a small cherry to a walnut. It is of a dull-red colour, and being somewhat irregular on the surface resembles a large raspberry in appearance. It may be sessile, or may have a pedicle varying in length from one to four or five inches.

The *fibrous polypus* differs from the adenomatous variety chiefly in the fact that the fibrous tissue is greatly in excess of the other elements in the growth. It is met with as a rule in adults, and forms a hard, nodular tumour covered by thickened mucous membrane. It is usually pear-shaped, and may reach the size of a hen's egg.

Clinical Features.—The main symptoms of polypi are irritability of the rectum, a sensation as if a foreign body were present, and a constant desire to empty the bowel. The tenesmus is accompanied by a discharge of thin and offensive mucus, and there is sometimes slight bleeding. During defecation the tumour may be extruded through the anus, and its pedicle grasped by the sphincter. In some cases the pedicle is torn and the polypus passed with the fæces. On digital examination, the growth may be detected by passing the finger well into the rectum and sweeping it round the bowel in order to catch on the pedicle. It may be possible to protrude the growth from the anus. Anal fissure is a common accompaniment of fibrous polypus, and prolapse of the bowel is frequently induced by the constant straining, particularly in children.

The *treatment* consists in stretching the sphincters, applying a ligature around the pedicle as high up as possible, and

snipping away the polypus. If the pedicle is very narrow, the growth may be twisted off without much risk of bleeding, but care must be taken in doing this not to tear the mucous membrane. When the base of the pedicle is broad, the anus should be dilated, and after the ligature has been applied and the tumour cut off, the mucous membrane should be sutured with catgut. The soft sessile adenomata of children are removed with the sharp spoon or curette.

The **papilloma** or **villous tumour** of the rectum, although not common, calls for special mention on account of its tendency to show signs of malignancy by recurring after removal and assuming the characters of a carcinoma. It forms a red, lobulated growth, about the size of a crown piece, on the surface of the mucous membrane, covered with long, club-shaped villous processes. It is usually sessile, but the mucous membrane at its base may become loose and lax and form a pedicle.

This form of tumour occurs in adults of both sexes, and gives rise to marked tenesmus and a profuse discharge of pale, sticky mucus and blood. There is not much pain, but the patient becomes weak and anæmic from loss of blood. The absence of fixation and induration at the base helps to distinguish the growth from carcinoma.

The *treatment* consists in early and free excision of the growth, the incision being carried well beyond its margins. If recurrence takes place recourse must be had to excision of the rectum.

Malignant Tumours—Carcinoma.—All forms of carcinoma are met with in the rectum, but the columnar-celled variety is by far the most common. The tumour originates in the epithelium of the glands of the mucosa, and on microscopic section exhibits appearances which have led to the name "malignant adenoma" being applied to it. The growth may extend in the form of a flat plaque between the mucous membrane and the muscular coat of the rectum, until it surrounds the bowel and gives rise to a form of annular stricture. Less frequently it grows uniformly in all directions, projecting on the one hand towards the lumen of the bowel, and on the other towards the pelvic cavity where it presses upon and infiltrates adjacent structures. In a majority of cases the growth involves, either primarily or by extension, the part of the rectum above the reflection of the peritoneum—a point of importance in prognosis and treatment. Colloid degeneration (Fig. 121) occurs in all varieties of cancer, and particularly in those of rapid growth and occurring in young subjects. Sooner or later

the mucous membrane covering the growth ulcerates, and the tumour fungates towards the bowel, forming an irregular, crater-like surface which bleeds readily. The edges of the ulcer are raised and indurated. As the tumour increases in size it forms adhesions to surrounding viscera—notably the bladder, prostate, and vagina—and to the pelvic walls, and in this way the rectum becomes unduly fixed. In the early stages the adhesions are for the most part inflammatory—a point of importance in regard to the question of excision of the growth. The growth may invade, either by direct spread or through the medium of an abscess, the bladder or vagina, and so establish a recto-vesical or recto-vaginal fistula. In some cases an ischio-rectal abscess forms, and, after bursting, leaves an intractable form of fistula-in-ano. The lymphatic glands in the hollow of the sacrum, and those lying alongside the lumbar vertebræ, are enlarged at an early stage of the disease; the enlargement, however, is not necessarily malignant, but in the early stages may be the result of septic infection. The glands may press upon the lumbar and sacral nerves, and give rise to severe neuralgic pains resembling sciatica. The enlarged sacral glands may sometimes be recognised on digital examination of the rectum, and the lumbar glands by palpation through the abdominal wall. Metastatic growths most frequently occur in the liver and lungs, but may appear in any part of the body.

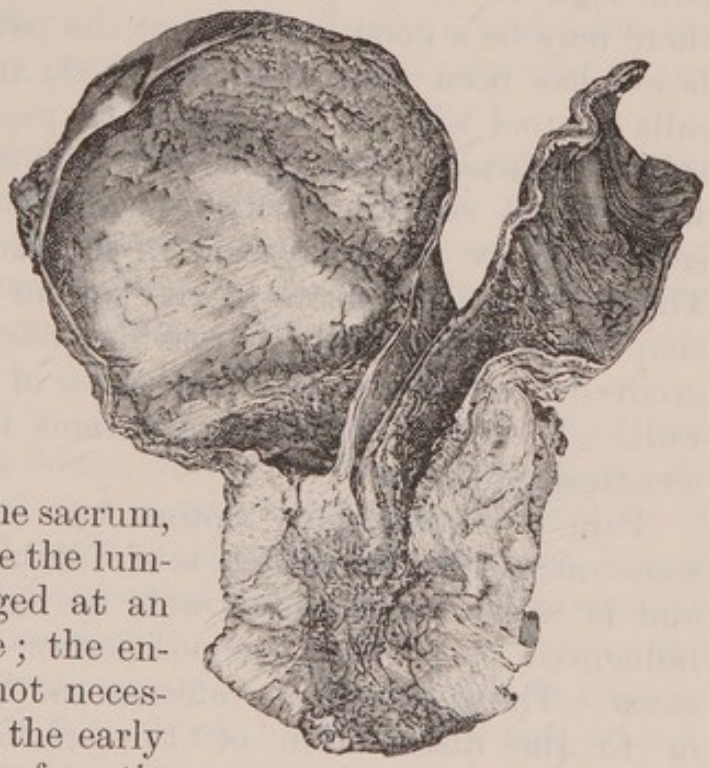


Fig. 121.—Colloid Cancer of the Rectum in a boy, æt. 12½, causing obstruction of the bowels and pressure on the urethra, which led to great distension of the bladder.

Clinical Features.—Cancer of the rectum is a disease chiefly of adult life, but is occasionally met with in patients considerably below twenty (Fig. 121). It is rather more common in men than in women. In the early stages of its growth the tumour gives rise to no characteristic symptoms. The first thing to arrest the patient's attention is an increasing difficulty in keeping the bowels regular, which necessitates the taking of

laxatives more frequently than hitherto. This is most marked when the tumour grows round the bowel and forms an annular stricture. Slight bleeding, which the patient is apt to attribute to piles, frequently accompanies the movement of the bowels. Alternating with this constipation are attacks of what the patient believes to be diarrhœa, but what is really the passage of a small quantity of thin fæces together with much blood-stained muco-purulent matter. This is usually passed soon after the patient gets out of bed in the morning, and is a characteristic sign of rectal cancer. After this "morning diarrhœa" there may be a good motion, but the patient never feels that the bowel has been completely emptied, and usually has repeated calls to stool without being able to pass more than some blood-stained mucus. The attempt to empty the bowel is attended with severe straining which may induce the formation of a certain degree of prolapse or of intussusception of the rectum. The solid motions passed by the patient are sometimes altered in shape, being flattened or tape-like, narrow like a pipe stem, or grooved according to the disposition of the growth in the rectal wall. The odour of the evacuations is extremely and characteristically offensive.

Pain is a variable symptom, but is usually present, and in some cases is agonising. It is of a stabbing or burning character, and is worst while the bowels are being moved. It is often influenced by posture, the position of ease varying in different cases. The pain may be referred to the bowel, to the sacrum, or to the distribution of the sciatic nerve, in which case it is liable to be mistaken for ordinary sciatica. When the bladder wall is invaded by the growth there may be pain and frequency of micturition, and if perforation occurs and a recto-vesical fistula is established, fæces and flatus may pass by the urethra.

On making a digital examination, if the growth is within reach of the finger, the irregular ulcerated surface, with firm, indurated edges, will be felt. The rectum is usually "ballooned," and the mucous membrane below the tumour healthy. The degree of fixation of the rectum, and its relations to adjacent parts can also be estimated. The hollow of the sacrum should be explored and infected glands sought for. When the diagnosis is doubtful, a piece of the growth may be removed for microscopic examination. In many cases a satisfactory digital examination is only possible under general anæsthesia, and when the growth is situated high up in the rectum the relaxation of the muscles thus induced enables the extent and connections of the growth

to be more definitely ascertained than is possible without an anæsthetic.

If left untreated, symptoms of chronic intestinal obstruction supervene, but the tumour seldom encroaches sufficiently on the lumen of the bowel to cause complete obstruction. If the narrowed lumen becomes occluded by a mass of fæces, however, the signs of complete obstruction ensue, but are never so acute and urgent as in cases of obstruction in the colon. Perforation of the bowel above the stricture occasionally occurs, and gives rise to septic peritonitis. The duration of the disease varies with the nature of the growth, the age of the patient, and other circumstances, but it usually proves fatal in from six months to two years of its onset.

Treatment.—For purposes of treatment cases of cancer of the rectum may be divided into those in which there is a reasonable prospect of being able to eradicate the disease, and those in which the surgeon cannot hope to do more than relieve the patient's suffering by forming an artificial anus above the site of the tumour.

The radical operation is indicated in all cases in which the tumour is confined to the bowel, or has formed but slight attachments to adjacent viscera, and in which there is no evidence of glandular invasion or of metastatic growths. It is no longer held that excision is contra-indicated if the tumour is beyond the reach of the finger, and invades the wall of the bowel above the point of reflection of the peritoneum. When excision is impracticable, or when the patient is too weak to justify the risk attending the operation, inguinal colostomy is indicated. A certain proportion of cases do not benefit from any form of operative treatment.

Excision of the Rectum—Proctectomy.—The rectum may be excised from below by an incision in the perineum (Langenbeck's operation); from behind by removing the coccyx and a portion of the sacrum (Kraske's operation and its modifications); or by a combined abdominal and perineal operation.

Opinions differ as to the value of a preliminary colostomy performed a week or ten days before the major operation. By some this measure is recommended on the grounds that it enables the bowels to be thoroughly emptied before the rectum is excised, and that it prevents the passage of fæces over the raw surface left by the operation. It is also urged that the opening into the peritoneal cavity will enable the surgeon to determine the upper limits and attachments of the growth and the condition of the pelvic and lumbar glands. Most surgeons only perform pre-

liminary colostomy if obstruction is actually present or is threatened.

The *perineal operation* is selected when the growth encroaches on the anal canal, and is well within reach of the finger. The patient is placed in the lithotomy position, and an incision is made backwards in the middle line from the posterior edge of the anus to the tip of the coccyx. If the tumour does not reach down to the anal orifice an attempt is made to conserve the external sphincter by carrying an incision round the bowel at the level of the white line of Hilton ; but if the anal region is invaded by the growth, and the external sphincter cannot be saved, the incision must be carried through the skin around the anus. The edges of the incision being held well apart, the rectum is separated from its surroundings with the aid of scissors and a blunt dissector, care being taken not to injure the urethra or prostate. An instrument should be passed into the bladder during this stage of the operation to indicate the position of the urethra. After the dissection has been carried for fully an inch above the upper limit of the tumour, the bowel is cut across. The bleeding having been arrested, a gum-elastic rectal tube is passed into the bowel to permit of the passage of flatus, and surrounded by a firm packing of iodoform gauze. The bowels should be kept closed with the aid of opium for four or five days. Frequent dressing of the wound is necessary to prevent septic complications, and to promote healing. The occasional passage of a bougie may be called for to prevent stenosis.

The *sacral operation* is employed when the tumour is situated too high to be reached from the perineum, and when the anal canal is intact and the sphincter can be preserved. The patient is placed on his right side, or on his face, with the pelvis well raised to diminish hæmorrhage, and an incision made from the middle of the sacrum, or along its left lateral margin, to the anus. The edges of the wound are then forcibly retracted, and the posterior aspect of the bowel exposed to a level well above the tumour by dividing the sacro-sciatic ligaments or removing a sufficient portion of the coccyx and sacrum. The rectum is then separated from its surroundings by the fingers or a blunt dissector. In separating the anterior aspect of the bowel, it is almost always necessary to divide the peritoneal reflection, and this should be done early and deliberately in order that the upper limits of the tumour may be defined and the bowel pulled down, and that precautions may be taken to prevent infection of the cavity during the operation, and to ensure that the opening may be efficiently closed or drained afterwards. The affected

segment of the bowel is now divided above and below the growth and removed. When possible the sphincteric region should be preserved in order that the upper end may be brought down and stitched to it, and so enable the patient to retain control of the bowels. When the whole circumference of the upper end cannot be brought into contact with the lower end, if possible the anterior walls should be stitched, to prevent extravasation of fæces into the cellular planes of the pelvis. When the rectum has to be removed right down to the anus, the divided upper end is stitched to the skin. The wound is packed with gauze and encouraged to heal by granulation. A certain amount of control of the bowels is usually obtained.

Colostomy.—In cases in which it is impossible to eradicate the disease, much relief may be afforded by colostomy. This operation should be performed before there are symptoms of obstruction. It can then be done in two stages, an interval of several days being allowed to elapse between the withdrawal of the loop and the opening of it. The resulting artificial anus gives less trouble if the external loop be completely divided across than if merely an opening is made into it.

In *inoperable cases* the palliative treatment consists in regulating the diet of the patient in such a way as to diminish the quantity of fæcal matter. The bowel should be washed out frequently with mild antiseptic lotions, such as boracic acid. When pain is a prominent feature opium must be given, either in the form of suppositories or by hypodermic injection.

Sarcoma is very rarely met with. When it occurs it originates in the submucous tissue, and is usually situated low down in the bowel near the anal orifice, where it forms a soft, globular mass, which grows rapidly and tends to fungate early. The sacral, lumbar, and inguinal glands are usually soon infected, and metastasis to the lung, pleura, or peritoneum is liable to occur early.

Sarcoma gives rise to symptoms very like those of cancer, but it usually occurs at an earlier age.

The *treatment* is carried out on the same lines as for cancer, but the great liability to local recurrence and to metastasis renders the prognosis even less favourable.

Epithelioma of the Anus.—Squamous epithelioma occurs at the muco-cutaneous junction. It begins as a nodular thickening of the skin or mucous membrane, which later develops a series of raw, warty projections on the surface. There is a scanty discharge of thin ichorous fluid, which dries on the sore and forms a crust. The base of the sore

is characteristically indurated. The tumour grows slowly, and tends to spread on the cutaneous surface rather than towards the lumen of the bowel. It causes a considerable amount of pain and slight bleeding. The inguinal lymphatic glands are usually enlarged. The *treatment* consists in excising the growth, and this usually entails sacrificing the sphincters.

Prolapse of the Rectum or Procidentia Recti.—The term "prolapse" is applied when any portion of the rectum is protruded beyond the anal margin. When the protrusion consists merely of the rectal mucous membrane, it is spoken of as a *partial* or *incomplete* prolapse; when all the coats of the bowel are protruded the prolapse is said to be *complete* (Fig. 122). The term "procidentia recti" is applied to the complete form. In the complete variety the peritoneum which forms the pouch of Douglas is sometimes dragged down in front of the prolapsed portion, and it is possible for a loop of intestine to enter the *cul-de-sac* thus formed.

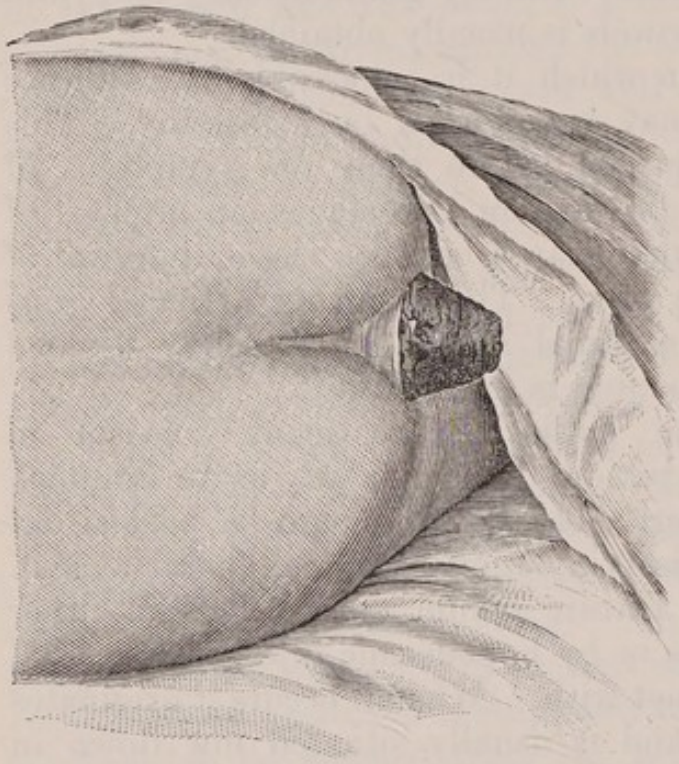


Fig. 122.—Complete Prolapse of Rectum in a woman, æt. 45.

While this condition may be met with at any period of life, it is most common in young children and between the ages of fifty and sixty.

Causes.—In most cases several factors contribute to the production of the prolapse, the most important and constant of which are undue laxity of the perineal and rectal tissues, including the sphincter and levator ani muscles, and some cause of repeated and excessive straining.

In young children, for example, after any exhausting illness the perineal muscles are liable to become weakened and relaxed, and the pads of fat which surround the rectum disappear, and thus the bowel is deprived of its natural support. If, under these conditions, the patient suffers from constipation, diarrhœa, rectal polypus, worms, phimosis, stone in the bladder, or any other condition which induces severe straining, prolapse of the

bowel is very liable to develop. The violent muscular efforts caused by whooping-cough, or bronchitis, may also determine the protrusion of the bowel in a weakly child. The condition has also been attributed to the pernicious habit of allowing the child to sit at stool long after the bowel has been emptied. In children the prolapse is, as a rule, of the partial or incomplete variety.

In adults, the cause of the condition is often obscure, but it is possible that loss of fat and muscular weakness may predispose to the production of prolapse, which may be determined by such causes for straining as constipation, piles, rectal polypus, vesical calculus, or enlarged prostate. In adults the prolapse is usually of the complete variety.

Clinical Features.—In the early stages, the condition consists merely in an exaggeration of the normal protrusion of the anal mucous membrane which accompanies the final expulsive effort of the bowel in defecation. This gradually increases until the prolapse forms a conical projection which varies in length from two to five or six inches. The mucous membrane of the protruded portion shows a series of circular or crescentic folds, and is at first of a pink or bright red colour, but, if it remain out for some time and be grasped by the sphincter, it assumes a bluish or purplish hue. At the apex of the cone is found the lumen of the bowel, while at its base the mucous membrane becomes continuous with the skin around the anal orifice.

At first the protrusion can be readily returned inside the anus, but it tends to reappear if the patient coughs or strains, or, in some cases, even if he stands up. As the prolapse increases in size, its reduction becomes more and more difficult, owing to constriction of its base by the sphincter, and œdematous infiltration of the submucous tissue. Eventually it may remain down permanently, in which case it becomes paler in colour, and the mucous membrane becomes altered so as to resemble skin. Superficial ulcers are liable to form on this extruded surface, and in some cases sloughing of a part, or of the whole, of the protrusion takes place.

In the more severe cases the patient may suffer from pain and difficulty in micturition, and from shooting pains in the loins and legs.

The only condition for which a prolapse is liable to be mistaken is an intussusception which has passed beyond the anal orifice. The distinction is readily made by noting that in intussusception the finger can be passed into a *cul-de-sac* between the anal margin and the protrusion, and the mucous membrane

covering the protrusion is not continuous with the skin around the anus.

Treatment.—The *reduction* of a prolapse, for example in a child, is best effected by raising the patient's pelvis—a good method is to have the child held up by the heels—smearing the protrusion with vaseline, and applying gentle pressure over the apex of the cone. After the mass has slipped through the anus, a soft pad is placed between the nates and fixed securely in position by a T-shaped bandage, or the buttocks may be pressed together and held in this position by a series of strips of adhesive plaster passed from one trochanter to the other. The patient should remain recumbent for an hour or two after reduction.

With regard to the further treatment, the first step is to discover, and, if possible, remove the cause of the condition. The general health of the patient must be improved, and the muscular system braced up. Constipation or any other existing cause of straining must be corrected, and means taken to ensure easy and regular movement of the bowels.

Injections of ice-cold water, or of astringent lotions, such as tannic acid, alum, or sulphate of iron, are sometimes useful. The patient should be made to defecate while lying on the back or on the side. If the bowels are costive a small injection of olive oil will facilitate passage. In children these preventive and palliative measures usually suffice, and it is seldom necessary to have recourse to operative treatment.

In adults, on the other hand, it is, as a rule, only by operative measures that a cure can be effected, and various procedures are employed according to the severity of the condition. In moderately severe cases the lower three or four inches of the mucous membrane may be cauterised by making a series of longitudinal eschars with a thermo-cautery. Care must be taken not to destroy the whole thickness of the mucous membrane, lest septic infection of the sub-mucous layer be set up.

In more severe cases a series of elliptical pieces of mucous membrane may be excised and the edges of the wounds united with catgut sutures.

When these measures are inappropriate or have failed, the whole of the prolapsed segment of the bowel may be excised, and the divided upper edge pulled down and sutured to the anal margin. Special care must be taken to return any portion of bowel which may be herniated into the prolapsed portion of peritoneum before proceeding with this operation. This can usually be effected by placing the patient in the Trendelenburg position. If possible the peritoneal pouch should not be opened;

but if this cannot be avoided, then every precaution must be taken to prevent it becoming infected. Equally satisfactory results are obtained by *colopexy*, the abdomen being opened and the pelvic colon pulled up and fixed by stitches passed through its mesentery, and the peritoneum and transversalis fascia along Poupart's ligament.

CHAPTER XXXII.

THE KIDNEY AND URETER.

Surgical anatomy—Terms denoting alterations in urine—Palpation and percussion of kidney — Cystoscope — Catheterisation of ureters — Kryoscopy. Operations on kidney and ureter—Congenital anomalies: *Horse-shoe kidney; Absence and displacement of kidney; Abnormalities of ureter*—Acquired displacements: *Movable or wandering kidney*—Contusion and rupture of kidney—Open wounds—Injuries of ureter—Hydronephrosis—Infective conditions: *Pyelitis; Pyelonephritis; Pyonephrosis*—Stone in the kidney and ureter—Calculous anuria—Tuberculosis—Perinephritis and perinephric abscess—Tumours and cysts of kidney and pelvis—Surgical aspects of nephritis.

Surgical Anatomy.—The kidneys are situated in the loins, lying behind the peritoneum in a mass of extra-peritoneal fat. They are applied against the posterior abdominal muscles close to their attachment to the last dorsal and upper three lumbar vertebræ, the psoas muscle intervening between the kidney and the transverse processes of the vertebræ (Fig. 124). The left kidney reaches slightly higher than the right, its upper border being on the level of the upper margin of the seventh costal cartilage, while that of the right kidney only reaches to the lower margin of the same cartilage. As viewed from the front the greater part of each kidney lies to the inner side of a line drawn vertically upwards from the centre of Poupart's ligament (Fig. 123). The kidneys are placed obliquely, so that one surface looks forwards and outwards, while the other looks backwards and inwards.

The layer of extra-peritoneal fat which immediately invests the kidney is termed the *adipose capsule*, in contra-distinction to the *fibrous or true capsule*, which is in immediate contact with the kidney. The *perirenal fascia* is a thin fibrous layer which surrounds the fatty capsule forming its outermost layer, and which is united to the true capsule by fibrous bands traversing the fat. The perirenal fascia is incomplete below, and its anterior layer is intimately blended with the parietal peritoneum. The pleural reflection passes from within outwards obliquely across the upper end of each kidney, and crosses the long axis of the eleventh and twelfth ribs. The right kidney is related in front to the supra-renal capsule, the liver, the descending part of the duodenum, and the hepatic flexure of the colon. The left kidney is related in front to the supra-renal capsule, the stomach, pancreas, and spleen, and to the splenic flexure of the colon and the upper coils of small intestine.

The ureter lies behind, and is closely adherent to the peritoneum covering the psoas muscle. It descends almost vertically about an inch and a half from the mesial plane, and dips into the pelvis in front of the termination of the common iliac artery, two fingers' breadths above a point where a line between the anterior superior iliac spines cuts a vertical line from the spine of the pubes. The renal blood-vessels enter at the hilum, the vein lying in front of the artery. The ureter lies behind the vessels. The lymphatics pass from the hilum to the retro-peritoneal lumbar glands.

The Urine.—Various terms are employed in relation to the amount and

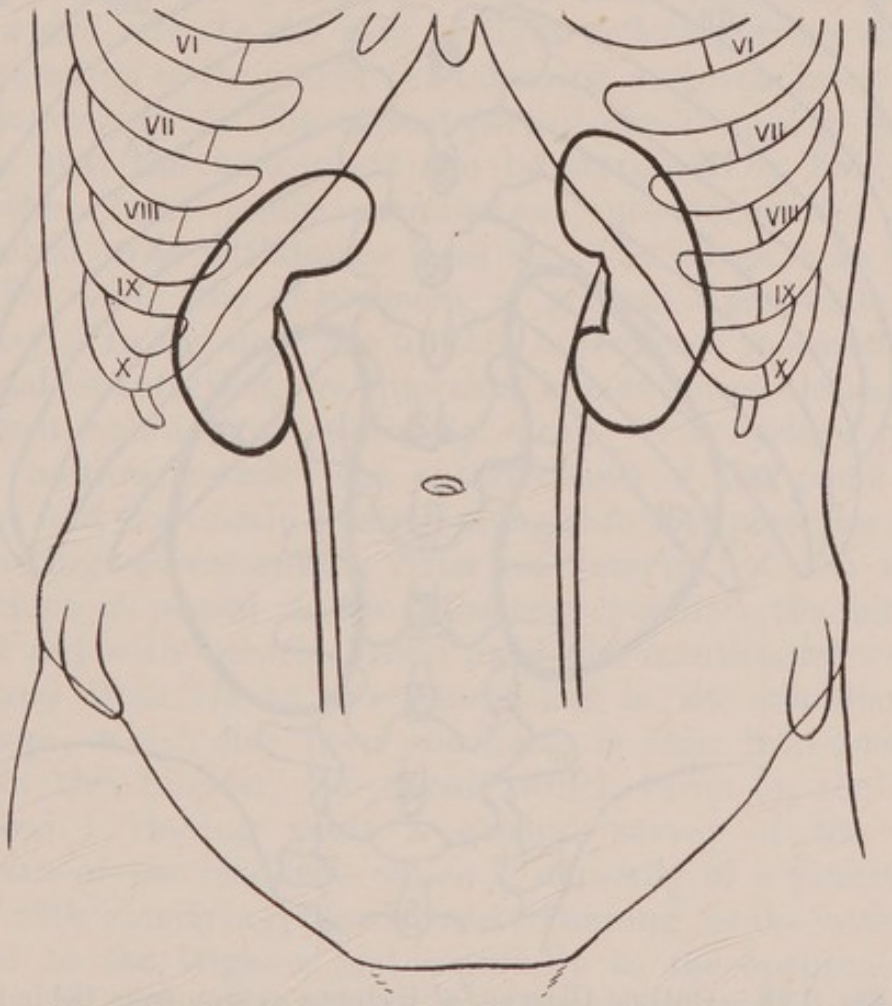


FIG. 123.—Outline Diagram of Kidneys as viewed from the front.

(After Stiles, Cunningham's *Text Book*.)

character of the renal secretion: thus *polyuria* indicates an increase in the amount of urine, *oliguria* a diminution, and *anuria* a complete suppression or arrest of secretion. *Hæmaturia* implies an admixture of the urine with blood, *pyuria* an admixture with pus. The term *bacteriuria* is employed when the urine contains micro-organisms, and *albuminuria* when albumin is present.

Methods of Examination.—*Palpation.*—The kidneys can only be palpated through the abdominal wall if enlarged or unduly movable, and even in the presence of renal disease the results of palpation are often negative. Such negative results,

however, are often of great value in diagnosis. The patient rests on his back, with the head and shoulders raised and the thighs acutely flexed to relax as far as possible the abdominal muscles. One hand of the observer is placed in the loin below the ribs, and the other on the anterior abdominal wall, and while the region of the kidney is being palpated the patient is asked to take deep breaths. The same procedure is repeated in the lateral

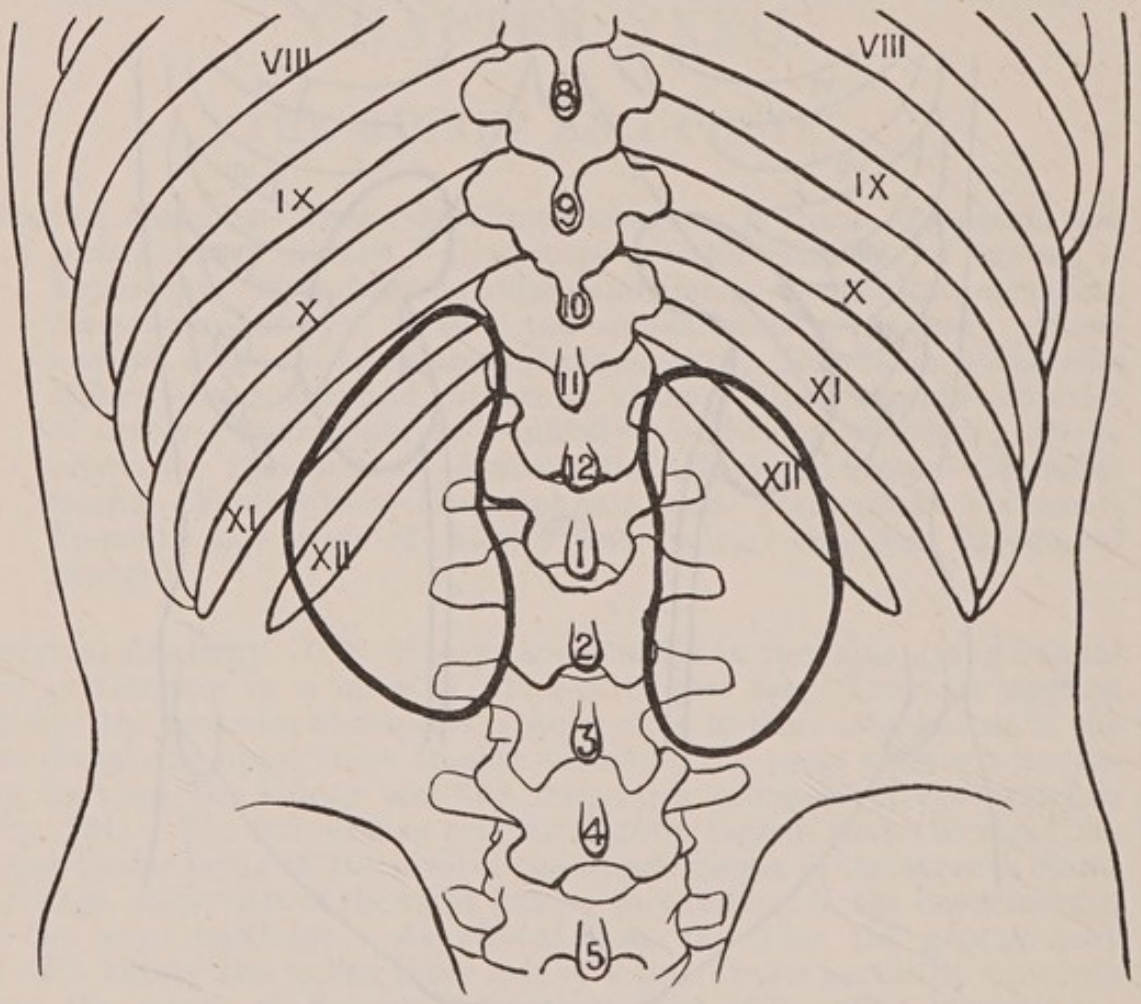


FIG. 124.—Outline Diagram of Kidneys as seen from behind.

(After Stiles, Cunningham's *Text Book*.)

position, the patient resting on the healthy side. If the kidney is enlarged it is felt to project beyond the costal margin, and if it is movable it slips up and down with respiration and tends to fall towards the middle line when the patient lies on the side. Anæsthesia is a valuable aid to palpation, especially when the muscles cannot be voluntarily relaxed.

Percussion may be useful in differentiating tumours of the kidney from those of the liver, intestine, or spleen, and in determining the position of the colon with regard to a supposed renal tumour. On the right side the ascending colon lies along the

inner side of a renal tumour; on the left, the descending colon crosses in front of it.

Examination of the Bladder with the Cystoscope.—This instrument resembles a sound in shape. The beak, which is about an inch long, joins the shaft at an open angle and contains near its tip an incandescent lamp, by which the interior of the bladder is illuminated, the wires passing back inside the shaft to be connected with a suitable battery. The shaft also contains a telescope. At the junction of the shaft and the beak is a prism which refracts the rays of light reflected from the object illuminated on to the end of the telescope, and thus into line with the observer's eye. The optical part of the cystoscope is removable, so that the instrument can be sterilised by boiling. To bring the object under examination into focus the beak is approached to or withdrawn from it. The image is an inverted one. In using the instrument a general anæsthetic is not necessary. In the male the urethra is rendered insensitive, after the usual disinfection, by injecting two or three drachms of a 1 per cent. solution of eucain by means of a syringe provided with a urethral nozzle; the anterior end of the penis is then clamped and the eucain pressed along into the posterior urethra by stroking movements. After an interval of ten minutes, the patient is placed in the lithotomy position, the bladder is washed out with boracic lotion until the solution returns quite clear, and from six to ten ounces left in the bladder. The cystoscope, which has been sterilised, is then introduced, and when in the bladder, the circuit which turns on the light is completed. Having made a general survey of the mucous membrane of the bladder—which is normally of a pinkish-white colour with ramifying blood-vessels running in it—attention is directed to the trigone, and especially to the openings of the ureters. If the ureters are functionating and if the urine escaping from them is normal, a wave-like movement is visible in the fluid each time the orifice opens. If there is pyuria from one kidney, minute particles are seen floating in the wave of fluid like dust in a sunbeam. If there is hæmaturia, a whorl of bloody urine is seen to escape or a blood-clot may project from the ureteral opening. In unilateral renal disease the ureteral orifice may project or be retracted, or the mucous membrane around it may be markedly injected or show minute superficial ulcers. It is important to observe whether there are two ureteral openings, and if so, whether both are functionating.

Separation of the Secretion from each Kidney—"One-Kidney Urine."—Various instruments, known as *separators*, have been

devised with the object of obtaining the secretion from each kidney. They are provided with a partition, which, after the instrument has been introduced into the bladder, is projected in such a way that it forms an antero-posterior septum between the ureteral openings, the urine which escapes on either side of the septum being conveyed by a separate canal in the shaft of the instrument into a receptacle.

Catheterisation of the ureters is more reliable, although it requires more skill and practice on the part of the observer. The ureteral catheters, which are made of silk, are sterilised by boiling in a saturated solution of ammonium sulphate, and are preserved dry in sterilised glass cylinders. Before use they are dipped in sterile glycerine. A preliminary examination with the simple cystoscope enables the operator to determine whether the ureteral openings will lend themselves to catheterisation, or whether this is impossible, as, for example, on account of marked swelling of the mucous membrane, extensive ulceration, or pronounced fasciculation of the bladder. If feasible, the cystoscope, armed with a ureteral catheter, is introduced, the bladder having been again washed out and filled with boracic solution. The ureteral opening—say, on the left side—having been brought into view at the lower part of the field, in order to introduce the catheter, the eye-piece of the cystoscope must be pushed to the opposite side and elevated. The head of the observer will then be close to the right thigh of the patient. Along with the cystoscope, the catheter is slowly pushed onward until its point enters the ureteral orifice, without touching the vesical mucous membrane. The catheter is pushed in for a distance of about three-quarters of an inch, the stylet withdrawn, and the urine collected. The urine from the other kidney accumulates in the bladder, and may be drawn off with an ordinary catheter, but it is better to catheterise the second ureter immediately after collecting a sufficient amount of urine from the first. In the female the second catheter may be introduced while the first is still in position. The urine obtained from each kidney is examined chemically, microscopically and bacteriologically, and its concentration determined by testing the freezing-point with Beckmann's apparatus.

In the female, the ureters may also be *catheterised directly* by Kelly's method. The patient is placed in the genu-pectoral or in the lithotomy position, with the pelvis elevated. The urethra is dilated until the speculum with its obturator can be introduced. When the obturator is withdrawn the bladder fills with air, and is illuminated by means of a frontal mirror re-

flecting sun or electric light. The ureteral orifice is searched for and tested with a probe before the catheter is introduced. The procedure is repeated on the opposite side.

Methods of Testing the Adequacy of the Excretory Functions of the Kidney.—Of these methods, which are of comparatively recent introduction, the best known is *kryoscopy*, or the *estimation of the freezing-point of the blood.* The introduction of this procedure is chiefly due to the influence of Koranje, while its merits have been especially advocated by Kümmell. The freezing-point is determined by Beckmann's apparatus. The greater the concentration of a fluid, the lower is its freezing-point, that of distilled water being reckoned as zero. Provided the excretion by the kidneys is maintained at the normal standard, the freezing-point of the blood remains constant, the average being ·56° Celsius. When both kidneys are diseased, there is diminished excretion, the blood becomes more concentrated and its freezing-point is lowered, while the urine becomes less concentrated and its freezing-point raised. When one kidney is extensively diseased, and the other only slightly affected, the concentration of the blood may not be altered, provided the healthier kidney is able to perform the excretory functions of both. Disease confined to one kidney does not affect the concentration of the blood. In practice, therefore, it may be assumed that a normal freezing-point of the blood (·56° Celsius) indicates that the renal affection is confined to one kidney, and that removal of that kidney may be undertaken with the assurance that the remaining kidney will be able to perform the work of both. On the other hand, if the freezing-point falls to ·6° Celsius or lower, removal of the diseased kidney may be fraught with serious danger from uræmia. The freezing-point of the urine, especially of the urine obtained separately from each kidney by the ureteral catheter, affords corroborative information as to their respective excretory capacities. Kryoscopy is of great value in the diagnosis of renal affections, in helping to decide the nature of the operative interference, and in forming a prognosis in many diseases affecting the urinary organs as a whole.

Operations on the Kidney and Ureter.—*Nephrotomy* implies exposure and incision of the kidney, usually from the loin; *pyelotomy*, incision of the renal pelvis. If the incised kidney is kept open by packing or tubes for purposes of drainage, the procedure is called a *nephrostomy*. *Ureterotomy* implies the exposure and incision of the ureter. The exposure and fixation of a movable kidney is known as *nephropexy* or *nephroraphy*. *Resection of the kidney* refers to the removal of a portion of the

organ for localised disease or injury. *Nephrectomy* implies the removal of the entire organ. *Nephro-lithotomy* refers to the incision of the kidney for the removal of stone. *Ureterectomy* refers to the removal of part or the whole length of the ureter. Operations on the pelvis and ureter are described in relation to hydronephrosis.

Congenital Anomalies of the Kidney.—Persistence of the *fœtal lobulation* of the kidney is occasionally met with, but is of little or no importance. The condition of *horse-shoe kidney* consists in the two kidneys being fused at their lower ends. The bridge of tissue joining them usually lies in front of the third lumbar vertebra, and is crossed by the ureters. One half of it may become the seat of disease, for example hydronephrosis, while the other half is healthy. Under normal conditions it is rarely possible to palpate a horse-shoe kidney.

Congenital absence or *arrested development* of one kidney is a possibility which should always be borne in mind when considering the question of nephrectomy. Disease of a solitary kidney is attended with a lower freezing-point of the blood, but the most conclusive evidence of the presence of two functionally active kidneys is the demonstration with the cystoscope of two normally placed functionating ureteral openings. The absence of one kidney is sometimes associated with defective development or imperfect descent of the testicle on the same side. On the side on which the kidney is congenitally absent there are no renal vessels, and the ureter also is absent. In cases of arrested development the affected organ is rarely larger than a bean or a walnut, the renal vessels are present, and the ureter, although narrow, may be patent and admit a probe or catheter, especially at its lower end. Where one kidney is rudimentary or absent the other is usually considerably enlarged.

Congenital Displacement or *Dystopia.*—The kidney may lie nearer the middle line than normal, or it may be displaced downwards so that it lies on a level with the sacral promontory, or even in the cavity of the pelvis. Anatomically this congenital displacement is differentiated from the acquired variety—the wandering kidney—by the low origin of the renal vessels which may spring from the common or internal iliac arteries. Clinically the condition may pass unobserved, unless the displaced kidney becomes the seat of disease, for example hydronephrosis or calculous pyonephrosis. Under these circumstances it may be difficult to diagnose the condition from tumours of the bowel, of the broad ligament and Fallopian tube, or of the retro-peritoneal tissue.

Congenital Anomalies of the Ureter.—*Abnormal origin of the ureter* from the pelvis of the kidney, with the formation of a valve at the orifice, is an important cause of hydronephrosis.

Double ureter is met with in a variety of forms. There may be two complete ureters draining the one kidney and opening separately into the bladder, or the ureter may only be double at its upper end. In cases of double ureter, hydronephrotic and pyonephritic processes are liable to occur, and may be confined to one segment of the affected kidney. This may result, for example, from *abnormal termination of the supernumerary tube*, the lower end of which may be so narrow, or may pass so obliquely through the wall of the bladder, that the outflow through it is interfered with and there results a hydronephrosis of the portion of kidney drained by it. In other cases the intramural portion of the ureter becomes distended into a cyst, which may interfere with the emptying of the bladder by projecting like a tumour into its interior, or may even compress the normal ureter of the opposite side. In some cases the supernumerary tube does not open into the bladder at all. In the male it may open into the prostatic urethra or seminal vesicle, but as the opening is controlled by the sphincter muscles, it does not cause any abnormality in micturition, and the condition is practically never diagnosed during life. In the female it may open into the urethra, vagina, or vestibule, and cause a continuous dribbling of urine, which is beyond the control of the patient. The usual history in such cases is that from childhood there has been a minor degree of incontinence or dribbling, although the patient is able to pass urine in a normal stream when she wishes to do so. This is pathognomonic of one ureter opening into the bladder and of an additional one opening into the urethra, and the diagnosis is completed by recognising the abnormal opening. If operative treatment is called for, the abdomen should be opened, the supernumerary ureter cut across and inserted by a fresh opening into the bladder.

Abnormal Mobility and Acquired Displacements of the Kidney—Nephroptosis.—A kidney which moves abnormally freely behind the peritoneum is said to be *movable;* one which moves forwards, or floats, towards the anterior abdominal wall is spoken of as a *wandering* or *floating* kidney. In the second variety the peritoneum and the layer of perinephric fascia in front of the kidney become loosened and the renal vessels elongated; a meso-nephron is extremely rare. The suprarenal capsule does not accompany the kidney in its wanderings.

Movable kidney is chiefly met with in women between the

ages of twenty and forty, and is about twelve times more frequent on the right than on the left side. In some cases the mobility is bilateral.

The most important factor in the *causation* of abnormal renal mobility would appear to be an inherited and congenital peculiarity in the anatomical relations of the kidney. This is evidenced by the frequency of the condition in certain families, its association with congenital anomalies in the shape of the kidney, and in the origin of the renal vessels, and the faulty formation of the niche or pocket in which the kidney lies. It is such congenitally disposed kidneys which become prolapsed and abnormally mobile from such determining or exciting causes as: (1) diminution in the intra-abdominal pressure from loss of tone in the abdominal muscles, emaciation with loss of the perirenal fat, repeated pregnancies, or the removal of large abdominal tumours; (2) alterations in the shape of the thorax produced by tight lacing; and (3) the disturbance of parts by falls on the feet or buttocks, violent gymnastics, and the lifting of heavy weights. When normally formed individuals are subjected to similar influences they do not tend to develop abnormal renal mobility.

Secondary Changes in the Displaced Kidney.—As it descends, in virtue of its pedicle the organ as a whole swings towards the middle line, and at the same time it rotates so that the upper pole moves forwards. The latter movement causes traction on the pedicle, and tends to bring about torsion or kinking of the renal vessels and of the ureter. Being fixed by the peritoneum, the ureter does not readily follow the kidney in its descent, and any alteration in its direction may interfere with the outflow of urine from the pelvis and induce hydronephrosis. As a result of inflammatory attacks, the organ may become fixed by adhesions in its abnormal position. The normal congestion of the kidney which accompanies menstruation is usually exaggerated.

The *clinical features* are subject to wide variations, and are not proportionate to the degree of abnormal mobility. In many cases there are no symptoms, and the condition is discovered accidentally in the course of an examination of the abdomen. In other cases the chief complaint is of vague abdominal pains, accompanied by symptoms which may be included under the term neurasthenia, and in some the patient only complains of symptoms after having been told that she is the subject of floating kidney. It is only in a minority of cases that there are *symptoms directly referable to the renal displacement.* These consist in pain and dragging sensations in the loin and on one side of the abdomen. The pain may shoot down the thigh,

it is aggravated by standing, walking and exertion, and is usually, but not always, relieved by lying down. Sometimes there are painful crises like renal colic, which last for several hours and are attended with shivering, vomiting, and pain down the ureter. During these attacks the kidney is tender and sometimes enlarged, and the amount of urine is diminished; after the attack the secretion of urine exceeds the normal. These attacks are believed to be due to torsion of the pedicle of the kidney, and especially to kinking or twisting of the upper end of the ureter, because it is usual to have a history of such attacks in cases of movable kidney which terminate in hydronephrosis. The irritation of vaso-motor and sensory nerve fibres in the pedicle is probably a factor in producing these phenomena.

Physical Examination.—If the kidney is displaced at the time of examination, a tumour is felt in the abdomen which corresponds in size and shape to the kidney, and which is easily replaced in the kidney recess. Although usually found on the same side of the abdomen as that to which the kidney belongs, it may be found on the other side. We have ourselves observed the right kidney engaged in the brim of the pelvis and easily felt per rectum. If the kidney is not displaced at the time of examination, it can usually be brought down by the patient taking a series of deep respirations, while the abdominal muscles are relaxed by flexing the trunk and the hips. At the end of the first inspiration the examiner's fingers are pushed in simultaneously from the front below the costal margin and behind, and with each successive expiration they are pushed in more deeply until the maximum displacement is brought about.

Three degrees of mobility may be recognised: a first in which the lower pole of the kidney can be grasped between the fingers towards the end of a deep inspiration; a second in which the greater part or the whole of the organ can be grasped, but ascends again during expiration; and a third in which the whole kidney descends below the examining fingers and can be retained in this position during and after expiration, or can be moved about in the abdominal cavity. If the examination is negative in the dorsal position, it should be repeated with the patient lying on the healthy side, or in the knee-elbow attitude. The first degree of mobility may be difficult to recognise in thick set and stout individuals. It may be possible to recognise the mobility on some occasions and not on others; hence the necessity of more than one examination if the first is negative.

The *diagnosis* of floating kidney from other abdominal tumours

is usually easy, but difficulty may arise in relation to a distended gall-bladder, a partially separated "constriction lobe" of the liver, an ovarian cyst or uterine fibroid with a long pedicle, a tumour of the colon or of the pylorus. Chief stress is to be laid on the fact that it is impossible to cause any other tumour than a floating kidney to disappear by pushing it into the renal pouch.

The existence of abnormal renal mobility having been demonstrated, the patient should be further examined with the object of determining whether the symptoms complained of are due to such mobility or to some other cause, for example, organic disease of the kidney, uterine displacement, disease of the uterine appendages, dilatation of the stomach, or enteroptosis. In cases attended with symptoms of neurasthenia and of gastro-intestinal disturbance, it is often difficult to estimate how far the renal mobility is responsible for these.

Treatment.—In the great majority of cases the condition can be relieved or cured by non-operative measures. Any affection of the stomach, bowels, or generative organs must first be remedied. The patient should be advised to avoid standing as much as possible, and to lie up at the menstrual periods. Where the nervous symptoms are prominent, the patient should be reassured, and such measures as massage, baths, and electricity should be employed to tone up the nervous system. It may even be necessary to have recourse to the Weir-Mitchell treatment.

As regards the use of a *belt* or *bandage*, it is to be borne in mind that the object of such an appliance is to retain the viscera which tend to prolapse by raising equably the intra-abdominal pressure, and replacing the muscles which have lost their tone. The best appliance is a corset made of elastic webbing and strengthened at the sides and in front by light steel springs (Israël). The support to the kidney may be further increased by an air cushion fastened within the corset; the cushion is triangular in shape, its base corresponding to the nipple line, and the two sides to the costal margin and iliac crest respectively. The corset should be applied when the patient is in the dorsal position with the pelvis elevated. When such a corset is not obtainable, the abdomen may be supported by a large pad of wool and a wide domette roller bandage.

Cases of renal mobility attended with symptoms of torsion of the pedicle, are to be regarded as belonging to a different category. During the crisis the patient is confined to bed, the foot of the bed is elevated, and hot fomentations are applied to the loin.

The operation of nephropexy is recommended when there are

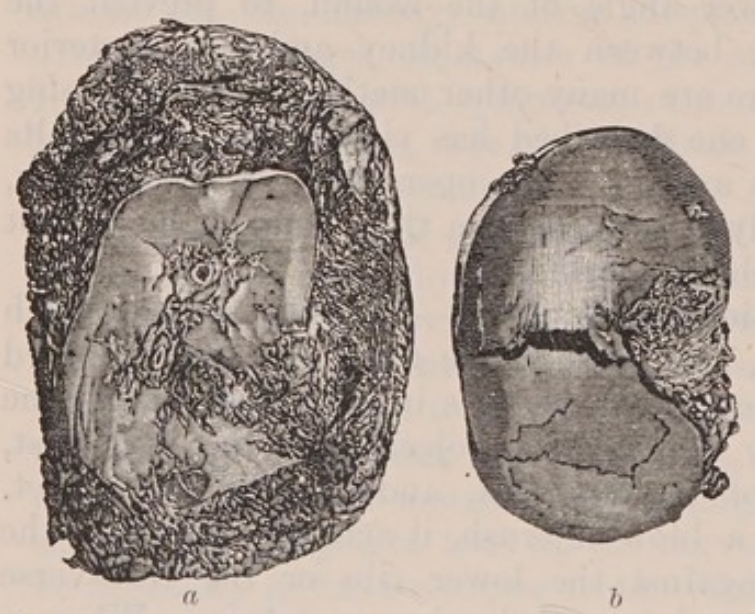
recurrent attacks of colic likely to be followed by hydronephrosis. In cases complicated with neurasthenia the operation is not only uncertain to cure the patient, but may prove a disappointment and do harm.

The operation consists in exposing the kidney by the usual lumbar incision and protruding it from the wound; chromic gut sutures are passed deeply through the capsule and parenchyma, after which the organ is replaced; the upper or anterior ends of the sutures are passed round the last rib, and the lower or posterior through the lumbar fascia and muscles, and are tied so as to anchor the kidney securely in its normal position. A drain is inserted at the lower angle of the wound, to prevent the accumulation of fluid between the kidney and the posterior abdominal wall. There are many other methods of performing the operation, but the one described has yielded the best results in our hands. In this and in other operations on the kidney, the organ is more easily protruded from the wound if the patient lies prone over an Edebohl's cushion.

INJURIES.—**Contusion and Rupture.**—These injuries are much more frequent in men, not only because males are more exposed to severe forms of violence, but because in the adult female the kidney is protected by the greater projection of the iliac crest, the greater amount of perirenal fat, and also by the corset. When the violence is a blow or crush, it acts directly upon the kidney, or drives it against the lower ribs or the transverse processes of the first and second lumbar vertebræ. When a person falls from a height, the kidney is injured by the sudden concussion of the body or by its abrupt flexion. In some cases other viscera, such as the liver or spleen, are ruptured at the same time. Where bruising of the kidney follows on muscular effort or on comparatively slight forms of violence, the presumption is that the organ was previously the seat of organic disease.

Morbid Anatomy.—In *contusions* the capsule and pelvis of the organ remain intact, and blood is extravasated into the perirenal fat, or into the parenchyma, whence it passes down the urinary tubules into the pelvis. When the organ is *ruptured* there are one or more deep fissures passing through the capsule and parenchyma (Fig. 125 *b*), and often extending into the pelvis; the organ may be completely torn across. In these injuries there is severe hæmorrhage, the blood infiltrates the perirenal fat (Fig. 125 *a*), and may spread widely in the loose cellular tissue behind the peritoneum. If the ureter remains patent, the blood passes down into the bladder, which may become distended with clots. In children, because of the absence of perirenal fat, the

peritoneum is liable to be torn, and the blood is then poured into the peritoneal cavity. If the rupture involve the pelvis, urine escapes into the surrounding tissues and follows the track of the extravasated blood. Rupture of the renal artery or of one of its main branches, and avulsion of the ureter, are occasionally met with. The risk from hæmorrhage is followed by that from septic infection, as pyogenic organisms derived from the blood or from the adjacent colon readily flourish in devitalised or detached portions of the kidney and in the extravasated blood, especially when it is mixed with stagnant urine. In the absence of septic infection, ruptures of the kidney heal rapidly and well, provided the blood supply is sufficient.



a *b*

FIG. 125.—*a*, Contusion of Kidney with extensive extravasation of blood into the perirenal fat; *b*, Rupture of Kidney, showing fissuring of the organ.

Clinical Features.—Immediately after the injury, the local symptoms are masked by shock, which is profound and lasting in proportion to the severity of the lesion. Shock is succeeded by nausea, vomiting, and pain in the region of the kidney and radiating down to the thigh and into the testicle. After subsiding for a time, the pain may return in the form of renal colic, due to the passage of clots down the ureter. There is marked tenderness in the region of the kidney, the abdominal muscles on the same side are rigidly contracted, and the bowel may become distended with gas, even although the peritoneum is uninjured. Bruising of the overlying soft parts is exceptional. Hæmaturia is one of the most important signs of injury to the kidney, being absent only in cases where the ureter is blocked by a clot, or where it has been torn off from the kidney. The blood may be small in amount—in slight contusions being only detectable by the microscope—more often it is abundant and pours down the ureter. If the bladder contains urine, the blood mixes with it, and the patient soon experiences a desire to micturate, and what is passed is seen to be tinged with blood or to resemble pure blood. If the bladder is empty, the blood accumulates and

clots in its interior, so that when the patient desires to urinate he is unable to pass anything, or only a few clots, in spite of severe and painful straining. In cases which recover, the hæmaturia lasts for from two to five days. In severe injuries the hæmorrhage may be very profuse; it aggravates the shock and causes increasing bloodlessness which may terminate fatally. Later or recurrent hæmaturia is due to the breaking down of clots either as a result of admixture of urine or of septic changes.

Swelling in the loin, due to perirenal extravasation of blood or of blood and urine, is present in most cases in which the kidney is actually ruptured; it is diffused over the loin, is hard, fixed, and very sensitive. When the hæmorrhage is abundant the swelling forms early, and as it increases it is accompanied by an aggravation of the bloodless state. Hæmorrhage into the renal substance, if the capsule remains intact, may be recognised by increase in the size of the kidney, forming a circumscribed, rounded, and mobile swelling which may be palpated and moved on bimanual examination.

If the peritoneum is torn, the blood pours into the peritoneal cavity, a condition which may be recognised by increasing dullness in the dependent parts of the belly, together with increasing anæmia and shock. Death usually results from shock or from septic peritonitis.

Diminution or suppression of the urinary secretion is a rare complication and is due to direct interference with the injured kidney, aided by the bloodless state and shock. It may be a cause of death.

Septic Infection is the chief danger in cases which do not succumb to shock, hæmorrhage, or suppression of urine during the first forty-eight hours. The septic changes may affect the kidney itself, but more frequently they occur in the blood and urine extravasated into the perirenal tissues. They may appear within a few days or may be delayed for weeks or even months. They have been observed to follow the use of an imperfectly sterilised catheter. Their occurrence is attended with a rigor and irregular fever, and with increased size and greater tenderness of the swelling in the loin; the urine is diminished in amount and often contains pus. In cases which occur early, the perirenal suppuration assumes the character of a diffuse suppurative cellulitis, the pus and decomposing urine surrounding the ruptured and inflamed kidney; in later cases the suppuration is encysted by reaction of the surrounding tissues, constituting a localised abscess. When infection spreads up from the bladder it may also involve the opposite kidney.

Treatment.—In cases seen soon after the injury, attention is directed to the relief of urgent symptoms—pain, shock, and hæmorrhage. In slight cases the patient is merely confined to bed, and a large mass of wool is retained over the loin by a firm flannel bandage, the diet is restricted to fluids, and urotropin is given to diminish the tendency to septic changes.

In severe cases the question of *operative interference* must be considered without delay. The indications demanding it are evidence of increasing loss of blood, whether external or internal, rapid increase of the swelling in the loin, or marked diminution in the amount of urine. The objects aimed at are to arrest the hæmorrhage, to afford a free outlet for the perirenal collection of blood and urine, to relieve the pressure which may be interfering with the function of the kidney, and to anticipate and prevent septic changes.

The kidney region must be freely opened up by the usual lumbar incision. If bleeding is still going on it must be arrested, if necessary by compression of the vessels at the hilum. If the organ is deeply ruptured but still viable, the rupture is closed with deep catgut sutures or packed with gauze. Completely detached portions are removed. If the kidney is crushed to a pulp, if the main vessels are ruptured, or if the ureter is torn across, the entire organ is removed—*primary nephrectomy*. If the bladder is distended with clots and micturition seriously interfered with, it should be emptied by means of the litholapaxy evacuator, and, if this fails, it should be opened from the perineum and a large drainage tube introduced, otherwise septic cystitis and ascending infection of the kidneys may supervene. If prolonged shock and symptoms of hæmorrhage point to tearing of the peritoneum over the kidney, the abdomen must be opened from the front, the blood removed, and the kidney dealt with as the injury demands.

In many cases there is no indication for immediate operation. *The later conditions which necessitate interference* are the occurrence of septic changes as shown by increase in the lumbar swelling, rigors, fever, and sweating. The swelling is then freely incised from the loin and drained. Whether or not the kidney is removed—*secondary nephrectomy*—will depend, not only on the condition of the affected kidney, but also on that of the opposite side.

Open wounds of the kidney are usually the result of stabs or gunshot injuries. The situation and direction of the external wound may suggest that the kidney has been injured, and the suspicion is confirmed if blood appears in the urine. Unless

the pelvis of the kidney is involved, urine does not escape from the external wound. These injuries may also implicate the pleura, diaphragm, liver, or intestine. In uncomplicated cases the wound, if aseptic, heals well; if septic, suppuration is liable to ensue in and around the kidney. The external wound should be disinfected and drained, and complications dealt with as they arise.

Subcutaneous Rupture of the Ureter is a rare injury, and usually results from violence applied to the anterior abdominal wall. The peritoneum over the ureter usually remains intact, and unless the rent in the ureter is blocked by a clot, a mixture of urine and blood accumulates in the retro-peritoneal cellular tissue, and forms within a few days or weeks of the injury, a rounded or sausage-shaped swelling in the line of the ureter, which is tender on pressure. If the ureter be obstructed and strictured, the kidney becomes enlarged and constitutes a *traumatic hydronephrosis*. The advent of septic infection results in the addition of suppuration to any of these conditions.

Treatment has usually been directed to evacuation of the retro-peritoneal collection by incision and drainage; nephrectomy being performed in the event of suppuration ensuing in the kidney, or of a permanent fistula forming. If by means of the ureteral catheter, the diagnosis can be made with certainty, the operation of primary suture of the ruptured ureter is indicated.

In the course of certain pelvic operations, such as removal of the uterus, the ureter is liable to be included in a ligature, divided or crushed so that it subsequently sloughs. If the injury is recognised at the time of its infliction, it must be dealt with at once. If completely divided it may be sutured, or if this be impracticable the proximal end should, if possible, be inserted into the bladder through a fresh opening.

Hydronephrosis.

(*Synonyms: Uro-nephrosis, Nephrectasis, Renal Retention.*)

Pathogenesis and Morbid Anatomy.—If the escape of urine from the kidney be suddenly and completely arrested, as by ligation of the ureter, the organ soon ceases to secrete, and finally undergoes atrophy; but if the outflow is merely hindered over a long period, the secretion continues, and the pressure of the urine gradually distends the pelvis into a cyst. The cause of the obstruction to the outflow may be situated in any part of the urinary tract, and in each individual case of hydronephrosis,

it is important to locate it in order that it may, if possible, be removed.

Causes in the Kidney itself.—Apart from such conditions as a calculus or a villous tumour blocking the outlet of the renal pelvis, the commonest cause is *an alteration in the position of the kidney*, whether congenital or acquired, whereby the outflow through the ureter is interfered with. Descent of the kidney usually results in a curving of the upper end of the ureter, the convexity of the curve being upwards, or, in extreme cases, it may be kinked and form an inverted V. If the hindrance to the outflow is temporary, as it is in a floating kidney which returns to its place, the pelvis readily returns to its former size — *intermittent hydronephrosis* — but with repeated recurrence of the obstruction, secondary changes occur in the pelvis and ureter which tend to perpetuate the stagnation of urine—*permanent hydronephrosis*. These changes at first consist in loss of elasticity in the wall of the pelvis and unequal dilatation of its cavity, as for example where the segment below the ureteral opening distends more than that above, and the orifice of the ureter, instead of being at the most dependent part of the pelvis, comes to lie above the level of the lower sac (Fig. 126). Further, as a result of the rotation of the kidney which accompanies its descent, the pelvis moves forward and the ureter comes to lie along the posterior wall of the sac. Congestive changes occur, and result in the formation of adhesions between the pelvis and ureter, fixing the latter in its bent position, and embedding it in the posterior wall of the dilated pelvis. The result is that the ureteral opening becomes more and more oblique and slit-like, while the layers of tissue intervening between the cavity of the pelvis and the lumen of the ureter become fused together and thinned out until they form a spur or valve which may entirely close the ureteral opening (Fig. 127). These secondary changes in the pelvis and ureter

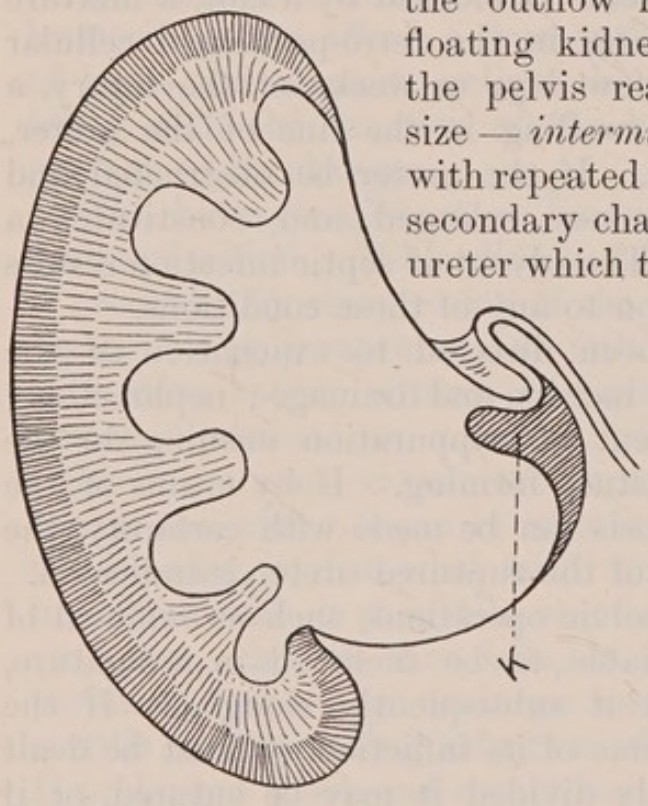


FIG. 126.—Diagrammatic Section of Hydronephrosis, showing valvular obstruction at outlet of pelvis. K = the valve (after Israël).

are of great importance; they are not confined to hydronephrosis originating from renal displacement. Recurrent attacks of intermittent hydronephrosis may occur from other causes; for example from *swelling of the mucous membrane of the pelvis*, such as may attend the congestion of menstruation, sexual excitement, or alcoholic indulgence; or from the sudden overfilling of the pelvis after the ingestion of large quantities of diuretic beverages. When all outflow from the pelvis is arrested, this is described as the conversion of an "*open*" into a "*closed hydronephrosis.*" It must be clearly understood that even in a closed hydronephrosis the lumen of the ureter is not necessarily obliterated; a ureteral catheter may be passed from the bladder upwards into the pelvis.

Obstacles in the course of the ureter are less common causes of hydronephrosis; they include such conditions as congenital anomalies in the course of the ureter, impacted calculus, villous growth, stricture, injuries to the ureter in gynecological operations, compression of the ureter by pelvic tumours, or traction upon and kinking of the ureter by cicatricial tissue formed around the uterus.

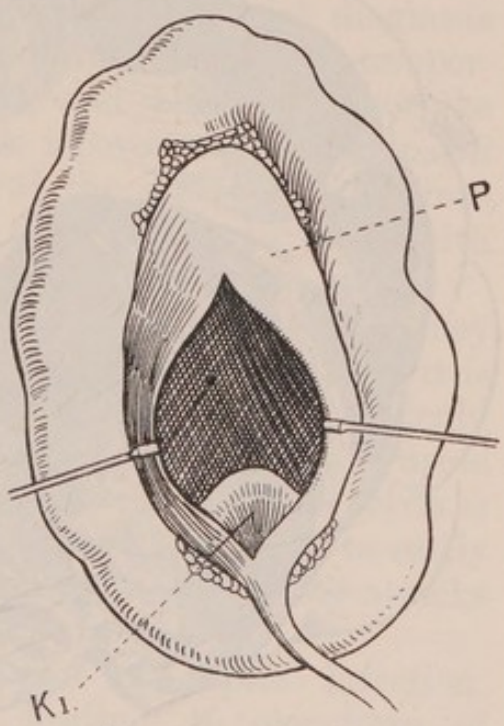


FIG. 127.—The Renal Pelvis laid open to show valve at outlet. P = pelvis. K = valve. (After Israël.)

Obstacles to the outflow from the ureter into the bladder may affect one or both kidneys; the most likely causes are tumours of the bladder, calculus, enlargement of the prostate, paralysis of the bladder, and stricture of the urethra. All of these cause increased backward pressure which may result in hydronephrosis, and in the majority of cases this is associated with septic infection resulting in pyonephrosis.

Functional Disturbances of Micturition.—Irritability of the bladder, characterised by excessive frequency and difficulty in passing water from reflex spasm of the sphincter muscle, may lead to hydronephrosis. The urine only escapes in drops, and the bladder contents are under great pressure, so that in course of time the ureters, and later the pelves of both kidneys, become dilated. It is characteristic of this form that the dilation of the ureters is relatively greater than that of the pelvis.

In all cases of hydronephrosis in which the hindrance to the outflow is situated below the pelvic origin of the ureter, the ureter is dilated above the obstruction, and its walls are stretched and lax.

Secondary Changes in Hydronephrosis.—The changes in the renal parenchyma are the result of the increased pressure within the pelvis, and consist in compression followed by atrophy; the distension of the pelvis and calyces results in atrophy and displacement of the septa between the calyces, until finally there is one large cavity with sacculations corresponding to the original calyces (Fig. 128). The renal parenchyma may entirely disappear.

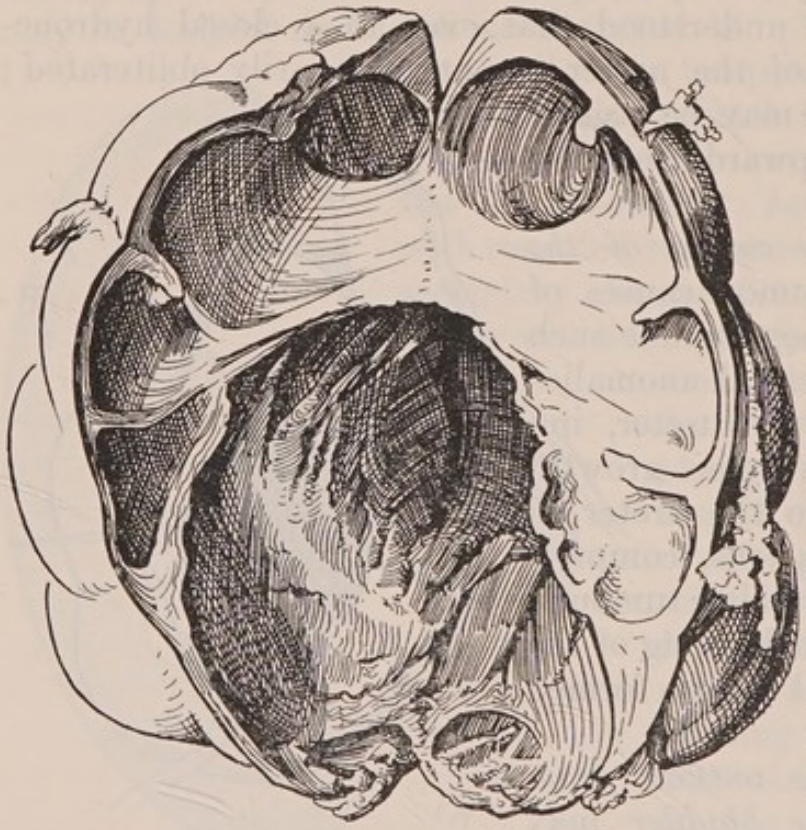


FIG. 128.—Hydronephrosis associated with valvular origin of ureter. Removed by lumbar nephrectomy from a woman, aged 30, on account of ascending infection from cystitis.

The contents of the cyst in course of time become poorer and poorer in urinary constituents; in a closed hydronephrosis of old standing the urea disappears, and a colourless serous fluid containing a trace of albumin remains. The fluid is sometimes coloured with altered blood pigment derived from antecedent hæmorrhages into the sac. In an infected hydronephrosis the fluid is turbid from the presence of pus corpuscles.

The *clinical features* vary according to the nature of the hydronephrosis. The development may be so insidious, for example in those cases depending on malformation of the ureter, that the patient first applies for treatment on account of swelling of the abdomen, of a lump in the loin which is discovered accidentally, or of a feeling of weight and pressure, and disturbance of the stomach and bowels.

A *closed hydronephrosis*, when of a large size, fills up the

flank, and can be palpated bimanually; the colon lies in front of it, and the dulness over the cyst is continuous with that of the liver. A very large tumour bulges the ribs outwards, fills up one side of the abdomen, and, by extending down to the pelvis, may simulate an ovarian cyst. When the cyst fills up the greater part of the belly, as it sometimes does in children, it may simulate a tuberculous ascites.

In *intermittent hydronephrosis*, such, for example, as that associated with abnormal renal mobility, there are attacks of pain and sickness like those produced by calculus, and from the fact that these attacks may be attended with marked tenderness of the kidney and with hæmaturia, the differential diagnosis may be difficult. During the attack, while the pelvis is temporarily closed, the kidney is congested, and bleeding may take place into the sac. When the attack is over and the occlusion relieved, the blood-stained contents of the sac pass down into the bladder and hæmaturia results. If the attacks recur with great frequency hæmaturia may be more or less constant.

In the early stages of intermittent hydronephrosis, the kidney returns to its normal size after the occlusion is relieved, and it is sometimes observed during the attack that the swelling suddenly disappears on manipulation, the kink being undone and the urine passing on. In the later stages the elastic recoil of the pelvis is lost and the organ remains enlarged, although it may not be easily palpable owing to the slackness of the cyst wall, and the attacks of pain may entirely disappear.

If hydronephrosis becomes the seat of septic infection, suppuration occurs in the kidney, leading to one form of pyonephrosis.

Differential Diagnosis.—The painful attacks met with in early cases of intermittent hydronephrosis may be confused with renal or biliary colic. The large palpable cyst of advanced hydronephrosis may be mistaken for a hydatid or other solitary cyst of the kidney, an ovarian cyst, a cyst of the pancreas, an encysted tuberculous ascites, or a retro-peritoneal lipoma. In open hydronephrosis it is sometimes observed that an alteration in the size of the cyst is accompanied by a corresponding alteration in the amount of urine. Valuable information is obtained by catheterising the ureters; the urine from the affected kidney shows a diminished degree of concentration. The X-rays may show whether or not the hydronephrosis is due to stone. Exploratory incision remains the final appeal in difficult cases.

Prognosis.—If the cause of the retention is capable of being removed, the kidney recovers its functions, and may return to

the normal if any healthy parenchyma remains in the wall of the sac. The danger to life lies in the risk of septic infection, and of uræmia when the condition is bilateral. The determination of the freezing-point of the blood is therefore of service in prognosis.

Treatment.—Treatment is directed towards the removal of the obstacle to the outflow from the pelvis; this implies not only the removal of the primary cause, but of the secondary changes in the pelvis and ureter.

Palliative Measures.—Tapping the distended pelvis may be of service by affording temporary relief in the painful crises of floating kidney, or where life is threatened by anuria in bilateral hydronephrosis. The trocar should be inserted at the outer edge of the quadratus lumborum, midway between the last rib and the iliac crest. The procedure is free from danger if the contents of the sac are aseptic. *Tapping and drainage* is an extension of the above. A fine drainage tube is passed down the cannula, and is left in after withdrawing the latter; this procedure may be useful in affording a means of examination of the secretion of the two kidneys separately. *Catheterisation of the ureter* can only be curative in rare cases of kinking or stricture of the ureter.

Curative Measures.—Having excluded such causes of hydronephrosis as may be found in the lower urinary organs and pelvic cavity, *the kidney and upper end of the ureter should be exposed* by the usual lumbar incision. It is only by this means that the factors concerned in the causation and perpetuation of the hydronephrosis can be discovered and dealt with. If the only cause be an abnormal mobility of the kidney, it may be possible, by means of *nephropexy*, to re-establish the outflow through the ureter. If, however, the kidney is not only movable, but also presents an irregular distension of the pelvis, or if the deviated ureter is fixed by adhesions, or its pelvic orifice is blocked by a valve, then the mere fixation of the organ cannot be expected to cure the hydronephrosis.

If there is a valve-like septum between the pelvis and the ureter (Fig. 127), it must be got rid of by the procedure introduced by Fenger in 1892. The pelvis is opened sufficiently to give a good view of its interior, the valve is divided longitudinally and then stitched at right angles, or the opening may be kept patent by inserting a catheter. If, on the other hand, the upper end of the ureter is twisted and buried in adhesions, it should be separated from the pelvis and inserted through a fresh opening at the most depending point of the sac—*uretero-pyelo-*

neostomy; or a lateral anastomosis made between the free portion of the ureter and the dependent portion of the pelvis —*uretero-pyelo-anastomosis.* If the ureter cannot be found at its exit from the pelvis, it must be exposed lower down and traced upwards. If the pelvis is greatly dilated, it may be reduced in size by folding in its walls by tiers of sutures—*pyeloplication* (Israël)—or by excising the greater part of the sac (Fenger), in either case endeavouring to bring the orifice of the ureter to the lowest part of the pelvis. Anastomosing the pelvis with the bladder has been carried out by Witzel. These operations are only performed if the kidney is still functionally adequate.

Nephrostomy and *temporary drainage of the pelvis* through the loin, is an essential accompaniment of these plastic operations on the pelvis and ureter. It not only favours the healing of the wound made in the plastic operation, by draining away the urine by the loin, but gives the relaxed wall of the pelvis a chance of recovering its tone. The fistula usually closes when the drainage-tube is removed. In some cases nephrostomy alone is followed by cure of the hydronephrosis, it may be by the mere fixation of the sac to the wound, as in cases of movable kidney, or by restoring the elastic tone of the wall of the pelvis and thus enabling it to overcome any remaining obstacle to the outflow through the ureter. A stone in the pelvis or ureter, or a stricture of the ureter, must be got rid of at the time the kidney and ureter are exposed at the operation. The formation of a *permanent fistula in the loin* is merely a palliative measure, and is only to be adopted when the cause of the obstruction cannot be removed.

Nephrectomy, or extirpation of the hydronephrotic kidney, is to be had recourse to when conservative measures are impracticable or have failed, provided always that the opposite kidney has been proved by kryoscopy to be functionating. The lumbar route is preferred, and the operation is seldom a difficult one. The trans-peritoneal route is only selected when the hydronephrosis affects a congenitally displaced kidney or one which floats freely within the abdominal cavity.

Pyogenic Infections of the Kidney.

Pyelitis, Pyelo-nephritis and Pyonephrosis. — The term *pyelitis* is applied to pyogenic infection of the renal pelvis, *pyelo-nephritis*, when both the pelvis and renal parenchyma are involved, and *pyonephrosis* when there is superadded

obstruction to the outflow of urine so that the calyces become distended and form abscess cavities. The term *surgical kidney* was formerly applied to suppurative affections of the kidney, because they frequently followed upon the passage of instruments or upon operations on the lower urinary organs.

Pyogenic organisms may reach the kidney by the blood-stream—*hæmatogenous infection*, or by way of the ureter from the lower urinary organs—*ascending or urogenic infection*. It is not always possible, either clinically or anatomically, to differentiate between these, and it is probable that they are frequently combined. The existence of pyelitis is not conclusive evidence of a urogenic infection, as the pelvis is commonly implicated by extension from the parenchyma, and may even be the primary seat of a hæmatogenous infection.

The kidney is specially liable to organismal infection if it be congested, or if its secretion be retained as a result of obstruction to the outflow of urine; hence it is that pyogenic affections of the kidney are frequently met with as a sequel of hydronephrosis, and of obstructive disease in the lower urinary organs. The blood infections, in which the colon bacillus is believed to play the chief part, may follow on any acute infective disease, such as carbuncle, lymphangitis, osteomyelitis or typhoid. The urogenic infections are most often met with as a sequel of septic cystitis, and the organisms concerned include the colon bacillus, staphylococci, streptococci and gonococci.

Acute infective pyelo-nephritis is usually a complication of septic cystitis. It is a well-recognised cause of death in cases of chronic septic disease in the lower urinary organs.

The most striking appearance is that of multiple minute abscesses scattered throughout the cortex and beneath the capsule, and of lines of suppuration in the medulla. The mucous membrane of the pelvis is in a condition of acute catarrh. The lesion may be confined to one kidney, but is usually bilateral, and is nearly always more advanced on one side than on the other.

Clinical features.—The illness is of sudden onset, and is ushered in by a rigor which may be repeated; there is thirst, headache, and constipation; the tongue is dry, coated, and cracked, and the patient goes downhill rapidly. If death occurs it is preceded by coma and other symptoms of uræmia. There may be pain and tenderness over the kidney, but the organ can rarely be palpated. The urine is scanty and turbid, and contains pus, albumin, blood and tube casts, and, if there has been antecedent chronic cystitis, it is usually foul and ammoniacal.

Treatment is usually confined to the relief of symptoms. The kidneys are flushed by administering diluted milk, Contrexéville and barley water, and urinary decomposition retarded by such drugs as urotropin. It was formerly believed that the condition was always bilateral and beyond relief by surgical means, but Israël has shown that the lesion may be confined to one kidney, and that incision or removal of this organ may be followed by recovery.

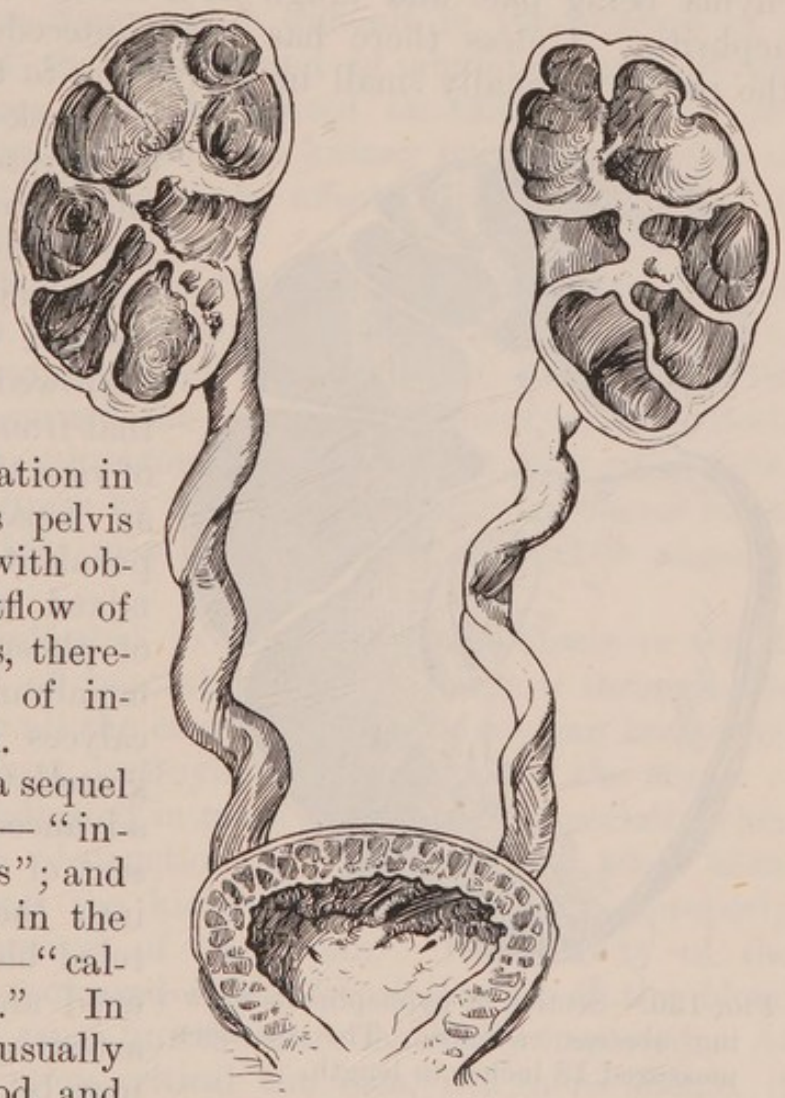


Fig. 129.—Bilateral pyonephrosis with dilatation and thickening of the ureters, resulting from gonorrhœal cystitis in a girl aged 18. (Semi-diagrammatic.)

Pyonephrosis may be defined as that form of suppuration in the kidney and its pelvis which is associated with obstruction to the outflow of urine. It represents, therefore, a combination of infection and retention.

It is met with as a sequel to hydronephrosis — "infected hydronephrosis"; and as a sequel of stone in the pelvis of the kidney — "calculous pyonephrosis." In these the infection is usually derived from the blood, and the affected organ may attain a considerable size (Fig. 130).

It is also met with as a sequel to septic cystitis, especially where there is a hindrance to the outflow of urine, such as is caused by a stricture of the urethra or enlargement of the prostate, or by frequent spasmodic contraction of the bladder, as in gonorrhœal or puerperal cystitis. In all of these the resulting pyonephrosis is usually bilateral, although it is frequently more advanced on one side. The infection is commonly an ascending one, taking place by way of the ureter and favoured by the increased backward pressure (Fig. 129). As a result of chronic inflammation, the walls of the ureter

become thickened and fused with the peritoneum and surrounding tissues, and the lumen is usually dilated, although it may be narrowed or strictured.

Morbid anatomy.—On section the kidney presents a number of comparatively large abscess cavities, the intervening parenchyma being pale and tough as a result of chronic interstitial nephritis. Unless there has been antecedent hydronephrosis, the pelvis is usually small in proportion to the greatly enlarged and flask-shaped calyces which constitute the abscess cavities, and form the chief bulk of the kidney (Fig. 130). Their communications with the pelvis and with each other are narrowed or obliterated, so that from the operator's point of view they are to be regarded as separate cavities. The purulent contents are often mixed with crumbly masses of phosphates. The mucous membrane of the pelvis and calyces is converted into granulation tissue, and, in advanced cases, becomes the seat of ulceration which eats into the parenchyma. The renal blood-vessels are thickened and narrowed by endarteritis, so that the kidney may be torn from its pedicle without more hæmorrhage than can be arrested by plugging. The perinephric cellular tissue is converted into granulation and scar tissue, and is frequently the seat of scattered foci of suppuration, and sometimes a large perinephric abscess is found to communicate directly with one of the dilated calyces. The perinephric suppuration may extend into the psoas and quadratus muscles, or into the cellular planes of the abdominal wall.

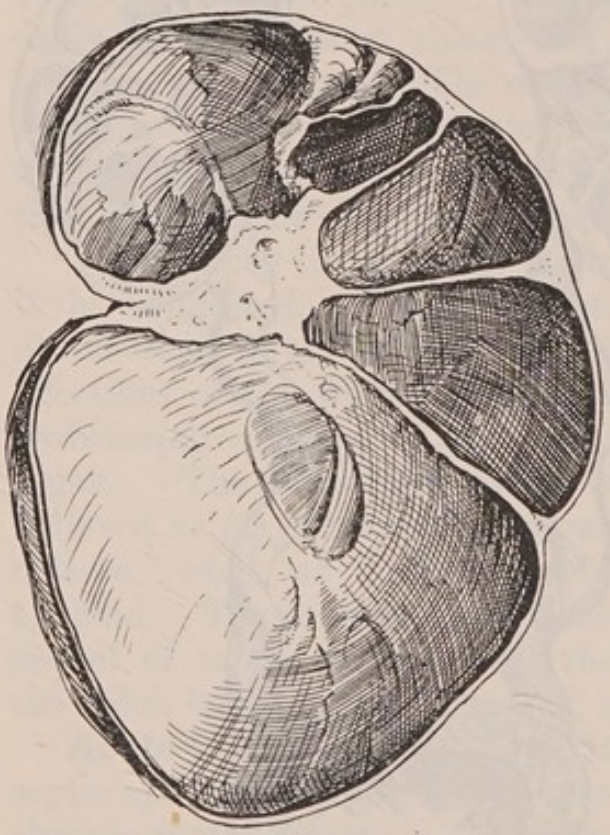


FIG. 130.—Section of pyonephrosis showing abscess cavities. The specimen measured 18 inches in length.

(Museum, Royal College of Surgeons of Edinburgh.)

Clinical Features.—With the onset of the renal affection the patient's general condition becomes worse, and to the symptoms of the antecedent condition are added pain in the kidney and abundant pus in the urine. If the outlet from the pelvis becomes

blocked the symptoms become aggravated, although the pus may disappear from the urine. There is high fever with or without rigors, the pain may amount to renal colic, and the kidney becomes enlarged and tender. Variations in the size and tenderness of the kidney, and in the amount of pus in the urine, are characteristic of a pyonephrosis which is alternately open and shut. The diagnosis is difficult in the absence of a palpable tumour of the kidney and of abundant pus in the urine. Most reliance is to be placed on examination of the urine obtained separately from each kidney by catheterisation of the ureters. If both kidneys are affected the freezing-point of the blood is lowered.

The *treatment* depends on the conditions present. In the ascending infections it must be directed towards the disease in the lower urinary organs as well as towards the kidney. So far as the kidney is concerned the surgical treatment resolves itself into nephrotomy or nephrectomy. Washing out with a 1 in 1000 solution of silver nitrate by means of a ureteral catheter introduced from the bladder may do good when the pelvis alone is involved.

Nephrotomy is indicated in cases of pyonephrosis in which there is a prospect of re-establishing the outflow through the ureter, and in which all the cavities in the kidney can be opened up and drained without destroying the functions of the organ.

Nephrectomy is indicated in more severe cases, especially when there is irremediable obstruction in the ureter, and when there is suppuration around the kidney which can only be properly dealt with after removal of the organ. The gravity of the operation is greatly increased if the freezing-point of the blood shows that the total renal functions are markedly impaired. At the same time the more critical the case, the more should it be our aim to cure the patient by one operation, and this is most likely to be effected by primary nephrectomy. Nephrectomy is performed by the lumbar route, and the divided ureter should be brought out at the wound.

Stone in the Kidney and Ureter—Calculous Diseases—Nephro-lithiasis.

We are here concerned only with the formation of a stone in a kidney which was previously healthy, that following on disease of the kidney—secondary stone—is referred to under the different affections in which it occurs.

General Characters of Urinary Calculi.—A stone consists of

solid urinary constituents held together by an organic basis of an albuminous nature, possibly derived from epithelium which has been shed as a result of catarrhal processes. A stone composed of *uric acid* or *urates* is yellowish brown in colour, of hard consistence, and has a smooth or morocco-leather-like surface; on section it is homogeneous or concentrically laminated. Such stones are frequently multiple, and may attain a large size. The *oxalate of lime calculus* is dark brown or black from admixture with blood pigment; it is very heavy and densely hard; the surface is rough, tuberculated, or beset with sharp projections, and on section shows a wavy lamination. It is of very slow formation, is usually solitary, and although rarely larger than a hazel-nut, is the type of stone most likely to give rise to symptoms. The *phosphatic stone* is composed of the triple phosphates and carbonates of lime and magnesia; it is usually of a white or dirty grey colour, is light and porous, rough on the surface, friable, and it may attain a considerable size. Its formation is frequently, but not necessarily attended with alkaline decomposition of the urine. Other varieties of stone are rare, but mention may be made of the *cystin calculus*, which is white or yellowish, soft and friable, and on section presents a resemblance to wax. The chemical composition of any stone is rarely the same throughout; the varieties are named according to the preponderating constituent. There is no constant relationship between the reaction of the urine and the composition of the stone.

The **etiology** of stone is unknown. The condition is more frequent in certain families, especially those tainted with a gouty inheritance, and it is much more common in some countries, particularly Hungary, India, and China, than in others. In this country it is most prevalent in Norfolk. It is met with chiefly during the early years of childhood, and in patients after middle life. It is usually said to be rare in the female, but operation statistics show that renal calculus occurs with almost equal frequency in the two sexes.

Seat of Formation, Shape, and Size.—A stone is rarely found in the parenchyma of the kidney, the pelvis or one of the calyces being the favourite seat. A stone which is lodged in a calyx is usually spherical, while one lodged in the pelvis is often triangular, with the apex directed towards and into the ureter. In exceptional cases the stone forms a cast of the entire pelvis, and presents coral-like branches corresponding to the individual calyces (Fig. 131). Small stones may pass into the ureter, and lodge either near the kidney or near the vesical orifice. A

ureteral calculus is usually elongated like a date stone, but may become rounded. The channel of the ureter may be obstructed by the stone itself, or obstruction may result from superadded swelling of the mucous membrane and spasm of the muscular coat.

Uric and phosphatic stones are not infrequently multiple, and are then usually faceted. Both kidneys are the seat of stone in about one-third of the total cases, and the stones may be of different composition on the two sides.

Morbid Anatomy of Calculous Kidney.—In the absence of septic infection the changes in the kidney are the result of mechanical irritation, with or without retention of urine according to the situation of the stone.

FIG. 131.—Branching Uratic Calculus which formed a cast of the pelvis and calyces of the kidney. (Removed by Prof. Annandale.)

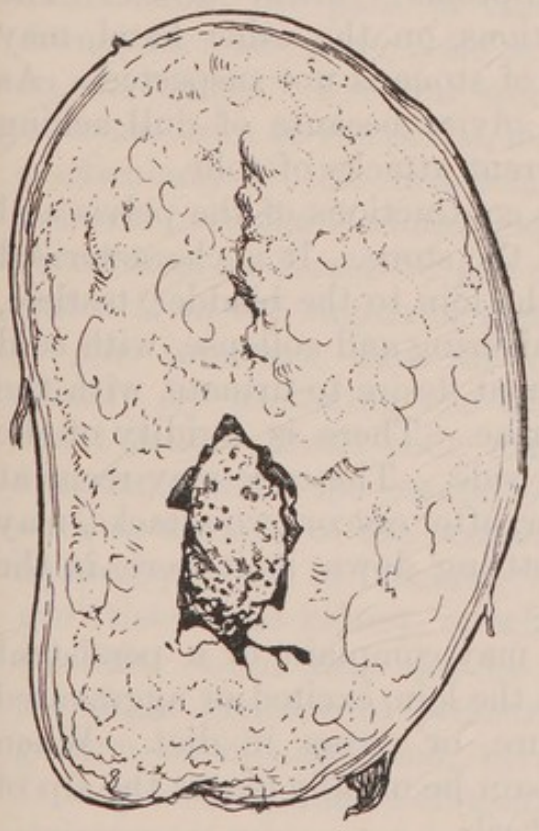


FIG. 132.—Fibro-lipomatous Kidney with Stone in Pelvis, removed by lumbar nephrectomy from a woman, æt. 55.

The irritation induces an increase in the interstitial connective tissue, whereby the organ becomes tougher and harder, and the fatty and fibrous capsules become thickened and fused with one another, and firmly adherent to the parenchyma. The mucous membrane of the pelvis is injected and swollen, and the stone tends to become buried in the swollen mucous membrane as a result of contraction of the wall of the pelvis. If the stone hinders the outflow from the pelvis hydronephrotic changes result, chiefly at the expense of the secreting tissue. There is rarely any marked increase in size of the organ, because of the sclerosis and thickening of the capsules.

In some cases there is a remarkable overgrowth of fat which originates at the hilum, surrounds the calyces, and finally replaces the parenchyma, the kidney being ultimately transformed into a solid lipoma enclosing a cavity—the pelvis—in which the stone is lodged (Fig. 132).

When infective processes are superadded, there ensue the same changes as have already been described under pyelonephritis and pyonephrosis. The perinephric cellular tissue also may become the seat of suppuration and of abscess. The addition of sepsis may result in the deposition of salts upon the existing stone, which may thereby be greatly increased in size.

The opposite kidney may remain healthy, and may even undergo hypertrophy to compensate for the loss of function in the diseased organ, but it also is liable to become the seat of stone formation and of infection and suppuration.

The clinical features vary widely in different cases. In the absence of sepsis a stone may lie in one of the calyces for years without giving rise to symptoms—*latent stone*. The symptoms of the septic complications, on the other hand, may so predominate that the existence of stone is not suspected. As a rule, however, the patient seeks advice because of dull aching and weight in the loin, or of recurrent attacks of colic.

Renal colic is due to spasmodic contractions of the pelvis and ureter in the attempt to get rid of the stone. It is characterised by agonising pain shooting from the loin to the bladder, testicle, or thigh; nausea and vomiting, shivering and collapse, with cold perspiration. There may be frequent desire to urinate, with the passage of a little blood-stained urine. There is rigidity of the abdominal muscles on the affected side. The colic may recur at intervals till the stone is passed, or, after one or two attacks, may disappear altogether, the stone settling down, as it were, in the renal pelvis.

Apart from colic, the patient may complain of a persistent boring pain or feeling of weight in the loin, excited or aggravated by exertion, jolting, local pressure, or errors in diet. When asked to indicate the seat of the pain he usually places the tip of his thumb over the end of the last rib.

Renal tenderness is most marked in the region of the hilum, and is best elicited on bimanual examination if the thumb be pressed into the angle between the last rib and the erector spinæ at the commencement of expiration. It is exceptional to recognise any enlargement of the kidney. Tenderness of the ureter may sometimes be elicited where this tube crosses the

brim of the pelvis, or at its lower end on rectal or vaginal examination.

Even if the urine appears normal a careful microscopical and chemical examination should be made. Red blood corpuscles are to be found, especially after exertion, and more often in the evening than in the morning urine; they are often devoid of colouring matter, and may be so altered in shape that it is difficult to identify them. Marked hæmaturia is sometimes present, but is not characteristic of stone. So long as there is no infection there is a complete absence of leucocytes, and only a faint trace of albumin.

The *diagnosis*, without the aid of the X-rays, is often extremely difficult. In cases attended with colic the first step is to ascertain that the colic proceeds from the kidney or ureter, and the second is to determine that it is due to stone.

Differential Diagnosis.—Renal colic is to be diagnosed from biliary colic chiefly by the seat of the pain and tenderness; from intestinal obstruction, by the seat of tenderness, and by the radiation of the pain to the thigh, buttock, testicle, or vagina; from pancreatic-stone colic by the presence of red blood corpuscles in the urine. Ureteral colic, when associated with tenderness over the brim of the pelvis, may simulate the pain of appendicitis, particularly if this is attended with inflammation of the peritoneum over the bladder, and frequent and painful micturition. According to Israël 50 per cent. of ureteral stones may be palpated from the vagina or rectum.

The inference that the colic is due to stone is arrived at mainly by excluding the other conditions which give rise to renal colic. Renal colic may be due to any condition which interferes with the escape of urine from the pelvis or ureter, such as kinking of the pedicle of a movable kidney, commencing hydronephrosis, or blocking of the ureter with clots as in new growths of the kidney, or with caseous debris as in tuberculous pyelitis. Colic may also be induced by anything which causes a sudden increase of pressure within the kidney, as acute congestion or inflammation, or hæmorrhage into the parenchyma. It may also be due to abnormal conditions in the ureter, such as stricture, involvement in adhesions, or injury occurring in the course of pelvic operations.

Great difficulty may arise in relation to certain forms of chronic nephritis attended with pain and hæmaturia, and in cases in which, from the vagueness of the patient's complaints, a diagnosis of lumbago and sciatica, chronic rheumatism, or nervous dyspepsia may be made. Statements by patients that they

have passed blood or sand are to be accepted with caution, as they are apt to be deceived by the high colour of the urine and the deposit of urates on standing.

The *demonstration of the concretions by the Röngten rays* is to be regarded as the only certain clinical means of recognising renal calculus. The procedure is best carried out after the method described by Kümmell of Hamburg. The bowels having been cleared out, the patient is placed in the dorsal position, with the thighs acutely flexed and the head bent forwards, so that the loin lies evenly on the sensitive plate. A trial radiogram is taken by means of a soft tube placed at the maximum distance from the plate, and if a suspicious shadow is found on the negative its position is accurately marked on the back of the patient, and the corresponding point on the anterior abdominal wall determined. A second radiogram is then taken with the tube immediately over this point, while the surrounding parts are protected by a leaden shield as large as a dinner plate; the tube is to be as close to the body as possible, so as to render, by magnification, even small stones more easily recognisable. In doubtful cases the procedure may require to be repeated. The shadow of a stone remains constant both in its contour and in its position; it is most often found a little below the twelfth rib, and about an inch distant from the second lumbar vertebra, in the area corresponding to the pelvis of the kidney. Kümmell has shown that by the above method any stone, whether in the kidney or ureter, may be demonstrated by the X-rays; and conversely, that stone may be excluded with equal certainty if repeated examinations yield a negative result. Information is also gained as to the exact situation of the stone, its size and shape, and whether there is more than one—all points of importance in planning an operation.

Treatment of Uncomplicated Stone.—Short of operation, treatment is directed chiefly towards diluting the urine by increasing its amount; the patient should take large quantities of bland fluids, of which the best is hot water, or such mineral waters as those of Contrexéville or Wildungen. Urotropin is useful in preventing the onset of septic complications. Renal colic is to be relieved by hot local applications or hot baths, and by large doses of belladonna, hypodermic injections of morphin, or the inhalation of chloroform.

Inasmuch as there is little or no immediate danger to life in uncomplicated renal calculus, there is great difference of opinion as to the advisability of operating for the removal of the stone. Operation is indicated in cases with severe recurrent colic, or

with constant aching in the loin which interferes with the pursuits of the patient. It is to be recommended in all cases in which a stone is impacted in the ureter, and where there is evidence of commencing septic infection. Operation is contra-indicated in cases of frequently recurring colic, in which every attack is followed by the passage of a small non-faceted stone, and the patient between the attacks, is quite well, and the urine normal, because in such cases there is probably fresh stone formation from time to time, and an operation would be useless.

The operation for the removal of stone is known as *nephro-lithotomy*, and was first carried out successfully by Henry Morris in 1880. The incision is made in the loin—from the angle between the last rib and erector spinæ downwards and forwards towards the anterior superior spine, and must be free enough to give access to the renal vessels and upper end of the ureter, and to enable the kidney to be brought to the surface. The vessels at the hilum are controlled by the fingers of an assistant. The organ is then laid open along its convex border, to admit the finger to the pelvis and calyces. If there are no septic complications the wound in the kidney is closed by deep catgut sutures. If the stone is lodged in the upper part of the ureter it is displaced by manipulation into the pelvis, and removed as above; if this is not possible, the ureter is incised in its long axis—*ureterotomy*—the stone extracted, and the opening closed by fine sutures. If the stone is impacted near the crossing of the iliac vessels the incision in the abdominal wall must be carried downwards parallel with Poupart's ligament, so as to expose the ureter by the extra-peritoneal method, or an incision is made directly over it, and it is reached by the trans-peritoneal method. Stones at the lower end of the ureter may be removed through the vaginal roof, or in the male, through the perineum or by the parasacral route.

Complications of Stone in the Kidney.—The most important of these result from septic infection or from arrest of secretion, the latter in its complete form being known as calculous anuria.

Calculous Pyelitis and Pyonephrosis.—The infection is usually derived from the blood-stream, and the changes are similar to those already described as occurring from sepsis apart from stone. The tendency is in the direction of progressive destruction of the secreting tissue, until, in the most extreme cases, the kidney is converted into a multilocular sac filled with stones and a mixture of pus and decomposing urine. Secondary deposit of phosphates commonly occurs both on the primary stone and on the walls of the pelvis and calyces. The septic process tends to

involve the surrounding cellular tissue, and to give rise to perinephric abscess, and this may rupture externally, forming a fistula, which discharges a mixture of pus and urine.

With the onset of septic complications the prognosis becomes much more serious. The opposite kidney may become infected through the blood-stream, or death may result from general pyogenic infection, while the mortality of operations for the removal of the stone is increased about ten-fold.

The diagnosis from other forms of pyelonephritis and pyonephrosis is suggested by the history, and established by skiagraphy. Before recourse is had to operation it is of great importance to determine the functional capacity of the opposite kidney by kryoscopy, and when possible by separate examination of the urine from each kidney.

The operative treatment consists in performing nephrolithotomy with subsequent drainage, or nephrectomy. In all cases attended with pronounced suppuration and destructive changes in the substance of the kidney, with obstruction to the flow of urine into the bladder, and provided the secretory functions of the other kidney are satisfactory, nephrectomy affords the best results. In either operation the wound is left open, being packed from the bottom with iodoform gauze around the drainage-tubes.

Bilateral Stone.—The presence of stone in both kidneys, as demonstrated by the X-rays, precludes nephrectomy, even if there be pyonephrosis. Nephro-lithotomy should be performed on the kidney least affected, and, after an interval, on that of the opposite side.

Calculous Anuria.—This term refers to the arrest of renal secretion resulting from calculous obstruction. It is nearly always due to the sudden blocking of the ureter in cases in which the opposite kidney is absent or has been destroyed by antecedent calculous disease. It is maintained by some authorities, and notably Israël, that the sudden blocking of the ureter on one side may arrest reflexly the secretion of the opposite kidney, but the trend of opinion is to the effect that only a diseased kidney will stop secreting under reflex nervous influence.

The anuria may develop suddenly in persons in apparent good health, it may be after jolting or exertion. It usually affects men after middle life, but has been observed in young children. Renal colic or aching in the kidney recently obstructed is often present at the outset, but disappears when the suppression of the renal secretion is complete. In complete suppression, uræmic symptoms supervene about the seventh or eighth day, and unless

the obstruction is relieved and the renal secretion re-established, the patient becomes drowsy, with contracted pupils, and dies about the tenth or eleventh day. It is not usually difficult to differentiate calculous anuria from other forms of suppression, such as that due to bilateral nephritis, but it may be extremely difficult to determine which of the kidneys was last obstructed, and yet this is of great importance, as it is this kidney which is most likely to recover its functions if the obstruction be relieved. Most reliance is to be placed on the site of the recent colic, and on unilateral rigidity of the abdominal muscles with tenderness of the kidney on the same side.

Treatment.—Palliative measures directed towards the elimination of waste products by way of the bowels and skin cannot with safety be prolonged for more than forty-eight hours, because of the danger that the renal epithelium may not recover its functions, even although the obstruction be relieved. The shortest and simplest operation is to be preferred. The kidney last occluded must be laid freely open and lightly packed with gauze, so as to relieve the intra-renal tension; the obstructing stone, unless readily accessible, is left till the crisis has been tided over. If it is found that the exposed kidney is functionless, or is not the seat of obstruction, then the opposite kidney must be exposed and laid open, either at once or within the next twenty-four hours.

Tuberculosis—Tuberculous Pyelonephritis—Renal Phthisis.

Chronic caseating tuberculosis in the parenchyma of the kidney is a comparatively common disease. In the great majority of cases the bacilli reach the kidney by way of the blood-stream.

Morbid Anatomy.—Although at first localised to particular parts of the organ, the disease becomes diffused by the confluence of areas of caseous infiltration, and these areas break down, forming cavities filled with cheesy debris, which subsequently perforate into the calyces and pelvis (Fig. 133). The mucous membrane of the pelvis and ureter becomes the seat of tuberculous thickening and ulceration, and if the ureter be blocked, the pelvis and calyces become dilated, as in pyonephrosis. The organ is then greatly enlarged, presents as a fluctuating tumour with a bossy, hillocky surface, the projections corresponding to the individual abscess cavities, and yellow foci are visible on the surface. The ureter becomes unduly adherent to its surroundings,

its outer and middle coats are thickened, its mucous membrane infiltrated with tubercle, and its lumen filled with caseous debris and pus. The fibrous capsule of the kidney and the perinephric fat participate in the chronic inflammatory process, and become thickened and indurated, so that the kidney becomes fixed in its bed and adherent to surrounding parts—notably the peritoneum. We have observed such dense adhesions to the spleen, stomach, and colon, that the removal of the organ by operation was impossible. A large perinephric abscess may form as a result of the rupture of a cortical abscess through the capsule. The pus both within the kidney and outside of it usually contains not only tubercle bacilli, but also colon bacilli, staphylococci and streptococci. The presence of stone in the pelvis is exceptional, although we have ourselves observed it in two cases, in both of which the resemblance to calculous pyonephrosis was so great that the tuberculous nature of the lesion was only cleared up by the microscope. The passage of tuberculous material down the ureter results in infection of the mucous membrane of the bladder, at first round the ureteral orifice on the affected side, later over the greater part of the floor.

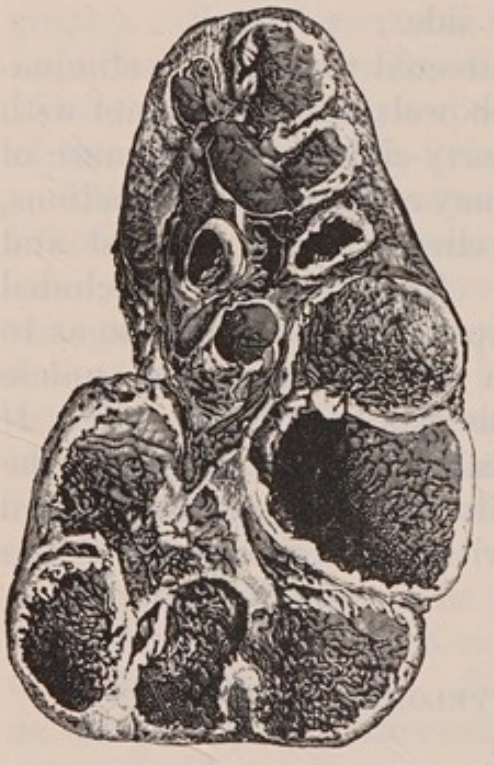


FIG. 133. — Advanced Tuberculous Kidney showing multiple abscess cavities in parenchyma. Removed by lumbar nephrectomy.

It is a fact of great clinical importance, that primary tuberculous infection of the kidney through the blood-stream is nearly always unilateral. The opposite kidney becomes enlarged and hypertrophied.

Ascending infection of the kidney from tuberculous disease of the lower urinary and generative organs is quite exceptional. Tuberculous disease of the Fallopian tube in the female, and of the epididymis and prostate in the male, not unfrequently occurs along with renal tuberculosis, but it is probably the result of an independent infection through the blood-stream.

Clinical features are absent in the early stages of renal tuberculosis. The first symptoms—frequent desire to urinate, pain at the end of the act, and turbidity of the urine—frequently suggest an affection of the bladder. Sometimes there are attacks like

renal colic from contractions of the ureter while tuberculous material is passing down the tube. Sometimes hæmaturia is one of the first symptoms, and when occurring in persons in apparent good health it is apt to be misleading. As the disease progresses the features become characteristic; there is failure of health and loss of flesh, the tenesmus of the bladder is almost continuous day and night, and as its cavity becomes more and more contracted there is practically incontinence, especially in the female. The urine shows an abundant mixture of pus and caseous debris, but at times may become almost clear, such intervals corresponding to blocking of the affected ureter. When the ureter is so blocked there is more lumbar pain, and the kidney may be felt to be enlarged. Septic infection of the urinary tract is liable to follow unskilful examination of the bladder, or the ill-advised treatment of the bladder symptoms by local measures; it greatly accelerates the progress of the disease. The amount of pus in the urine is greater, and if there is retention in the pelvis there is fever, often of the hectic type, attended with rapid emaciation and sweating; the kidney is felt as a tender movable tumour, or, if a perinephric abscess be superadded, the loin is filled up by a diffuse fixed swelling in which fluctuation may be detected. In advanced cases the urine may become alkaline and stinking.

Diagnosis.—Cases of irritability of the bladder suggestive of cystitis, which cannot be traced to gonorrhœa or to infection during catheterisation, should raise the suspicion of tuberculous kidney. As tubercle bacilli are not constantly found their absence does not exclude tuberculosis, but their presence in acid urine along with pus is characteristic. The cystoscope, which can scarcely ever be employed in advanced cases because of the contracted and irritable state of the bladder, shows in the early stage minute tubercles and ulcers, and injection of the mucous membrane around the ureteral orifice on the side of the affected kidney. Examination of the urine obtained from each kidney separately by the ureteral catheter affords the most conclusive evidence. That from the affected organ is pale, turbid, and shows great diminution of urinary solids as shown by its freezing-point; it may also yield tubercle bacilli. That from the healthy kidney shows increased concentration. When performed in the early stage of the disease and with proper precautions these procedures are harmless; in advanced cases they are not only difficult or impossible, but may aggravate the symptoms. The freezing-point of the blood affords corroborative information as to the functional capacity of the other kidney.

The *prognosis* is good when the disease is recognised early and is got rid of by nephrectomy; advanced cases with septic infection and tubercle of the whole genito-urinary tract are unfavourable.

Treatment.—Lumbar nephrectomy is the procedure of choice. The fibrous and fatty capsules should be removed along with the kidney, but where adhesions render this impossible the organ is shelled out from its capsule. If there is a perinephric abscess between the parietes and the kidney, it should be emptied in the first instance through a large trocar and suction syringe to avoid flooding the wound with pus. Similarly, if the kidney is found to be merely a bag of pus, it should be emptied in the same way before enucleation. The ureter is stitched in the angle of the wound, or, if diseased, may be removed if the condition of the patient permits. Partial resection of the kidney is not recommended. The bladder tubercle tends to get well of itself, although in the female irritability and incontinence may persist for some weeks. If a sinus persist as a result of tuberculous disease of the ureter, this tube should be irrigated with iodoform emulsion, or should be removed at a subsequent operation.

When the renal disease is bilateral the kidney which is most affected is opened and drained by nephrotomy, and if subsequent to this the freezing-point of the blood returns to normal, the kidney may be removed. After any operation for renal tuberculosis the patient should be placed under open-air treatment as soon as the shock has passed off, usually at the end of forty-eight hours. We have found this an invaluable addition to our therapeutics.

Perinephritis and Perinephric Abscess.—**Non-suppurative inflammation** of the perinephric fat may result in its transformation into a mass of dense fibrous tissue which binds the kidney to the parietal peritoneum, the diaphragm, and adjacent viscera. Should it become necessary for any reason to remove the kidney under these conditions the organ must be shelled out from its fibrous capsule—*subcapsular nephrectomy*—to avoid injuring the organs to which it is attached.

Phlegmonous or suppurative perinephritis results from bacterial infection of the perirenal cellular tissue, and is usually secondary to some septic condition in the urinary tract or to tuberculosis.

Less commonly the perinephric tissue is infected by direct or lymphatic extension from other areas of the retro-peritoneal cellular tissue, for example, as a sequel to appendicitis, typhoid ulceration, ruptured empyema, psoas abscess, or pelvic cellulitis in women.

The abscess seldom surrounds the kidney, as the pus usually

forms between the parietes and the kidney, displacing this organ forwards and upwards. The abscess may spread upwards into the subphrenic space or downwards into the iliac fossa, and may rupture externally in the loin, in the buttock, or in the thigh. Rupture has occurred into the colon and into the bronchi.

A perinephric phlegmon or abscess is to be differentiated from a renal tumour by the absence of definition, by extension of the swelling into the surrounding parts, and by the fact that it does not move with respiration. A bulging in the lumbar region without a correspondingly large tumour in front is very significant, as is also persistent flexion at the hip.

The abscess should be opened by the usual oblique lumbar incision, and its interior investigated both as to the existence of secondary collections of pus, especially in the deep retro-peritoneal tissue, and also as to the condition of the kidney. Any suppurative lesions of this organ may be dealt with either then and there, or on a subsequent occasion.

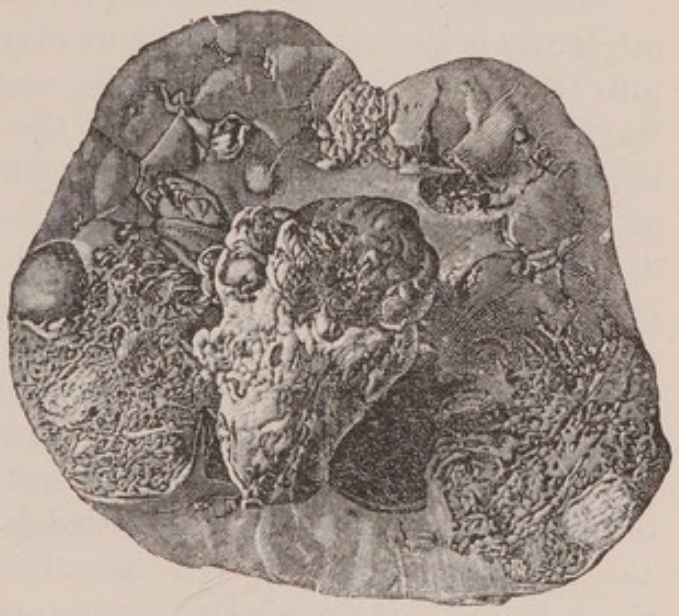


Fig. 134.—Cancer originating in Parenchyma of Kidney and erupting into the Pelvis.

(From Mr. Wallace's Collection.)

Tumours and Cysts of Kidney.—**Innocent** new growths, such as fibroma and adenoma, are merely of pathological interest.

Cancer occurs in a diffuse infiltrating and in a circumscribed nodular form. A circumscribed cancer in the parenchyma may erupt into the pelvis, and cause bleeding and partial obstruction of the outlet (Fig. 134). Even diffuse cancer may not cause any appreciable enlargement of the kidney.

Sarcoma is occasionally met with *in childhood*, between the ages of one and four, and it has been met with at birth. In addition to embryonic connective tissue, the tumour contains a proportion of newly formed epithelium arranged in a glandular manner, and a number of smooth and striped muscle fibres in the stroma. It may attain an enormous size—equal to one-third of the weight of the body—but has comparatively little tendency to form secondary growths, or to fungate into the pelvis and cause hæmaturia.

In adults the malignancy of sarcomata varies widely. The tumour usually causes great enlargement of the kidney, and in a considerable proportion fungates into the pelvis and causes hæmaturia.

Accessory adrenal tumours, derived from the suprarenal capsule, may originate in the cortex or immediately beneath the capsule of the kidney. In some cases they remain indefinitely of small size and innocent in character, but in others they become malignant and grow very rapidly, and are then differentiated with difficulty from other forms of malignant disease in the kidney.

Malignant tumours of the kidney may perforate the capsule and infect the perirenal cellular tissue, may spread along the renal vein into the vena cava and spermatic vein and plug these vessels, or fragments may be carried off in the blood-stream and give rise to secondary growths. On the whole metastasis takes place at a late stage of the disease, and less widely than in malignant disease of other internal organs. Infection of the retro-peritoneal lymphatic glands is exceptional.

Clinical Features. — In the child there are, as a rule, no symptoms until the tumour has attained sufficient size to attract the attention of the mother or nurse, and by this time the disease is so far advanced that operation holds out little prospect of permanent cure, and is scarcely to be recommended. *In the adult*, the tumour has usually existed for a considerable time before giving rise to symptoms, and attention may first be drawn to it by the discovery of a swelling in the loin, or by the occurrence of a profuse hæmaturia. In a few cases there is an obvious failure of health, with anæmia and uneasiness in the loin for some months before any swelling is discovered. Sometimes, and especially in rapidly growing tumours, there is pain which may shoot downwards to the thigh or testis; it is due to stretching of the capsule. Hæmaturia is common, and is due to the growth erupting through the mucous membrane of the renal pelvis. It may follow some exertion or slight violence, but there is seldom any obvious cause. The patient may experience no discomfort, or he may have to strain to express a clot before the urine, which is of the colour of burgundy, escapes. The urine gradually becomes clear, or if clots are a marked feature, it may cease abruptly from temporary blocking of the ureter. Clots may also cause typical renal colic, and worm-like coagula forming casts of the ureter may be passed in the urine. The recognition of a tumour in the loin is not always possible; growths at the

upper pole, especially in stoutly built men with rigid parietes, are only palpable at an advanced stage. When present, the tumour is irregularly ovoid, firm or hard, with a smooth or bossy surface.

The diagnosis may be aided in the early stages by the use of the cystoscope and the ureteral catheter. The urine thus obtained from the affected kidney is less concentrated than normal, and contains albumin. In a certain proportion of cases there is a recent varicocele on the same side.

Prognosis.—The most favourable cases are those in which hæmaturia occurs early, and draws attention to the condition so that the kidney can be removed while the growth is still localised in the central part of the organ. A palpable tumour which is fixed by adhesions, the presence of anæmia, and loss of flesh are unfavourable symptoms. In cases left to nature the patient may live for as long as five or even ten years (Guyon).

Treatment.—Lumbar nephrectomy is to be performed in selected cases, and the fatty capsule is removed along with the kidney. If adhesions are so great that it is only possible to shell out the organ from its capsule, the operation should be abandoned.

Tumours of the renal pelvis and ureter form a group of which the villous papilloma is the best known representative. Hæmaturia is the chief symptom, but the growth may block the pelvic outlet and cause retention of urine and blood, and, in infected cases, of pus, whereby the kidney may become sufficiently enlarged to be recognised on bimanual examination. Fragments of the villous growth may be grafted on the mucous membrane of the ureter, and if sprouting from the lower opening of this tube, may be seen with the cystoscope. Fragments of villous growth and clumps of epithelial cells may be found in the urine. An exact diagnosis can rarely be made without an exploratory incision through the kidney into the pelvis; if a tumour is discovered nephrectomy should be performed, as it is never safe to regard such tumours as innocent.

Solitary Cysts of the Kidney.—These arise in the cortex usually at one of the poles or in the perirenal cellular tissue, and become closely applied to the capsule of the organ. As the cyst enlarges it projects from the surface, and may attain enormous dimensions (Fig. 135). The cyst causes no symptoms, and is not recognised unless it is large enough to form a palpable tumour, and it is then liable to be mistaken for a hydronephrosis, or, if at the lower pole, for an ovarian tumour. The treatment is to remove the cyst by dissection, preserving the kidney.

Polycystic Kidney—Cystic Degeneration of the Kidney.—This is a comparatively rare condition, in which the kidney becomes permeated with a vast number of cysts which greatly add to the size of the organ, and which lead to the almost complete disappearance of the secreting tissue (Fig. 136). The cysts vary in size from microscopic minuteness to the dimensions of grapes or walnuts, and their contents are clear and straw-coloured or dark yellow, purplish or deeply blood-stained.

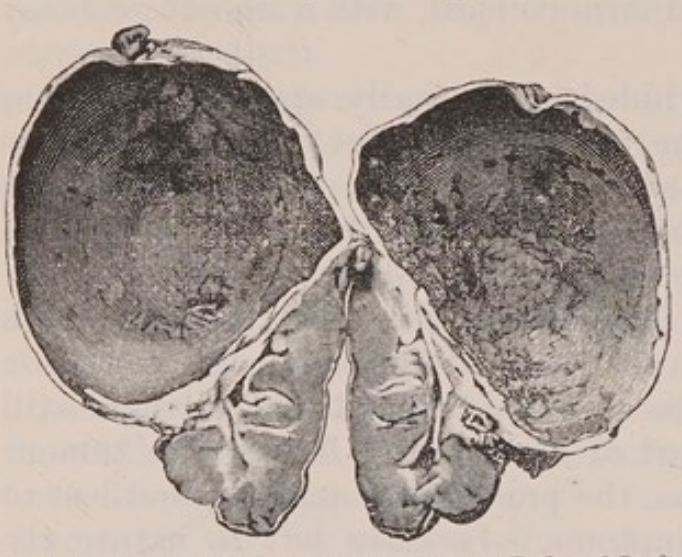


Fig. 135.—Solitary Cyst at Upper Pole of Left Kidney, removed from a woman, æt. 29.

The cysts do not communicate with the pelvis or calyces, but they often communicate with one another. Both kidneys are commonly affected, although the disease is usually more advanced on one side. The liver, and less frequently the spleen, is also the seat of multiple cysts in a considerable proportion of cases. As in other chronic affections of the kidney, there may be hypertrophy of the left ventricle of the heart and general arterio-sclerosis.

Clinical Features.—The disease may run a latent course for many years, and then cause death within a few days from suppression of urine. Not infrequently there are symptoms referable to the urinary functions—such as polyuria, slight hæmaturia, thirst or dryness of the mouth—which are apt to be ascribed to the contracted form of chronic interstitial nephritis. Sometimes the chief complaint is of palpitation and breathlessness, or an enlargement in the abdomen may have attracted attention.

Fig. 136.—Polycystic Kidney from a woman, æt. 40, in whom the other kidney also was affected.

In typical cases there is no difficulty in recognising bilateral renal tumours, with smooth hemispherical projections on the surface corresponding to the individual cysts.

Each tumour is reniform in shape, moves with respiration, and can be moved between the two hands. These characters should allow of its being differentiated from a malignant tumour, hydronephrosis, or an hydatid cyst. If only one kidney can be felt to be enlarged the diagnosis is more difficult, unless the liver is also affected, in which case the liver is enlarged, and the cysts may be felt on its anterior surface.

The urine is like that met with in the contracted kidney; it is increased in amount, pale in colour, and of low specific gravity; there is a trace of albumin, occasionally tube casts, and decolorised hæmocytes; sometimes there is visible hæmaturia. The presence of concentrically laminated colloid bodies like those met with in the prostate is believed to be pathognomonic.

The surgical importance of this condition lies in its diagnosis, as it is not amenable to any form of treatment. If not recognised until the kidney is exposed, the proposed operation should be abandoned.

Hydatid cyst of the kidney gives rise to no urinary phenomena unless it ruptures into the pelvis, in which case daughter cysts and hooklets may be found in the urine.

Surgical Aspects of Nephritis.—It has now been established that certain forms of chronic nephritis may be attended with pain and hæmaturia. From the fact that the pain may be confined to one side and may amount to definite colic, and that the hæmorrhage at the time of examination may be confined to the secretion escaping from one ureter, it will be readily understood how it has come about that such cases of nephritis have been subjected to operation on the assumption that the lesion was renal calculus, tumour, or tuberculosis. When no such lesion has been found at the operation or afterwards, the condition has been described as "*essential hæmaturia*," "*renal hæmophilia*," and the like. It is now maintained that these cases are really of the nature of nephritis, and that the pain and hæmorrhage are the result of renal congestion attending inflammation of the organ. It has been shown by Kümmell that although the pain and hæmorrhage may be unilateral, the nephritis invariably affects both kidneys. Kümmell's conclusions are based on observations of the freezing-point of the blood, and on the urine obtained separately from each kidney by the ureteral catheter. If it can be demonstrated of any renal affection that only one kidney is affected, it may be safely assumed that the lesion is not a nephritis in the ordinary acceptation of the term. In cases of unilateral pain and hæmaturia due to stone the freezing-point of the blood remains unaltered.

Operative Treatment of Nephritis.—The removal or resection of the fibrous capsule of the kidney has been practised for the cure of nephritis, and splitting of the kidney for the relief of pain and hæmorrhage resulting from nephritis. Such operative procedures are not devoid of danger, and the benefits to be derived from them by no means certain.

CHAPTER XXXIII.

THE URINARY BLADDER.

Surgical anatomy—Methods of examination—Catheters—Extroversion or ectopia—Injuries: *Rupture; Penetrating wounds*—Foreign bodies—Bacterial infection: *Cystitis; Special forms of cystitis; Tuberculosis; Pericystitis*—Stone, Vesical calculus—Tumours—Pouches, diverticula and cysts—Animal parasites—Disturbances of function, Nocturnal incontinence.

Surgical Anatomy.—The bladder occupies the anterior part of the pelvic cavity lying behind the symphysis pubis. In the adult, the bladder, when empty, is entirely within the pelvis, its walls are contracted and firm and lie in contact with one another. As the organ becomes filled with fluid the cavity becomes spherical or oval, and the superior wall is projected upwards until the highest point lies above the symphysis. As the bladder rises into the abdomen it carries with it the peritoneum of the anterior abdominal wall, so that there is an area of the organ uncovered by peritoneum, extending for from one to two inches above the symphysis, through which it may be punctured or incised without opening the peritoneal cavity. Posteriorly the peritoneum dips down, in the male, between the bladder and the rectum forming the recto-vesical pouch; in the female, between the bladder and the uterus. Laterally the peritoneum passes on to the sides of the pelvis. The region of the urethral orifice or neck of the bladder, although the most fixed part of the organ, is slightly lower when the bladder is full, and higher when it is empty, especially if at the same time the rectum is distended. The mucous membrane of the bladder is devoid of glands; in the empty organ it is thrown into folds except in the triangular area—the trigone—the apex of which is at the urethral orifice, while the base is represented by a line drawn between the openings of the ureters. Stretching across between the ureteral openings is a smooth, curved ridge due to bundles of muscle fibres disposed transversely; this ridge is known as the inter-ureteral bar, and becomes unduly prominent in cases of enlarged prostate with difficulty in emptying the bladder. The ureters pierce the bladder wall obliquely, thus affording a valvular hindrance to the reflux of urine; their orifices are readily seen with the cystoscope as elliptical slits opening at intervals to emit urine. The desire to micturate comes on when the bladder contains from eight to twelve ounces, but it easily holds as much as a pint, and under abnormal conditions may contain several pints, and project as a rounded tumour between the symphysis and the umbilicus (Fig. 137). In the female, the bladder as a whole lies deeper

in the pelvis, and even when distended does not rise so freely into the abdomen. In the child, it occupies relatively a much higher level, and even when empty its anterior aspect is usually in contact with the abdominal wall, and is therefore more liable to be cut into in performing a median laparotomy below the navel than in the adult.

The "space of Retzius" is the name given to the area in front of the bladder which is occupied by loose, mobile, fatty lobules, which are easily moulded and displaced as the bladder fills up from below. The space is limited in front by the pubes, above by the peritoneal reflection, and behind by the bladder; laterally it is continued into the general space occupied by the extra-peritoneal fat, and below with the cellular tissue of the pelvis. The capacity and relations of the space are best recognised in cases of extravasation of urine from rupture of the anterior wall of the bladder below the peritoneal reflection.

The bladder receives an abundant blood-supply through the vesical arteries. The lymphatics form a network in the submucous and muscular

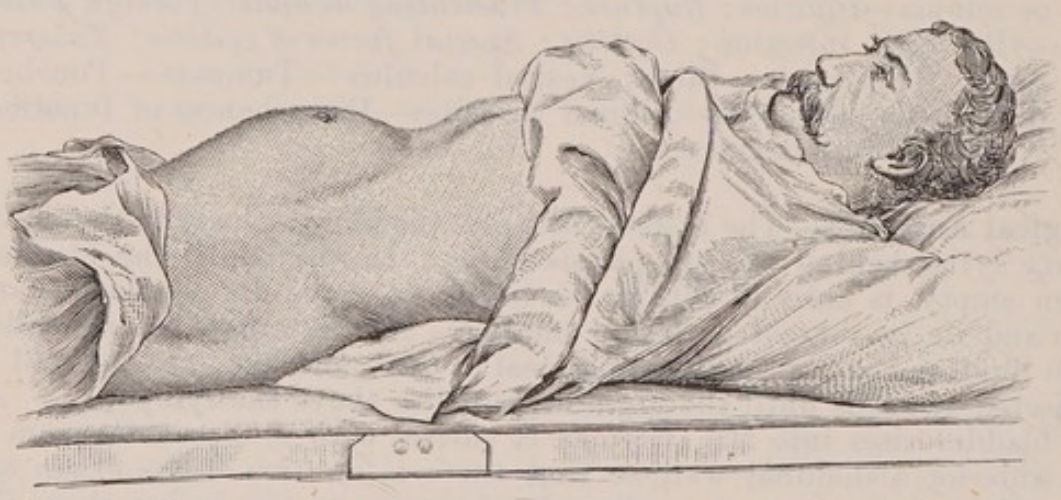


FIG. 137.—Over-distended Bladder forming an Abdominal Tumour.

coats, and communicate with those which surround the prostate, seminal vesicles, vas deferens, and terminal portions of the ureters.

So long as the epithelial covering of the mucous membrane is intact there is no absorption from the bladder, this being in marked contrast with the urethra, which absorbs with remarkable rapidity. In the absence of inflammation the mucous membrane is but slightly sensitive to contact—except in the region of the neck—hence a foreign body or a stone may be present without giving rise to symptoms, and the contact of instruments employed for exploration is scarcely appreciated except while passing through the neck.

Methods of Examination.—A careful physical, chemical, microscopical and bacteriological examination of the urine should be made in all cases, as information is thereby obtained which may be of great value in diagnosis and treatment. The first portion of urine passed is liable to be contaminated with epithelium, pus cells, or bacteria as it passes through a diseased or inflamed urethra. It may therefore be necessary to draw off the urine through a sterile catheter, or to have recourse to what is known

as "the three glass test." This consists in making the patient pass the first portion of urine into one glass, the next portion into a second glass, and the last portion into a third glass. The glasses should be sterilised before being used.

When the bladder is over-distended it forms a visible tumour in the middle line above the pubes. Percussion usually elicits a dull note over a distended bladder, but may prove misleading, especially in corpulent subjects and in flaccid conditions of the bladder muscle. The bladder may be palpated when it projects above the pubes, and by the rectum or vagina. A bimanual examination gives most information, and should be conducted under anæsthesia in the case of children, and when the muscles are rigid in adults. The rectal finger comes in contact with the prostate in the middle line, above it with the base of the bladder, and on each side with the seminal vesicle. In the female the urethra may be dilated and the little finger inserted into the bladder; with the other hand above the pubes successive areas of the bladder may be accurately palpated.

Catheters.—A catheter is a hollow instrument employed to draw off the contents of the bladder. It may be made of pure rubber, gum-elastic material, or silk covered with shellac, or of metal or glass. In general terms it may be said that where there is no obstruction in the urethra one made of pure rubber is to be preferred, because it is readily sterilised by boiling, and is least likely to injure the mucous membrane of the urethra. In using a catheter every means must be taken to prevent septic infection. The operator's hands must be disinfected or protected with sterile gloves. The meatus and glans are cleansed, and the penis, after being wrapped round with sterile gauze, is drawn through an aperture in a sterile towel. The anterior urethra is irrigated with boracic solution by means of a glass-barrelled syringe provided with an acorn-shaped urethral nozzle. The material used for lubricating the catheter is best carried in a collapsible tube, from which the required amount is expressed on to sterile gauze, and transferred to the catheter. Sterilised vaseline, glycerine, or soap are the materials commonly employed. Rubber, glass, and metal catheters are sterilised by boiling, or by prolonged immersion and washing through with carbolic solution (1 in 20); gum-elastic catheters by suspension in formalin vapour or prolonged immersion in corrosive sublimate (1-1000).

Other methods of examining the bladder, such as the use of the sound, the electric cystoscope, and skiagraphy, will be described along with the diseases of the bladder.

MALFORMATIONS.—**Extroversion of the Bladder—Ectopia**

vesicæ.—This is a rare malformation, in which there is an arrest of development of the lower part of the anterior abdominal wall, symphysis pubis, bladder, urethra, and external genitals. The term extroversion is applied to it because the posterior wall of the bladder, being unsupported in front, is pushed forwards like a hernia, and projects in the middle line below the navel (Fig. 138). In the infant, it presents as a rounded tumour about the size of a walnut, showing respiratory movements, and being partly reducible on pressure. The surface is covered with mucous membrane, which is sensitive, and may show the effects of surface irritation, and the skin around the projection often presents

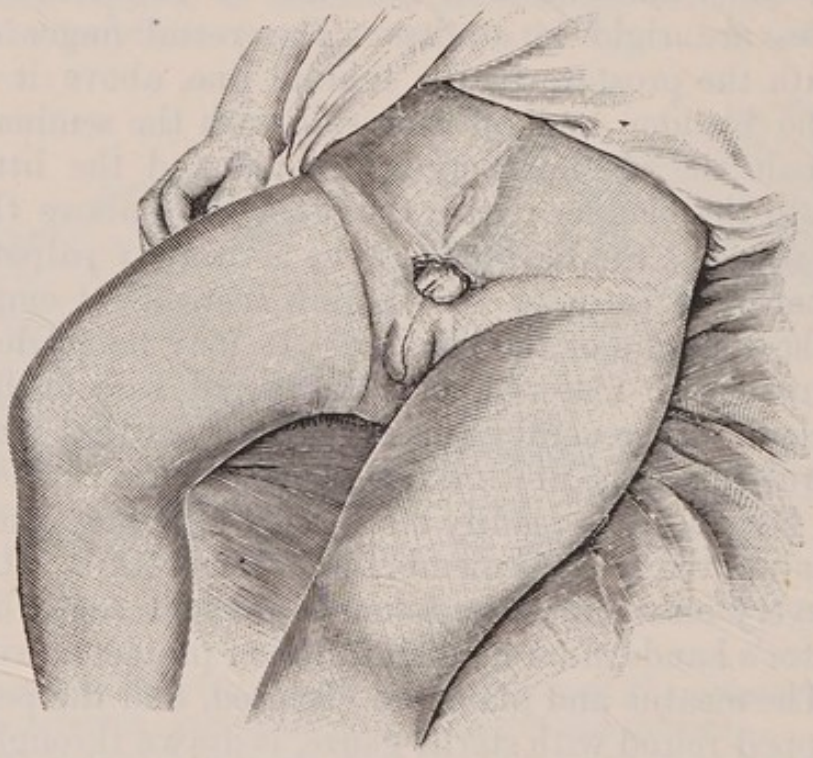


Fig. 138.—Extroversion of the Bladder in a Female Child.

irregular cicatrices. At the lower part of the tumour are the ureteral openings, from which the urine escapes in jets from time to time. In the male the tumour is continuous below with a rudimentary penis, the urethra being represented by an open gutter on the dorsum—epispadias.

The malformation entails considerable suffering, the urine dribbles away, so that the clothing is constantly wet, and the skin becomes red and excoriated. Decomposition of the urine and inflammation of the exposed mucous surface of the bladder are liable to occur, and the infection may ascend to the kidneys and prove dangerous to life.

Various plastic operations have been performed with the object of forming a new anterior wall to the bladder, but because

of the absence of any sphincter muscle the incontinence is not benefited, and if decomposition of the urine with deposition of lime salts take place, the newly-formed bladder is liable to become the seat of stone formation. Within recent years surgeons have endeavoured to overcome the incontinence by transplanting the ureters into the sigmoid flexure. To diminish the risk of ascending infection from the bowel, Maydl of Vienna transplanted the segment of bladder wall containing the ureteral orifices intact, thus preserving the valvular character of these openings. More recently an extra-peritoneal operation has been introduced by Peters of Toronto, the ureters being inserted into the rectum. After either of these procedures the patient is able to retain the urine in the rectum for several hours, and to void it at will independently of the fæces. The mucous membrane of the extroverted bladder soon regains a healthy appearance, and may be left alone, or it may be excised, the resulting raw surface being covered over with grafts or flaps of skin derived from the adjacent abdominal wall.

Hernia of the bladder—or cystocele—is described under Hernia.

Injuries.—**Rupture.**—Rupture of the bladder is a serious form of injury met with chiefly in adult males. It may result from any form of violence applied to the lower segment of the belly, such as a blow, a kick, a crush by the wheel of a vehicle, or a fall on a projecting object. It is a frequent complication of fracture of the pelvis. The bladder may be perforated by a catheter or other instrument introduced into its interior. Violence applied to the abdominal wall is more likely to rupture the bladder if the organ be distended.

Intra-peritoneal rupture is that form which involves the portion of bladder covered by peritoneum, and is nearly always the result of violence applied to the abdominal wall when the organ is distended. The tear is vertical or oblique, and is very constantly situated at the highest part of the posterior wall, a fact which was formerly believed to be due to the impact of the organ against the promontory of the sacrum, but is now ascribed to the arrangement of the muscular fibres, the tear occurring where the mucous membrane is least supported. The rupture is believed to take place from within outwards, and the serous coat is that most widely torn. The ruptured organ collapses, and the urine, slightly tinged with blood, escapes into the peritoneal cavity, and comes to lie in the pouch of Douglas and among the coils of intestine. In spite of active absorption by the peritoneum, the amount of urine in the abdomen increases,

and with the advent of organisms from the kidneys, the intestine, or an infected catheter, there ensues an insidious form of septic peritonitis which usually develops about the third day. Death occurs from a combination of septic and urinary poisoning.

Extra-peritoneal rupture is met with under two sets of conditions. *In the first variety* the bladder is over-distended, and is ruptured by localised violence applied to the lowest part of the abdomen, the tear being situated in the anterior wall below the reflection of the peritoneum. The bladder collapses, and the urine escapes into the cellular tissue of the space of Retzius, and as the amount of urine increases, it infiltrates the cellular tissue upwards towards the navel, outwards as far as the anterior iliac spine on either side, and downwards behind the symphysis as far as the neck of the bladder. *The second variety* is associated with fracture of the pelvis, and the bladder—which is not necessarily distended at the time of the injury—is torn, usually by the outer fragment of the horizontal ramus of the pubes, sometimes by the body of the pubes when the symphysis is forced asunder, rarely by traction on the anterior ligaments of the bladder. The tear is usually situated in the anterior wall close to the neck, and the urine escapes into the cellular tissue around the neck; it may then ascend towards the abdominal wall, or infiltrate the cellular tissue of the pelvis and accumulate between the bladder and the rectum.

Bacterial infection usually occurs later than in the intra-peritoneal rupture, and results in a diffuse septic cellulitis which follows the track of the extravasated urine.

Clinical Features.—Apart from cases associated with fractured pelvis—an injury which should always excite suspicion of a rupture of the bladder—it is a remarkable fact that this lesion is frequently overlooked. This error is more likely to occur in intoxicated individuals, and in those who have sustained the lesion in a street brawl or accident, and are brought to hospital without a reliable statement of what has taken place. As in other abdominal injuries the degree of shock varies, and the patient may be able to walk, although he is rarely able to stand erect. If the patient is conscious he complains of hypogastric pain and tenderness, and of a desire to pass water but is unable to do so. A catheter is easily introduced, but although the bladder may not have been emptied for many hours, only a few drops of blood-stained urine are drawn off. If a rigid catheter be employed the bladder is usually recognised to be contracted, and the point of the instrument is restricted in the range of

its movements. It is quite exceptional for its point to pass through the rent and tap the collection of urine outside the bladder; in the event of its doing so a large amount of urine slightly tinged with blood may escape.

In the intra-peritoneal variety there are rarely any characteristic signs of the presence of the accumulation of urine in the abdominal cavity. Dulness when present is ill defined, but a fulness of the pouch of Douglas may be recognised on rectal examination. From the third day onwards there is general illness with vomiting, gradually merging into septic peritonitis, and death usually ensues on the fifth or sixth day. In the extra-peritoneal variety the urinary extravasation, through being confined within narrower limits, shows recognisable signs within from twelve to twenty hours of the accident. When it spreads upwards above the pubes there is a well-defined area of dulness, and there may be also a fulness in the hypogastric region, with a convex upper border directed towards the umbilicus. When it accumulates in the cellular tissue of the pelvis the resulting swelling is recognised on bimanual examination.

It is sometimes stated that the existence of a rent in the bladder may be demonstrated by injecting a measured quantity of fluid through the catheter into the bladder, and observing the amount which returns, but the procedure is deceptive, as all the fluid may return even although the bladder is ruptured.

Treatment.—The indications are to get rid of the extravasated urine, and to close the rent in the bladder before septic changes have had time to occur. In the intra-peritoneal variety the abdomen is opened in the middle line below the navel, the peritoneal cavity is irrigated with saline solution, the rupture in the bladder sutured, and a glass drain inserted into the pouch of Douglas, after which the abdominal wound is closed except where the tube emerges. If there are already signs of pelvic peritonitis, a drain should be passed from Douglas's pouch into the rectum and brought out at the anus.

In the extra-peritoneal variety the position of the incision is determined by the seat of extravasation. If this be in the hypogastric region the incision is made above the pubes as in suprapubic cystotomy; the urine thus escapes, and the contaminated area is washed out with saline solution introduced through a catheter passed along the urethra into the bladder. The fluid used for irrigation should not be hotter than 100° F., otherwise the muscular coat of the bladder contracts, rendering the rupture inaccessible to suture. When the extravasation is low down, around the neck of the bladder and between the bladder and

rectum, the incision is made in the middle line of the perineum, as in rupture of the posterior urethra.

Suture of the rent in the bladder is carried out after the method employed in other hollow viscera, except that fine catgut is to be preferred to silk, and the sutures must not project on the mucous surface, as this may result in the deposition of phosphates from the urine. One row of Lembert sutures is passed through the serous and whole thickness of the muscular coat, and a second through the serous coat only. After completing the operation a catheter may be tied in the bladder and attached to a suction apparatus, or the patient may be directed to void his urine every two or three hours.

Penetrating Wounds.—These result chiefly from falls on pointed objects, stabs, and gunshot injuries. The penetrating instrument may enter through the anterior abdominal wall, the vagina, the rectum, or the perineum, or by way of the buttock through the sacro-sciatic foramen. Under this heading also may be included wounds accidentally inflicted on the bladder in the course of pelvic operations, and in the radical cure of hernia. Gunshot wounds are usually associated with injury to the pelvic bones.

The *clinical features* are similar to those of ruptured bladder, and similar dangerous complications are liable to ensue. The escape of blood-stained urine by the external wound is not constant. Unaided recovery is most likely to occur in wounds traversing the perineum, the vagina, or the rectum. In some cases a urinary fistula persists, and if a foreign body has been carried into the bladder it may form the nucleus of a calculus.

The treatment is the same as in ruptured bladder; if the peritoneal cavity is not implicated, it is usually sufficient to open up and drain the external wound; means are also taken to combat septic infection in the bladder.

Foreign Bodies.—A wide range of objects have been met with in the bladder, and these may gain access by various routes. Bodies entering by the urethra include portions of catheters, lithotrites, or other instruments introduced by the patient or surgeon; and hair-pins, pencils, and similar objects employed for onanistic purposes by the patient. As a result of suppurative and ulcerative processes involving the wall of the bladder, various objects may gain access to its interior, as for example sequestra from disease of the pelvic bones, hairs and teeth from ovarian dermoids, or silk threads employed in operations in the vicinity of the bladder. The clinical features vary with the foreign body. A pointed object, such as a hair-pin, may cause

cutting pains, tenesmus, and hæmaturia soon after its introduction, but some bodies give rise to no symptoms until the occurrence of cystitis and the deposition of phosphates upon the object leads to the formation of a stone (Fig. 139). These secondary changes may occur within a few days, or may be delayed for several months.

The *diagnosis* is often rendered difficult by misleading information, or by wilful deception on the part of the patient. In the female the body may be recognised on vagino-abdominal examination, or by introducing the finger through the dilated urethra. In both sexes, however, chief reliance is to be placed on the cystoscope, which not only tells of the presence of the body, but also its nature, its position, and how best to remove it. Opaque bodies may be detected by the X-rays. Hard bodies, or soft ones encrusted with phosphates, may be struck with the sound or grasped with the lithotrite.

The *treatment* consists in removing the body, if its shape

FIG. 139.—Deposition of Phosphates upon a portion of Catheter.

(From Professor Annandale's Collection.)

and size permit, by way of the urethra. In the female this may be accomplished by means of dressing forceps introduced through the dilated urethra, or in the male by means of the lithotrite. If these methods are inapplicable or do not succeed, the bladder should be opened above the pubes.

BACTERIAL INFECTION OF THE BLADDER—CYSTITIS.—The bladder and the urine contained in it are normally sterile. While organisms readily gain access by various routes, they rarely succeed in infecting the bladder unless there is also present some factor which favours their lodgement. Such factors are to be regarded as *predisposing causes* of cystitis. These include all conditions which interfere with the functions of the organ or with the vitality of its tissues. Complete evacuation of the contents of the bladder at each act of micturition is the greatest safeguard against infection, while retention of urine from any cause is an important factor in the production of cystitis. The stagnant urine constitutes a favourable medium for the growth of organisms, and ample opportunity is afforded for the bacterial products to act upon the mucous membrane.

Paralysis of the bladder from injury or disease of the nerves or nerve centres is frequently followed by cystitis, because the organ is not completely evacuated and the nutrition of its tissues is impaired. Congestion of the mucous membrane—such as may result from exposure to cold, sexual excess, active diuretics, cantharides, alcohol, the mechanical irritation of urinary salts, foreign bodies, calculus or tumour—is one of the commonest predisposing causes of cystitis, especially when it is combined with incomplete evacuation of the contents of the bladder.

The *determining cause* of cystitis is bacterial infection. The organisms concerned are the diplococcus and the urobacillus liquefaciens, both of which decompose urea, and the various pyogenic bacteria such as colon bacilli, staphylococci, streptococci, pneumococci, gonococci, and probably a great many others which have not been identified. The colon bacillus is found in nearly one-half of the total cases observed. There is rarely only one species of organism present; those most frequently associated are the colon bacillus, the urobacillus, and the staphylococcus. The urobacillus and the yellow staphylococcus are probably the most potent in causing cystitis, because they split up urea and bring about ammoniacal decomposition of the urine, which thereby becomes an irritating fluid and damages the mucous membrane with which it is in contact.

The urethra is by far the most important route of infection. While the normal urethra is sterile except in the immediate vicinity of the meatus, when diseased it is very liable to harbour organisms, and these may ascend to the bladder, or be carried thither by the passage of instruments or by injections. Organisms from the diseased urethra are the most frequent agents of infection, and while this may take place spontaneously it commonly follows the passage of instruments. The short urethra of the female readily transmits organisms from the vulva, especially in the conditions which attend the puerperal state.

Organisms derived from the blood and excreted by the kidneys are conveyed to the bladder by the ureters, but so long as the bladder and urethra functionate normally, these organisms are expelled with the urine before they are able to establish themselves. It is of interest to note that the kidney may, over long periods, discharge a large amount of pus by way of the bladder without causing cystitis. The walls of the bladder may be traversed by organisms derived from the surroundings, possibly from the rectum, certainly from pelvic abscesses of appendicular or other origin, but here even the fact of the abscess having ruptured into the bladder does not entail the development of cystitis.

The organisms cause cystitis directly by the action of their toxins on the mucous membrane, or indirectly by the changes which they bring about in the urine.

Changes in the Bladder.—The inflammatory changes in acute cystitis are most marked in the region of the neck of the bladder, and they affect chiefly the mucous membrane, which is intensely congested—of a brilliant scarlet when seen with the cystoscope—and may show minute hæmorrhages. Pus and flakes of fibrin adhere to the surface and float in the urine, and shedding of the epithelium may result in the formation of small superficial ulcers. In chronic cystitis the inflammatory changes extend throughout the whole thickness of the bladder wall and result in cirrhosis, whereby the elasticity of the organ may be much impaired. The mucous membrane is of a slate or violet colour, is often roughened or villous, and bleeds readily, or it may be the seat of ulcers; when the urine is ammoniacal the surface is covered with a foul-smelling layer of phosphates and decomposing pus. In streptococcal infections the walls of the bladder may be studded with minute abscesses. The entire mucous membrane may necrose and slough off, as for example in the cystitis which attends retroversion of the gravid uterus—the condition being spoken of as *membranous* and *gangrenous cystitis*. The condition of the muscular coat and the capacity of the organ vary with the condition of which the cystitis is a complication, and will be considered under the chapters on stone, tumour, enlarged prostate and stricture. It may be noted, however, that where there is a long-standing obstruction to the outflow of urine the bundles of muscle-fibres may stand out in interlacing columns—*fasciculated bladder* (Fig. 140)—while the mucous membrane may be herniated between the columns forming cysts or pouches in which the urine stagnates and decomposes, thus favouring the formation of stone.

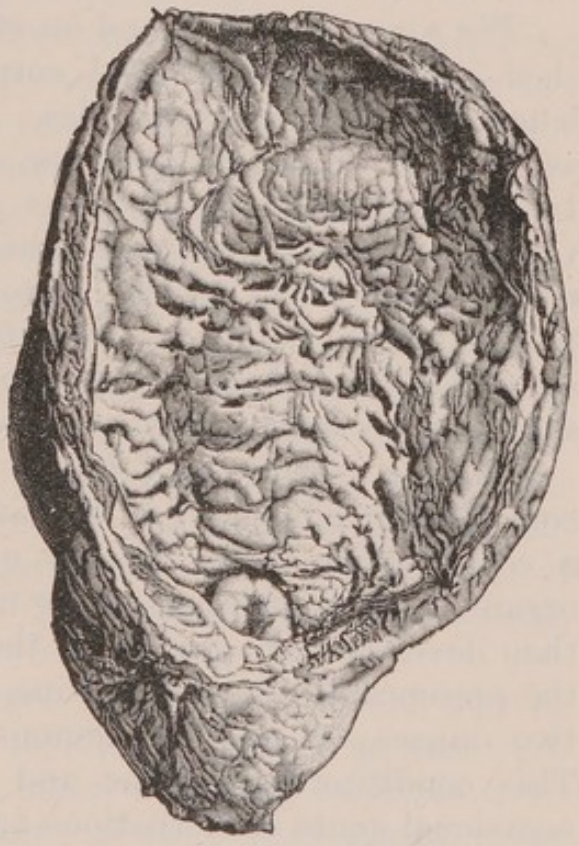


FIG. 140.—Fasciculated Bladder resulting from enlarged prostate.

Clinical Features.—These vary according to the cause of the cystitis and the conditions associated with it. Frequently recurring spasmodic contraction of the bladder is the dominating feature in acute cystitis, the patient complaining of frequent, urgent, and painful micturition. The pain is most marked at the end of the act, and is felt in the hypogastrium and radiating along the urethra. The spasm at the neck of the bladder may be so great that the organ is imperfectly emptied, and the tension of its contents raised, thus favouring the spread of the infection to the ureters.

The urine is turbid, and on standing deposits flakes of fibrin, shed epithelium, red blood corpuscles, bacteria, and abundant leucocytes and pus corpuscles. In acid urine the pus appears as a light, floating cloud or as a dense greyish deposit. In ammoniacal urine the pus corpuscles fuse together into a viscid, semi-translucent mass which entangles the other suspended matters and sinks to the bottom of the vessel. The recently passed urine should be centrifuged and films of the deposit stained for organisms. In gangrenous cystitis the urine contains shreds of necrosed mucous membrane, and is brown and putrid.

Chronic cystitis may follow on the acute variety, or may commence insidiously; in the latter case it is almost invariably a complication of an already existing affection of the urinary organs, such as stricture of the urethra or enlarged prostate. It then develops very gradually, the most prominent feature being the presence of pus in the urine, chiefly passed in the last one or two ounces, as may be demonstrated by the three glass test. This condition may come and go for a period of years with occasional acute exacerbations attended with pain and frequency of micturition. If, from the presence of staphylococci or other urea-decomposing organism, the urine undergoes alkaline fermentation, and if at the same time there is some hindrance to the outflow of urine, there is great risk of the infection ascending to the kidneys, causing pyelo-nephritis or pyonephrosis, these being the commonest causes of death in cases of chronic septic cystitis. The presence of fever, a tendency to shiver or to actual rigors, should always raise the suspicion that the infection is no longer confined to the bladder.

Diagnosis.—It must be borne in mind that the cardinal symptoms of cystitis—pyuria, frequent and painful micturition—may also result from lesions of the kidney, especially tuberculosis. When the pus is derived from the bladder it appears at the end of micturition, and tends to sink to the bottom of the vessel. When derived from the kidney the urine is more uni-

formly turbid, and remains so after standing; the quantity of pus is scarcely influenced by washing out the bladder, there is more albumin than is accounted for by the pus, and the microscope often shows tube casts. Except in acute cystitis, the source of the pus should be determined by cystoscopic examination, and the cause of the cystitis at the same time be cleared up.

The *prognosis* depends chiefly upon whether or not the predisposing cause can be got rid of; if so, then in the majority of cases the infection readily yields to treatment.

Treatment.—In addition to the removal of the predisposing cause the objects in treatment are to relieve the congestion and irritability of the bladder, and to render the contents as unfavourable a soil for the growth of bacteria as possible.

In acute cystitis the patient is confined to bed with the lower limbs and pelvis raised, and hot fomentations are applied to the hypogastrium and perineum. Spasm is relieved by hot baths, as hot as can be borne, by full doses of henbane, and by suppositories of belladonna and morphin. The urine is rendered bland and non-irritating by abundant diluent drinks, such as milk and hot water, or barley water, and by mineral waters such as those of Wildungen and Contrexéville. If the urine is highly acid and tends to deposit uric acid, the bicarbonates and citrates of soda and potash may be given. The bowels are freely opened, preferably by saline purgatives.

When the acute symptoms have subsided, solid food may be allowed in the form of fish, milk-puddings, white meat, and fresh fruit, but the amount of fluids taken must not be diminished. Urotropin (ten grains thrice daily) or salol (five grains every four hours) should be given, especially if there is the slightest tendency to alkaline fermentation of the urine. Boracic acid acts beneficially on the urine, but is liable to derange the stomach.

Treatment applied to the inflamed bladder is not called for unless the organ is unable to empty itself completely, or the inflammation persists in spite of the measures above indicated.

Drainage of the Bladder. — To keep the bladder empty, continuous suction drainage should be employed after the method devised by C. W. Cathcart. The method is founded on the principle of the Sprengel pump. A full-sized soft rubber catheter is tied in the bladder. The catheter is connected, by means of about two inches of glass tubing, with one end of a flexible rubber tube, the other end of which is attached to the stem of a T-shaped glass tube pinned to the edge of the bed. To each end of the transverse limb of the T-tube a

piece of rubber tubing is fixed. The upper tube leads to a douche can or reservoir, which is suspended at the head of the bed above the level of the patient's body; the lower tube passing over the side of the bed, ends in a glass tube with several bends like a double S, which hangs over a pail on the floor. A screw clip on the upper tube regulates the rate of outflow from the reservoir; a drop every few seconds is sufficient. By introducing a Y-shaped glass tube (Fig. 141 *g*) into the rubber tube between the bladder (*f*) and the T-shaped tube (*c*) the urine can be collected in a separate receptacle (*h*).

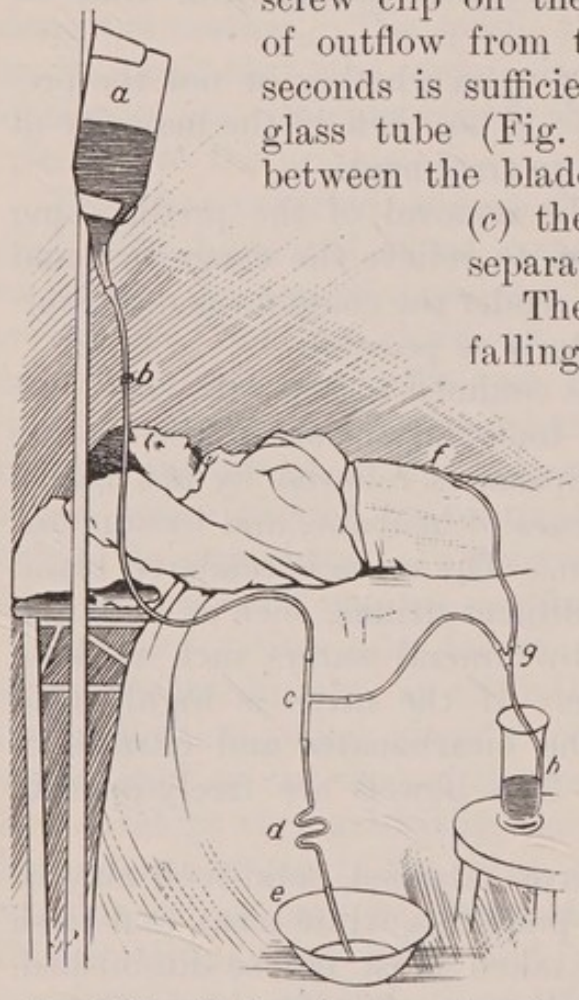


FIG. 141.—Cathcart's Apparatus for Drainage of the Bladder.

a, Reservoir.
b, Screw clip.
c, T-shaped glass tube.
d, S-shaped glass tube.
e, Receptacle for lotion.
f, Tube attached to catheter in bladder.
g, Y-shaped tube.
h, Receptacle for urine.

The principle is that the water falling by its own weight through the dependent part of the lower tube, causes negative pressure or suction above it, which, owing to the regulating clip, can only be partially satisfied by entrance of water from the reservoir. The rest of the sucking force is necessarily exercised upon the tube from the bladder.

It is essential that there shall always be some portion of the tube between the T and the pail completely filled, otherwise air will pass and destroy the suction; hence the value of the S-tube, at least one bend of which is always filled with fluid. It is also essential that the calibre of the narrowest part of the tube from the reservoir (*i.e.* at the clip) shall be less than that of the narrowest part of the tube between the T and the pail; otherwise the reservoir becomes an ordinary head of water, the pressure in the system of tubes becomes positive, and water is forced into the bladder.

The apparatus works equally well in draining by the urethra, through the perineum or suprapubically. The difference is that in the two former cases there is no air in the system of tubes; in the last case there is necessarily air in the bladder which is

sucked along with the urine down the tube. An average case of suprapubic drainage requires a flow of about four to six pints in twenty-four hours. In urethral or perineal drainage one pint is often sufficient.

Irrigation of the bladder for the purpose of cleansing the mucous membrane may be carried out with the apparatus above described—the outflow tube being clamped to allow the fluid (boracic lotion or normal salt solution) in the reservoir to run into the bladder. Another method is to use a glass barrelled syringe provided with a nozzle which readily fits into the mouth of a rubber catheter. Nitrate of silver is the best germicide in septic cystitis, the insoluble chloride which is formed appearing to have a special faculty of inhibiting the growth of organisms; the strength varies from a half to one per cent., and a sufficient amount—about three to five ounces—must be introduced partially to distend the bladder; after four or five minutes it is allowed to escape, and to prevent the silver solution coming into contact with the urethra, the bladder is then rinsed out several times with sterilised water before the catheter is withdrawn.

Instillation of the bladder — a procedure introduced by Guyon—consists in injecting slowly drop by drop a small quantity—15-30 minims—of a more concentrated solution into the neck of the bladder after the organ has been completely emptied. This is carried out by means of a small graduated syringe attached to one of Guyon's flexible olivary-headed catheters, with a terminal orifice and a very fine bore. Nitrate of silver is used in the strength of from 1 to 5 per cent., or perchloride of mercury (1 in 5000 to 1 in 10,000). The procedure is repeated every alternate day.

Drainage of the bladder by an open operation—*cystotomy*—is rarely called for in uncomplicated cystitis; it is best carried out by a median incision from the perineum. A staff with a median groove is passed into the bladder, the patient is placed in the lithotomy position, an incision about an inch and a half in length is made in the middle line of the perineum extending downwards to about one inch in front of the anus. After dividing the superficial structures the left forefinger nail feels for the groove in the staff as it lies in the membranous urethra, the knife is inserted along the finger nail into the groove in the staff, and is pushed on until its point enters the bladder. The staff is then withdrawn and the forefinger is passed into the bladder to explore its cavity. A tube is then tied in and attached to a suction apparatus.

The most important element in the treatment of chronic

cystitis is that directed towards the condition with which it is associated, such as stricture, enlarged prostate, stone, or tumour.

Special Forms of Cystitis.—**Gonorrhœal cystitis** results from the extension of the gonococcal infection from the posterior urethra to the bladder, and involves chiefly the region of the neck and trigone. It is remarkable for the frequency and severity of the spasms which attend micturition, the urine being passed with great agony in very small quantities. Gonococci as well as ordinary pus microbes are usually found in stained films of the pus. Treatment is conducted on the lines already indicated; the spasms are to be relieved by large doses of henbane or opium; if the disease persists, instillation into the neck of the bladder of a solution of silver nitrate, protargol, or argyrol should be carried out, or the bladder may be irrigated with permanganate of potash solution, 1 in 5000.

Typhoid cystitis due to the typhoid bacillus occurs in the later stages of the fever, or during convalescence.

Cystitis complicating lesions of the spinal cord is remarkable for the absence of any complaint on the part of the patient. The urine rapidly becomes loaded with pus and readily undergoes alkaline fermentation. The amount of pus and the reaction of the urine vary from time to time, as if there were waves of activity on the part of the bacteria concerned. The patient is directed to take large quantities of fluids and full doses of urotropin and salol. The latter may be pushed until the urine presents a slight greenish tinge. The bladder should be washed out twice daily with boracic lotion, and occasionally with a half per cent. solution of nitrate of silver. In the male, if there is complete incontinence, the penis is wrapped round with sterilised gauze and inserted into the neck of a urine bottle—the latter being frequently changed and disinfected; or a catheter is inserted into the bladder and connected with a suction apparatus. In the female it is better to insert a catheter, which conducts the urine into a receiver, or is connected to the suction apparatus. If there are threatenings of ascending renal infection the question of cystotomy may be considered; in the male this is done by the perineal route, in the female through the anterior wall of the vagina, the incision commencing a little below the cervix uteri; a drainage-tube is inserted through the wound, and attached to a suction apparatus.

Tuberculous Cystitis—Tuberculosis of the Bladder.—The bladder appears to be fairly resistant to infection by tubercle bacilli contained in the urine, and is practically never the seat of a primary infection from the blood Vesical tuberculosis is

nearly always secondary to tubercle of the kidney or of the seminal vesicle, prostate, and epididymis. From the kidney—*descending infection*—the bacilli pass by way of the lymphatics of the renal pelvis and ureter to those in the submucous coat of the trigone and neck of the bladder, and the disease commences in the vicinity of the orifice of the ureter on the same side. From the seminal vesicle or prostate—*ascending infection*—the disease spreads by direct continuity, or by the lymphatics, to the submucous coat, and finally to the mucous membrane in the region of the trigone. The mucous membrane presents tuberculous nodules and superficial ulcers with ragged edges, at first in the region of the trigone, but more widely spread as the disease progresses. The tuberculous infection is soon complicated with pyogenic organisms, and septic cystitis with or without alkaline decomposition of the urine is liable to occur. In consequence of the excessive irritability of the bladder the walls become indurated and contracted, and the capacity of the organ greatly diminished.

The *clinical features* are those of cystitis, developing without apparent cause in a young adult, usually of the male sex, who is already the subject of tuberculous disease in the kidney, prostate, seminal vesicle or epididymis. The cystitis is of an aggravated type and is particularly intractable. The pain on micturition is referred to the distal end of the urethra. There is usually a small quantity of blood in the urine at the end of micturition, and the amount is not influenced by rest. Bacilli are found with difficulty, even after centrifuging the urine.

The *diagnosis* is greatly aided by the recognition of tubercle in the kidney, seminal vesicle, or prostate. The cystoscope is of value in the early stages ; later it can scarcely be used because of the extreme irritability and the contracted state of the bladder. In the female direct examination with a Kelly's speculum is more generally applicable.

Treatment.—As vesical tuberculosis is always a secondary condition, its radical treatment involves the removal of the primary focus of infection. If this be done, or if the primary disease become arrested, the bladder trouble is highly amenable to treatment, and it may even undergo spontaneous cure. The general dietetic and hygienic treatment for tuberculosis should be carried out, and marked benefit usually follows treatment in the open air. The local measures employed in septic cystitis are of little or no value, and irrigation as a rule does more harm than good. If the urine is ammoniacal the injection of two or three ounces of boracic or corrosive sublimate lotion (1 in 10,000)

may relieve the symptoms. In some cases the bladder should be opened above the pubes, the diseased mucous membrane removed with the scissors or sharp spoon, and the raw surface cauterised.

Pericystitis.—Inflammation of the peri-vesical cellular tissue is a localised form of pelvic cellulitis, which may result by lymphatic extension from lesions of the bladder or of neighbouring organs, such as the uterus, Fallopian tube or vermiform appendix. The inflammation may resolve with the formation of adhesions and fixation of the organ—a common result of chronic cystitis—or may be suppurative, resulting in the formation of one or more abscesses bounded by peri-vesical adhesions. Such abscesses are found chiefly on the posterior or lateral aspect of the organ, and may be discovered on bimanual examination; they are liable to be overlooked, however, and to rupture into the bladder, and it may be also into the bowel, causing a recto-vesical fistula.

Peri-vesical suppuration frequently follows on extra-peritoneal rupture of the bladder, and is then seated in the space of Retzius in front of the bladder. The pus may burrow downwards into the pelvis or in an upward direction beneath the recti muscles, causing a brawny, painful swelling above the pubes simulating a distended bladder.

The *treatment* consists in incision and drainage either above the pubes or through the perineum, along with measures directed to the lesion of the bladder or other organ with which the suppuration is associated.

Stone—Vesical Calculus.

The general facts as to urinary lithiasis have been referred to in describing stone in the kidney. The same varieties of stone are met with in the bladder as in the kidney, but phosphatic concretions due to ammoniacal decomposition of the urine are more commonly met with in the bladder, and are much softer and more friable than phosphatic stones which have come down from the kidney. As regards their shape, in contrast to renal calculi which frequently present a triangular or branching formation in association with the form

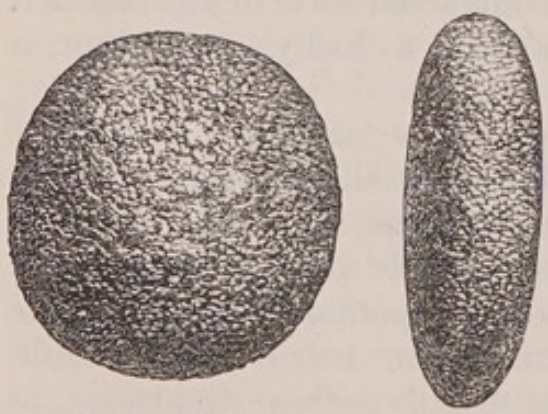


Fig. 142.—Uric Stone, surface and profile view.
From Professor Annandale's Collection.)

of the renal pelvis and calyces, vesical stones are usually rounded, ovoid, or discoid (Fig. 142), and when there are several they tend to acquire a faceted surface as a result of mutual contact (Fig. 144). The stone may form a cast of the portion of the bladder with which it lies in contact. Many stones, for example, present a groove on the lower aspect due to the inter-ureteral bar. When a stone lies partly in the bladder and partly in the prostatic urethra, it may present a characteristic hour-glass constriction corresponding to the junction of the two cavities (Fig. 145).

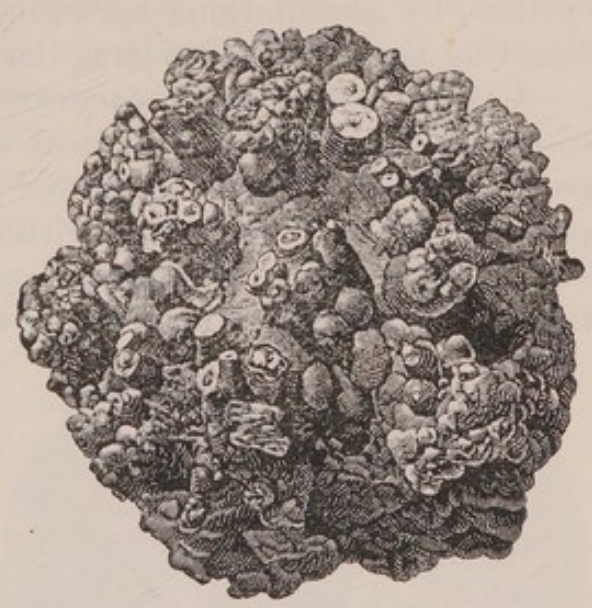


FIG. 143.—Oxalate of Lime or Mulberry Calculus.

(From Professor Annandale's Collection.)

Sources of Origin.—The great majority of vesical calculi have descended from the kidney, and after entering the bladder have increased in size. The minority take origin in the bladder, most commonly by the precipitation of phosphates as a result of alkaline decomposition of the urine. The formation of stones around foreign bodies affords the most striking example of the latter method of origin (Fig. 139). Little is known of the rate of growth of vesical stones in general, but foreign bodies may become encrusted with phosphates in a few days, and a stone of considerable size may be formed in this way within a few months. Guyon states that a uric stone takes several years to attain a diameter of two inches.

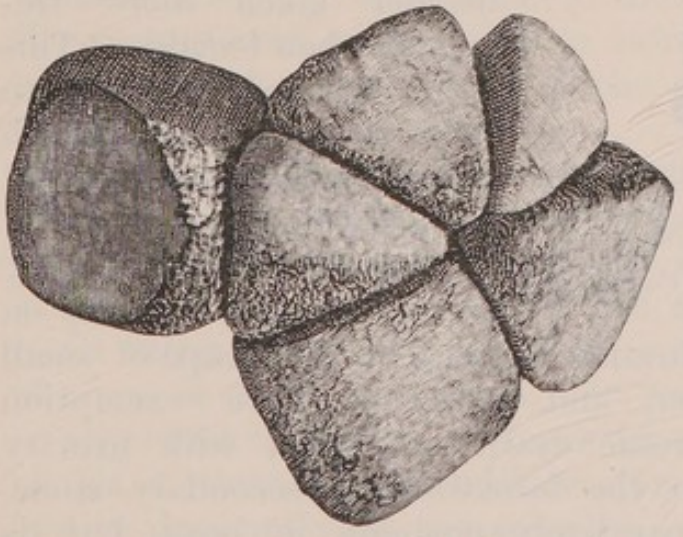


FIG. 144.—Faceted Phosphatic Stones from a case of septic cystitis complicating enlarged prostate.

(From Professor Annandale's Collection.)

Relations to the Bladder.—A stone usually lies free in the cavity of the bladder and alters its position with the attitude of

the patient. A very large stone tends to become fixed by the walls of the bladder contracting upon it, and, when there is chronic cystitis, by granulations springing from the mucous membrane inserting themselves into irregularities on the surface of the stone.

A stone is said to be *encysted* when it lies in a pocket which communicates with the vesical cavity. The encystment of a stone may be due to its partial retention in the ureter, to its passing into, or forming within, one of the pouches of a sacculated bladder, or, the cyst may result from a localised contraction of the bladder-wall upon the stone; in the latter case the wall of the cyst contains muscle fibres. As an encysted stone does not move about in the bladder, the characteristic symptoms of calculus are usually absent, and it easily escapes detection by the sound, while on bimanual examination it may feel like a tumour.

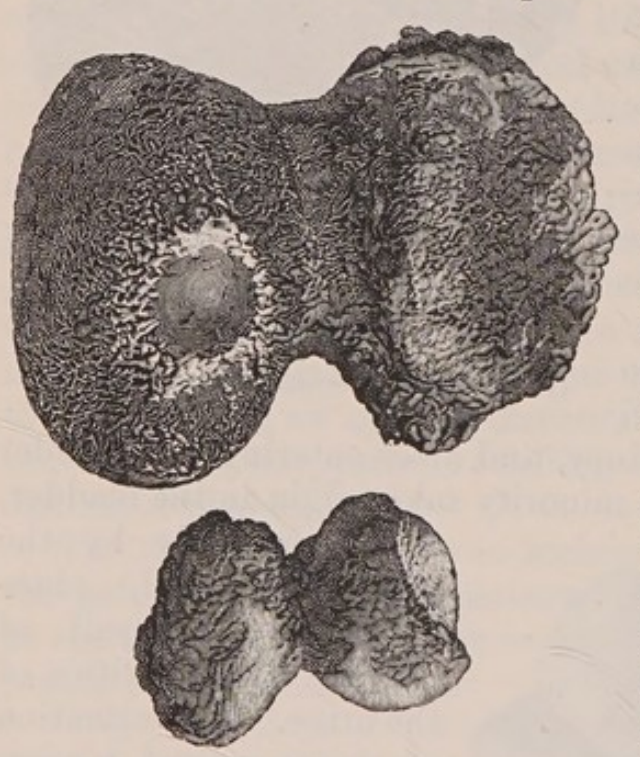


FIG. 145.—Hour-glass Stones.
(From Sir Patrick Heron Watson's Collection.)

Clinical Features.—Males suffer from stone in the bladder much more frequently than females. This is in marked contrast to stone in the kidney, which occurs with about equal frequency in the two sexes. The comparative immunity of women depends partly on the fact that the female urethra permits of the escape of small calculi from the bladder, and partly on their exemption from those forms of chronic cystitis attended with urinary stagnation which lead to the formation of secondary stone. Vesical calculus is comparatively common in boys, but is extremely rare in girls. The symptoms of stone are due in the first place to the presence of the calculus as a foreign body, and in the second place to inflammatory changes in the bladder. A stone with a smooth surface may lie in the bladder for an indefinite period without causing symptoms, and is then said to be latent, while a rough stone such as that composed of oxalate of lime soon attracts attention. A small stone may give rise to as characteristic symptoms as a large one.

The classical symptoms are pain, frequency of micturition and

hæmorrhage, and all three are aggravated by exercise or jolting, and, so long as the bladder is not infected, are relieved by rest in bed. The pain is referred to the perineum or the point of the penis, and is most marked at the end of micturition, when the sensitive neck of the bladder contracts upon the stone. Sudden arrest of the stream from the stone obstructing the meatus, with renewal of the stream on a change of posture, is not a common symptom. If the stone enter the prostatic urethra it may cause retention, or it may only partly obstruct the canal while keeping it open, and so cause incontinence. Hæmaturia is rarely a prominent feature; a few drops of bright blood may accompany the last few drops of urine, but in exceptional cases the hæmorrhage is as profuse as in vesical new growths, but it ceases promptly when the patient is confined to bed. In children, the irritation of the stone causes them to drag upon the penis, and the prepuce may become elongated.

At a varying stage in the history of stone, the features are complicated by the occurrence of septic cystitis. The urine tends to undergo alkaline decomposition, and the stone increases in size by the deposition of phosphates. The symptoms are no longer decidedly relieved by rest, and the patient suffers by night as well as by day. Spasm of the rectum occurs at the end of micturition and often tends to the development of prolapse of the rectum and piles. Septic infection may ascend to the kidneys, causing impairment of the general health and danger to life.

Secondary Stone.—Secondary stones are those which develop as a sequel to chronic cystitis in patients who are unable to empty the bladder completely, and are met with chiefly in the subjects of enlarged prostate. The symptoms characteristic of stone being masked by those of septic cystitis, the possibility of stone is often overlooked. In such conditions stone should be suspected if the urine shows an abundant deposit of phosphates, if there is pain and hæmaturia after exertion, and if the cystitis does not yield to treatment.

Methods of Examination and Diagnosis.—In any case of suspected stone in the bladder it is essential that an investigation be made of the urine, as this may reveal conditions which should receive treatment before the bladder is explored. In thin subjects and in children it may be possible to feel the stone on recto-abdominal examination, especially under an anæsthetic. In adult males the condition of the prostate should be investigated by the rectum.

Sounding the Bladder for Stone.—The patient should be

confined to bed for some hours before the exploration. The urine is drawn off, the bladder filled with boracic solution, and the patient placed in the Trendelenburg position. The instrument—preferably a combined catheter and sound with a length of beak in proportion to the probable size of the prostate—is then passed. If the stone is free and movable, it is usually struck at once; if not, the sound must be rotated and moved backwards and forwards systematically so as to explore the entire cavity. If the prostate is enlarged, the floor of the retro-prostatic pouch must be raised by a finger in the rectum. When the stone is struck there is a metallic click in the case of uric and oxalic calculi, or a soft grating in those composed of earthy phosphates. In the event of failure to strike the stone, the table is lowered to the horizontal, and the bladder is then allowed to empty itself through the catheter, when the stream may bring the stone against the point of the instrument. An idea of the size of the stone may be gained by drawing the beak of the sound from end to end and then from side to side of it. When the sound fails, a small lithotrite may succeed; its blades should be opened at the most dependent part of the bladder; the pelvis is shaken with the left hand and the stone tends to fall between the blades of the instrument. The cystoscope is, as a rule, unnecessary, but is often instructive, as it tells the shape, size, and nature of the stone, may reveal an encysted stone, and gives information as to the condition of the bladder. The patient should remain in bed for some time after the exploration.

The X-rays are of great value in doubtful or difficult cases, and should be had recourse to when for any reason it is undesirable to introduce an instrument into the bladder.

Treatment.—By whatever means it is proposed to remove the stone, the patient should previously be confined to bed for some days, and the urine and bladder brought into the best possible condition.

Litholapaxy—introduced by Bigelow in 1878—is the ideal operation in all cases in which it is possible to perform it. Such is the unanimous opinion of those who have had large experience in the treatment of stone. After disinfection of the parts concerned, the patient is anæsthetised and placed in the Trendelenburg position. The bladder is irrigated with boracic solution, and from six to ten ounces of the fluid left in the bladder. The urethra may require to be dilated with bougies and the meatus incised, in order to permit of the passage of the instruments employed—about Nos. 16-20 of the English scale.

The lithotrite is introduced into the bladder, and when its blades are opened at the most dependent part of the organ, the stone usually falls between them, and may thus be grasped. The stone is then moved towards the centre of the cavity to ensure that the bladder wall is not included. The blades are locked and the screw action of the instrument employed to crush the stone, the pressure being increased gradually to avoid bending or breaking the blades. As the stone breaks the fragments fall to the most dependent part of the bladder and are in turn picked up and crushed. The stone is ultimately reduced to fragments small enough to pass through the evacuating catheter, which is introduced after withdrawing the lithotrite and attached to a suction pump known as the evacuator. The latter is filled with hot boracic solution, which, when the rubber ball is compressed, is forced into the bladder, stirring up the fragments; on relaxing the pressure, the lotion is sucked back into the ball, carrying with it the fragments, which fall out of the stream and remain in a glass bottle attached to the rubber ball. When all the fragments have been extracted, the operation is completed by withdrawing the catheter. In the case of small stones, one introduction and crushing by the lithotrite is usually sufficient, but in the case of large stones, the crushing and evacuation may require to be repeated several times. To ensure that all fragments have been removed, the bladder may be searched with a sound, or, what is better, inspected with the cystoscope. In children smaller lithotrites and evacuating catheters must be employed, ranging from No. 4 upwards of the English scale. In uncomplicated cases, the patient is up and about again in the course of a week. The mortality recorded by surgeons of the Indian Army, who have a wide experience of the operation, is slightly under 4 per cent.

When it is impossible to pass the instruments required by way of the meatus, the membranous urethra is opened upon a staff in the middle line of the perineum, and the largest size of lithotrite introduced through the wound into the bladder, the stone crushed, and the fragments removed through an evacuating catheter. The wound in the perineum is usually healed before the end of a week. This is known as perineal litholapaxy or Keith's operation.

When the stone is so large and so resistant to crushing that even the largest lithotrite is likely to fail, the membranous urethra is opened in the middle line as in the last procedure, and the prostate is incised sufficiently to admit the finger into the bladder. A strong straight crushing forceps or lithoclast is

then introduced and the stone broken into fragments small enough to be extracted by the ordinary lithotomy forceps or scoop—perineal lithotrity.

Lithotomy—"Cutting for Stone."—It is difficult to define the conditions which render a cutting operation preferable to one or other of the crushing procedures. Formerly it was largely determined by the size and consistence of the stone, but increased experience has shown that even the largest and densest stones may be crushed, provided the operator possesses the necessary skill and a perfect set of instruments. Within recent years the limits of litholapaxy have one by one been removed.

The following may be regarded as *indications for lithotomy* :—(1) when there is some condition within the bladder, such as enlargement of the prostate, which is to be dealt with at the same time as the stone is removed ; (2) when the stone cannot be grasped by the lithotrite, for example, in some cases of encysted stone ; (3) when the bladder is so contracted upon and adherent to the stone that there is no space for the manipulation of the lithotrite ; (4) when there is a stricture of the urethra which cannot be dilated sufficiently to allow the passage of the instruments required for litholapaxy ; (5) in stones immovably fixed in the neck of the bladder.

Except in the last of these indications, the bladder is opened above the pubes—*supra-pubic lithotomy*. The patient is placed in the Trendelenburg position ; the bladder is washed out and then filled with boracic lotion, and the urethra compressed by a turn of bandage round the penis. An incision is made in the middle line, beginning over the symphysis and running upwards towards the navel, and the pyramidales muscles are drawn apart. Where more room is required, Kocher's incision, which runs parallel to the brim of the pelvis, may be employed. The pre-vesical fat behind the symphysis is displaced upwards, carrying with it the reflection of the peritoneum. The wall of the bladder is recognised and incised from below upwards, the finger following the knife to explore the bladder before the lotion has escaped. The stone is felt for and removed with the scoop or lithotomy forceps, the wound in the bladder being enlarged if necessary. The interior of the bladder is then further explored in case of there being more than one stone. If the prostate is enlarged, its removal may be undertaken at this stage, particularly if the bladder is pouched, as these conditions are likely to favour the formation of fresh concretions. If the urine is aseptic the wound in the bladder is sutured. If there

is septic cystitis, a large drainage tube is introduced and connected with a suction apparatus. Healing takes place in from three to six weeks.

Perineal lithotomy is performed when the stone is impacted in the neck of the bladder, or when crushing procedures are contra-indicated by the presence of a stricture of the urethra. The available space is very limited however, and only comparatively small stones can be extracted by this route. The steps of the operation have been described under the heading of perineal cystotomy. A tube is inserted into the bladder through the perineal wound and connected with a suction apparatus. The wound heals in three or four weeks. The operation known as *lateral lithotomy* is no longer practised.

Stone in the female is removed by litholapaxy or by supra-pubic cystotomy.

Recurrence of stone may be due to failure to remove all the fragments after litholapaxy, to the descent of another stone from the kidney, or to the formation of a fresh phosphatic stone in the bladder. The last is the most frequent and usually occurs in men over sixty with enlarged prostate, pouching of the bladder and septic cystitis; in such cases, therefore, it is essential that treatment should be directed not only to the removal of the stone, but also of those conditions which are liable to result in the formation of fresh concretions.

Tumours of the Bladder.

The commonest innocent tumour is the **papilloma**, which projects from the mucous membrane into the interior of the bladder. In its typical form it appears as a villous growth whose long thread-like processes are floated out like seaweed when the organ is filled with fluid. The purely innocent variety is usually pedunculated, and is situated in the vicinity of the trigone, and although solitary in the first instance, it is common to find one parent tumour with a number of satellites around it, or the entire mucous membrane may be studded with villous growths, suggesting a local contagiousness like that observed in papillomata of the skin. A warty form of papilloma, resembling the cauliflower growths of the skin, is also met with; it is more commonly sessile and solitary, and is more prone than the villous growth to acquire malignant characters.

The outstanding *clinical feature* is hæmaturia, which comes on suddenly without apparent cause, and without any other urinary symptom, and after lasting for a variable period disappears as

suddenly as it came. The urine may look like burgundy owing to a uniform admixture with blood, or the discoloration may be most marked in the urine passed towards the end of the act from the compression of the delicate growth by the contracting bladder. Pain or difficulty of micturition is exceptional, and is due to mechanical blocking of the urethra by a pedunculated growth near the neck of the bladder, or by clots. The health does not suffer unless the amount of blood lost is sufficient to cause anæmia. The progress of the disease is uncertain, but it is quite common for the hæmaturia to come and go over a period of years without further developments.

The *diagnosis* is suggested by the history and is confirmed by examination with the cystoscope, a period being chosen when the urine is free from blood. The cystoscope may fail from the view being obscured by hæmorrhage, or from the bladder being filled up with villous growth so that there is no cavity to illuminate. In a limited number of cases the urine may show under the microscope minute fragments of the tumour. Bimanual examination is rarely instructive in innocent tumours. In the female the cystoscope is again the chief resource in diagnosis; failing it, the interior of the bladder may be inspected with the speculum or explored with the finger.

Although innocent tumours have been known to exist for many years without detriment to health, there is always the risk of malignant transformation.

Treatment.—The best results are obtained when the operation immediately follows upon the cystoscopic examination. In men, the bladder is opened above the pubes; the mucous membrane around the base or stalk of the tumour is outlined with the knife or scissors, and is removed along with the tumour. The "caisson" speculum is often useful. Growths near the trigone are made more accessible by a Petersen's air-bag or by the fingers of an assistant in the rectum. Hæmorrhage is arrested by irrigation with a solution of adrenalin in hot water, 1-5000, or by sponge pressure exerted directly against the bleeding area. If possible the raw surface is closed by sutures. Small, multiple villous patches may be scraped with the curette. In the female, the growth may be removed through the dilated urethra or through a supra-pubic opening. Herring recommends repeated injections of nitrate of silver to arrest the growth of villous tumours and to prevent recurrence after removal.

Myoma, *fibroma*, *myxoma* and *angioma* are very rare.

The commonest form of malignant disease of the bladder is a squamous **epithelial cancer**, which may commence as such or

may originate in a pre-existing papilloma, particularly of the sessile, warty type. The tumour tissue infiltrates the wall of the bladder, causing induration, fixation, and adhesion to surrounding structures. The exposed surface of the tumour may become encrusted with phosphates. As the patient usually succumbs at a comparatively early stage to septic complications in the urinary tract, or to obstruction of the ureters and suppression of urine, metastasis to lymphatic glands or to distant organs is exceptional.

The *clinical features* of vesical cancer are similar to those of villous growth, but the hæmaturia is less abundant and more continuous. Cystitis from superadded pyogenic infection sets in early, and causes frequent and painful micturition and impairment of the general health. The later stages of the disease are attended with great suffering; spasmodic contractions of the bladder causing unbearable agony, which is only relieved by large doses of hyoscyamus or the inhalation of a few drops of chloroform on a handkerchief. The patient finally succumbs with symptoms of pyelo-nephritis and uræmia.

The *diagnosis* is to be made with the cystoscope, or, failing this, by opening the bladder above the pubes; growths which are palpable on rectal or bimanual examination are usually beyond removal by surgical means.

Treatment.—Removal of the disease is only to be attempted when it is strictly localised. The bladder is widely opened above the pubes, preferably by Kocher's incision. The portion of bladder wall affected should be removed along with the tumour, and as this is not possible in the case of tumours situated in or near the trigone, these are better left alone. Tumours on the anterior wall are most amenable to radical removal. Should one of the ureters be involved, the affected portion is removed along with the growth, and the proximal end inserted through a fresh opening into the bladder. When removal is contra-indicated, the bleeding is arrested, and the patient is rendered more comfortable by supra-pubic drainage, although this does not altogether get rid of the painful spasms. Complete extirpation of the bladder is rarely indicated, because when the disease is so extensive as to necessitate it, it is seldom confined to the bladder. When the operation is performed the ureters are inserted into the bowel.

Sarcoma of the bladder is rare, and is met with in children as well as in adults. The clinical features vary in different cases; hæmaturia, frequent and painful micturition attended with straining are usually present, and there may be sudden

retention or incontinence. Not infrequently the tumour can be recognised on bimanual examination, and the bladder may form a prominent tumour above the pubes resembling the over-distended organ, but on passing the catheter only an ounce or two of urine escapes. Removal is usually out of the question; the symptoms are best relieved by supra-pubic drainage.

Pouches, Diverticula, and Cysts of the Bladder.—Acquired pouches or cysts are usually the result of obstruction to the escape of urine, and are met with in the form of hernial protrusions of the mucous membrane through the spaces between hypertrophied bundles of muscular fibres. Small pouches are comparatively common in cases of urethral stricture and enlarged prostate, and are usually multiple. When of large size and solitary, the term cyst or diverticulum is applied. A diverticulum may be like a hen's egg in shape and size, or it may be much larger than the bladder from which it springs, and its wall may be very thin and contain no muscle fibres. Sometimes the urine which stagnates in such diverticula decomposes, and phosphatic stone of the "encysted" variety results. We have observed more than one case in which a large diverticulum of the bladder was protruded at the inguinal canal, constituting one form of bladder hernia.

The condition seldom gives rise to definite symptoms. In some cases the patient micturates in two stages, first passing clear urine from his bladder, and then, on making pressure over the pubes, expelling turbid urine from the diverticulum. A large diverticulum may be recognised on bimanual examination as a fluctuating tumour distinct from but fixed to the bladder. The cystoscope may demonstrate the existence of a pouch, its situation, and possibly a stone in its interior.

In the majority of cases the *treatment* is merely directed towards complete emptying of the bladder and the prevention of bacterial decomposition. It is sometimes, however, possible to excise the diverticulum.

Cystic tumours related to the bladder but derived from structures outside the organ are represented by cysts of the urachus, which are situated in the hypogastric region between the bladder and the navel; cysts derived from the prostate or seminal vesicle, which develop behind the bladder and below the level of the recto-vesical reflection of peritoneum; dermoid cysts; and hydatids. Any one of these may cause frequency of micturition and difficulty in emptying the bladder, and may be recognised on bimanual examination.

Animal Parasites in the Urinary Tract.—The *Filaria san-*

guinis hominis may be brought to the urinary organs through the blood-stream, and in the course of its attempted elimination through the kidney it may give rise to hæmaturia and chyluria. The condition is met with in those who have resided in tropical countries. The urine looks like milk or cream, and streaks or clots of blood appear mingled with it. The embryo filariæ are found on microscopical examination.

The *Bilharzia hæmatobia* is met with in those who have resided in certain parts of Africa, and especially in Egypt. The parent worm inhabits the portal vein and its tributaries, but after impregnation the female buries herself in the submucosa of the renal pelvis, ureter and bladder, where she lays her eggs. These are provided with a sharp terminal spine, by means of which they bore their way through the mucous membrane and gain access to the urine. These processes are attended with hæmaturia and sometimes with pain and spasm. The mucous membrane may become the seat of granulations and fungosities, which may partly block the pelvis and ureter. In the bladder, especially if septic infection be superadded, there is an aggravated form of cystitis with a tendency to phosphatic deposit and stone formation.

The Echinococcus hominis is responsible for the development of hydatid cysts in the kidney. If these rupture into the pelvis, daughter cysts and hooklets may be found in the urine, with the addition of pus when septic infection is superadded. Hydatid cysts do not form in the bladder itself, but when situated in the recto-vesical space, they may cause such difficulty in micturition as to call for surgical interference.

Disturbances of the Functions of the Bladder—*Neuropathic Affections of the Bladder.*—The functions of the bladder are frequently disturbed in affections of the nervous system. Gross lesions of the brain, such as cerebral hæmorrhage, or of the cord, such as may attend fracture of the spine, myelitis, or Pott's disease, are frequently attended with motor and sensory paralysis of the bladder. The organ is unable to empty itself and becomes over-distended, until the intra-vesical pressure overcomes the sphincter muscle of the urethra, when there is incontinence or dribbling from overflow. This condition, which has been called *ischuria paradoxa*, predisposes to infection of the retained urine and of the walls of the bladder, hence the measures employed for its relief demand the most rigid exclusion of sepsis. The bladder must either be emptied at regular intervals—every four or six hours—or a catheter tied in and connected with a suction apparatus. In cord lesions the paralysis may affect the motor

functions, while sensation is retained, in which case the patient is aware of the necessity of emptying the organ but is unable to do so; or sensation alone may be abolished, so that the patient passes water unconsciously.

In *locomotor ataxia* the functions of the bladder are frequently disturbed, sometimes before the characteristic features of the disease are developed. There may be spasm of the bladder with urgent desire to urinate; the flow may be interrupted and recommence after the patient thinks he has finished; there may be difficulty in commencing the act; or retention with distension and dribbling. There are sometimes neuralgic and colicky pains, or there may be anæsthesia, so that the patient is unaware of the state of his bladder, or unconscious of the urine being passed.

In functional derangements of the nervous system, notably in *hysteria*, the bladder functions are frequently disturbed, but over-distension of the organ rarely terminates in dribbling. In certain individuals a peculiar mental attitude may develop regarding the act of micturition, a nervous incontinence, the patient making water with undue frequency from no apparent cause, perhaps thirty or forty times a day, while during sleep the bladder remains at rest. "Stammering of the bladder" is the term employed by Paget to describe a disorder of micturition of nervous origin in which clonic spasm of the urethral muscles plays a part.

Lesions of the rectum and anus in the male, and of the generative organs in the female may be attended with disturbances of the functions of the bladder. Retention of urine, for example, frequently supervenes upon an operation for piles.

A feeling of irritation in the bladder, and increased frequency of micturition, without the relief and satisfaction which normally follow the act, may be due to changes in the urine such as hyperacidity, or excess of phosphates or of oxalates.

Nocturnal Incontinence of Urine: Enuresis.—This is a functional disturbance which from its frequency calls for separate consideration. It is characterised by the involuntary discharge of urine during sleep, not a dribbling as might be inferred from the term incontinence, but a normal micturition with a full stream. It is a symptom rather than a separate entity, and may be due to a variety of causes. It is met with chiefly in boys between the ages of two and fourteen, and in the great majority of cases micturition is quite normal during the waking hours. In a few cases there is urgent and frequent micturition during the day, or micturition may take place involuntarily into

the clothes by day, as well as into the bed by night, and there may also be a want of control over the bowel. In a minority of cases some source of peripheral irritation is discovered, which may explain the undue irritability of the bladder,—crystals of uric acid in the urine, a tight or adherent prepuce, or rectal irritation such as may result from worms. In the great majority no such explanation is to be discovered, and the phenomena are ascribed to "nervousness" of the child, which may be aggravated by the punishment inflicted, a tendency to dream of the act of micturition, an undue sensitiveness of the bladder and of the micturition centres in the spinal cord, an anæsthesia of the deep urethra, or a want of tone in the sphincter muscles. These muscles are too weak to resist the vesical pressure, and the bladder empties itself before the patient awakes, or, if it occur during the day, before he has time to get to a urinal. The condition tends to disappear at puberty. In the case of adults, the occasional involuntary passage of urine during sleep may be a manifestation of epilepsy.

The *treatment* must be selected according to the features of the case. Any such condition as spina bifida occulta, phymosis, or lithiasis, should be dealt with. In purely neurotic cases suggestion may prove of service. The general health must be improved by tonics and sea-bathing. The child should be trained to lie on his side, preferably on a hard bed, the foot of which is raised some eight or ten inches. It is better to wake him regularly just before the bladder is likely to empty itself than to administer corporal punishment. If it is believed that the bladder or the spinal centres are unduly irritable, belladonna may be given in increasing doses as recommended by Trousseau. If it is believed that the sphincter muscles are wanting in tone, a course of faradic electricity may be employed, one pole being placed in the rectum and the other over the pubes. In some cases improvement has followed upon stretching the posterior urethra by means of bougies, or applying to its mucous membrane a solution of nitrate of silver. The injection of saline solution into the retro-rectal cellular tissue has been followed by disappearance of the incontinence.

CHAPTER XXXIV.

THE PROSTATE.

Surgical anatomy—Methods of examination—Injuries—Pyogenic affections: *Acute prostatitis; Abscess; Chronic prostatitis; Prostatorrhœa*—Enlargement of the prostate—Calculi in the prostate and prostatic urethra—Malignant disease—Tuberculosis.

Surgical Anatomy.—The prostate gland surrounds the first part of the male urethra, and is itself enclosed in a strong capsule or sheath derived from the pelvic fascia. It is traversed from behind forwards by the ejaculatory ducts which open on the floor of the prostatic urethra. The superior surface is related to that part of the floor of the bladder which surrounds the opening of the urethra, and each lateral surface rests against the fascia covering the levator ani muscle. The posterior surface is in contact with the anterior wall of the rectum, while the anterior surface faces the symphysis pubis. The apex points downwards and is in relation to the posterior layer of the triangular ligament. The urethra traverses the gland nearer its posterior than its anterior surface, and describes a curve with the concavity forwards. The prostate is surrounded on the front and sides by a plexus of large veins which intervene between the cortex of the gland and the fibrous capsule. The lymphatics arise in its substance and form around the organ a network which communicates with the lymphatics of the bladder, urethra, and seminal vesicles.

The prostate is composed of tubular glands lined with columnar epithelium and embedded in a connective tissue stroma abundantly provided with non-striped muscle. The glands discharge their contents by a number of minute ducts which open into the floor of the urethra. The secretion, which serves to lubricate the urethra and to dilute the semen, is normally added to the urine, but when the prostate is compressed by the levator ani, as in straining during defecation, it may be forced along the urethra and appear at the meatus as a clear viscid fluid.

The evolution of the prostate is closely related to the development of the sexual functions, and begins at puberty at the same time as that of the testes. When the sexual functions are on the wane, the gland is liable to undergo an enlargement, which constitutes the most important lesion to which it is liable. In addition to its secretory functions, the muscular fibres assist in the ejection of the semen, and by encircling the neck of the bladder and commencement of the urethra they play a part in retaining the urine.

Examination of the Prostate by the Rectum.—The bladder and rectum having been emptied, the patient bends over the back of a chair, resting his hands on the seat, so that the body forms a right angle with the lower extremities. If the patient is unable to get out of bed, the examination is made in the dorsal position. In the healthy adult the symmetrical contour of the lateral lobes and the interlobular sulcus or shallow median groove between them can be recognised. These details are felt more distinctly if there is a rigid instrument in the urethra. The firm consistence of the prostate contrasts with the soft smooth feeling of the bladder wall above and beyond it. The seminal vesicles which lie on each side of the organ are not felt unless they are distended with fluid or indurated by inflammation or tuberculous disease.

Injuries of the prostate occur chiefly as the result of the unskilful passage of urethral instruments, or of operations on the bladder; rarely from fracture of the pelvis or from sharp foreign bodies introduced into the rectum. They are attended with hæmorrhage, and it may be with extravasation of urine, and when there is septic infection this may attack the venous plexus around the organ and may spread to the pelvic cellular tissue or peritoneum. When there is extravasation of urine it may be necessary to open and drain the bladder by the perineum or above the pubes.

Pyogenic Affections — *Acute Prostatitis and Prostatic Abscess.*—A gonorrhœal or other infection may spread from the urethra along the prostatic ducts to the glands and subsequently to the stroma of the organ, resulting in inflammation of varying degrees of severity, which may or may not terminate in suppuration. When pus forms it may do so at different points corresponding to the individual gland follicles, and these foci may fuse together into a single abscess. The infection may spread along the ejaculatory ducts to the seminal vesicles, or along the lymphatics to the peri-prostatic cellular tissue, especially that between the prostate and rectum.

The condition is most often met with towards the end of the third week of a gonorrhœal urethritis, and its occurrence is favoured by congestion, induced, for example, by exposure to cold, the riding of a horse or bicycle, or indulgence in alcohol. In mild cases there is merely a feeling of weight in the perineum with pain on micturition and defecation, and on rectal examination the prostate is felt to be swollen, hot, and tender. In more severe cases there is extreme pain, the perineum is so tender that the patient is unable to sit, and micturition becomes urgent, frequent, and very painful.

The condition is to be differentiated from gonorrhœal cystitis, in which there is no enlargement of the prostate, but marked vesical tenesmus.

If suppuration ensue the pain becomes throbbing in character, and the difficulty of micturition may terminate in retention; the prostate is greatly swollen, boggy or fluctuating. The abscess usually ruptures into the urethra, and for some time the first portion of urine contains pus.

In the case of a peri-prostatic abscess the constitutional symptoms are more severe, the outlines of the prostate are obscured, and the fluctuation more superficial; the abscess may rupture on the perineum, into the rectum, or it may open both into the urethra and rectum, and so cause a recto-urethral fistula.

A *chronic* form of prostatic abscess is met with in patients who have suffered for a long period from urinary troubles; it aggravates the already existing difficulty of micturition, and is apt to be mistaken for the ordinary form of enlarged prostate.

Treatment.—The patient is confined to bed, the foot of which is elevated, the bowels are freely opened, and the diet is restricted to slops. Hot fomentations or leeches are applied to the perineum, and the rectum may be irrigated with hot water. Local treatment of the urethritis is discontinued. In the event of retention, hot baths, morphin suppositories, or even aspiration of the bladder above the pubes, should be employed, but if these measures fail a soft rubber catheter of small calibre must be passed. A prostatic abscess is opened in the middle line of the perineum, the depth of the incision being controlled by the left forefinger in the rectum, and the cavity is lightly packed with iodoform worsted around a drainage-tube.

Less acute and *chronic forms of prostatitis*, or so-called *urethro-prostatitis*, are met with chiefly in cases of long-standing gonorrhœal urethritis, although they may occur apart from this. There are catarrhal changes in the glandular follicles, resulting in the discharge into the urethra of a glairy fluid which may be clear, or turbid from admixture with pus corpuscles. This discharge appears at the meatus, especially on straining at defecation, or on pressing on the prostate from the rectum. The affection—sometimes spoken of as *prostatorrhœa*—is often associated with sexual hypochondriasis and depression, especially in neurotic individuals who have had recourse to quack literature and advice. The treatment is directed to the improvement of the general health by open-air exercise and tonics, and in persistent cases stretching the urethra by a full-sized bougie, or the instillation of a solution of nitrate of silver into the prostatic urethra, may be tried. Benefit has followed massage of the prostate by the rectum.

Tuberculous Disease.—This is a fairly common disease in

young adults, in association with tubercle in the seminal vesicles and epididymis. The symptoms may suggest stone in the bladder or in the kidney. Micturition is frequent and painful, the pain being referred to the point of the penis at the end of the act, and the last few drops of urine are stained with blood. The prostate when palpated with the pulp of the forefinger may give the impression of pea-like nodules buried in its substance, of tender boggy areas, or there may be fluctuation. A cake-like induration of either seminal vesicle or a nodular thickening of the epididymis usually affords confirmation of the diagnosis. If a cold abscess develop it may rupture into the urethra, and pus and debris appear in the urine, or it may point and burst in the perineum, leading to the formation of a sinus or a urethral fistula. The prognosis is uncertain, because, although prostatic tubercle may undergo involution, the disease may extend to the bladder, or it may be only a part of a widespread infection of the genito-urinary organs on one or on both sides. If the epididymis is the original seat of the disease, improvement or recovery may follow removal of the testis; even double castration may be called for. Direct interference with the prostate is usually confined to cases in which a cold abscess has formed; this is opened from the perineum, cleared out, and packed with iodoform worsted. Open-air treatment should be instituted from the outset, and persevered with whether an operation is performed or not.

Enlargement of the Prostate.—This vague but convenient term refers to an affection which is met with in men after middle life, and of which the most prominent feature is an inability properly to empty the bladder. It is neither inflammatory nor malignant in nature, and cannot be regarded as a pure hypertrophy, because the increase in size of the organ is often due to the presence of newly formed glandular masses, analogous to the adenomata met with in the breast, thyroid and other glandular organs.

The essential change would appear to be an exaggerated activity of growth in the gland tissue, which may be confined within the spaces of the connective tissue framework of the organ, or may be so exuberant as to lead to the formation of independent adenomatous masses or tumours, often of considerable size. Such tumours gradually displace and compress the surrounding prostatic tissue, until the latter may be reduced to a mere film on the surface of the organ, and may be only identified on microscopical examination. This film of compressed prostatic tissue has been erroneously named the "true capsule"

of the organ; it is, however, a pathological formation, and it is through this film of tissue that separation takes place in shelling out the organ in the operation of prostatectomy. The adenomatous tumours may project on the urethral or on the vesical surface of the organ and form lobulated masses, of which the so-called "middle lobe of the prostate" is the best example. There may be several adenomatous masses in different parts of the organ or connected with one another. Albarran describes transition forms between the innocent adenoma and carcinoma of the prostate. The fibro-muscular stroma may also be the seat of overgrowth, and when this is the predominant feature the enlargement of the prostate is fairly uniform and its shape is preserved. When the adenomatous element predominates, the characteristic shape of the prostate is often lost, and the organ bulges more or less towards the urethra and bladder. The exuberant growth is prevented from projecting towards the rectum by the intervening layer of pelvic fascia. The unyielding character of the triangular ligament and the want of space beneath the pubic arch are responsible for the tendency of the gland, after enlarging to a certain degree, to project upwards in the direction of least resistance, that is, into the cavity of the bladder.

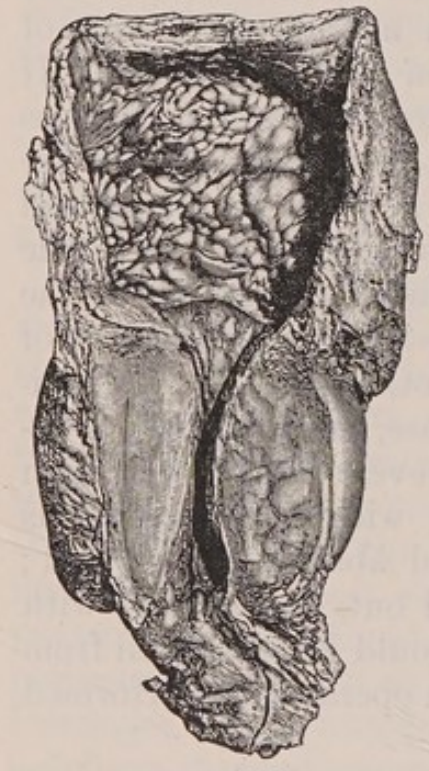


FIG. 146.—Section of Bladder showing uniform enlargement of Prostate and lengthening of Prostatic Urethra. (From a photograph lent by Mr. C. W. Cathcart.)

(Museum of Royal College of Surgeons, Edinburgh.)

Enlargement of the prostate alters the length, direction and calibre of the prostatic urethra, and the relations of the urethral opening to the floor of the bladder. When the organ is uniformly enlarged the urethra is elongated, it may be by as much as two inches, and the intra-vesical projection may surround the opening of the urethra after the fashion of a collar. If the enlargement specially affects one lateral lobe the urethra is displaced towards the opposite side, and its transverse diameter is diminished. The so-called "middle lobe" is an adenomatous offshoot from one of the lateral lobes. It may project forwards into the urethra, displacing the latter towards the pubes, diminishing its antero-posterior diameter, and exaggerating its forward curve, or it may project upwards into the

bladder as a spherical or lobulated tumour immediately behind the urethral opening, and interfere mechanically with the escape of urine (Fig. 147). If pedunculated, the middle lobe may act as a ball valve.

When from any cause the prostate becomes congested the enlargement may rapidly increase, the mucous membrane on its urethral and vesical aspects becoming swollen so that the escape of urine is rendered more difficult, or even impossible; or hæmorrhage may take place, the blood escaping by the urethra, or regurgitating into the bladder and mixing with the urine.

From the increased difficulty in voiding the urine, the muscular coat of the bladder undergoes hypertrophy, and the interior of the organ presents a fasciculated appearance (Fig. 140). The mucous membrane may then be protruded between the reticulated columns of muscle fibres, constituting sacculi or cysts, in which phosphatic concretions may be deposited and lead to the formation of encysted stone.

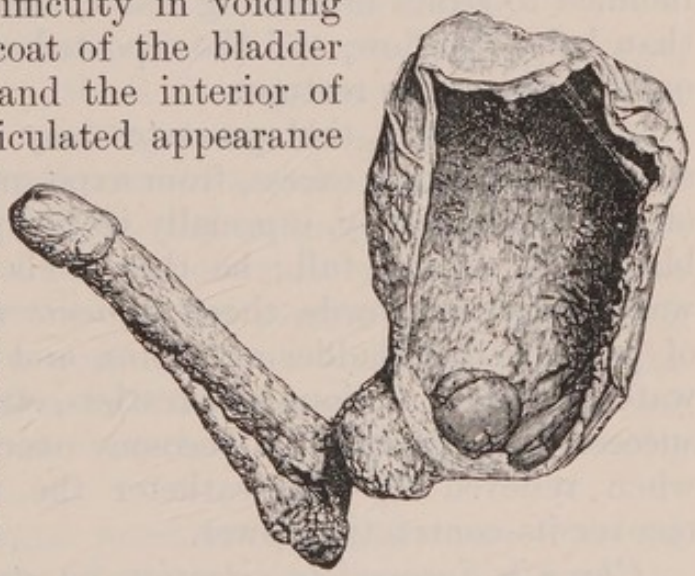


FIG. 147.—Enlargement of Prostate, showing intra-vesical projection of the so-called Middle Lobe. (From a photograph lent by Mr. C. W. Cathcart.)

(Museum of Royal College of Surgeons, Edinburgh.)

When the bladder undergoes dilatation as the result of the accumulation of residual urine, its wall becomes pouched in front of and behind the intra-vesical projection of the prostate, while the urethral opening rises more and more towards the pubes. The retro-prostatic pouch is usually deeper and more capacious than the pouch in front of the prostate, and is especially liable to become the seat of stone formation. When septic infection is superadded, the urine undergoes ammoniacal decomposition and deposits phosphates; the mucous membrane of the bladder presents the changes which attend cystitis. The muscular fibres degenerate and become replaced by fibrous tissue, and as a result of the inflammation spreading through to the cellular tissue around the bladder—pericystitis—the organ may become fixed in its dilated and pouched condition, so that it is no longer a contractile organ under the influence of the will, but an inert sac subject only to the laws of fluid pressure.

The kidneys are frequently the seat of chronic interstitial

nephritis with or without dilatation of the pelvis and ureter, and in many cases there is superadded septic infection.

Clinical Features.—Enlargement of the prostate is compatible with vigorous health and an entire absence of urinary symptoms for a period which may range from months to years, according to the physical conditions at the outlet of the bladder. The earliest symptom is that the patient has to rise to make water, especially during the early morning hours (6-7 A.M.). The urine is slow in coming, the stream is feeble, and urine escapes after the patient thinks the act is completed. The patient is inclined to strain in making water, although this hinders rather than helps the flow, and the repeated straining may induce piles or prolapse of the rectum.

At any time the prostate may become congested from alcoholic or sexual excess, from exposure to cold, or as the result of a railway journey, especially if the patient have allowed the bladder to become full; he then finds himself unable to make water, in other words, there is *acute retention.* He complains of pain in the bladder and loins, and an urgent desire to make water, becomes anxious and restless, strains unduly, but without success, and his bladder becomes over-distended, so that even when relieved by the catheter the muscular coat may not recover its contractile power.

Chronic, incomplete retention or stagnation of urine is the condition which results from the patient failing to empty his bladder completely. The amount of residual or stagnating urine gradually increases until the bladder has very little extra capacity, and the patient has to make water every half-hour or so, thus greatly disturbing his night's rest, and preventing his taking part in business or in social functions. If a catheter be passed after he has made water, and, as *he* thinks, emptied his bladder, the residual urine is drawn off, and varies in amount from two to ten ounces or more. This condition may merge into incontinence, the bladder being continually filled to its utmost, and the overflow escaping continuously in drops from the urethra. The patient states that he cannot hold his water, and is usually quite unaware that his bladder is full. The general health is now affected, the kidneys perform their work under difficulties, there is indigestion and want of appetite—the result of chronic urinary poisoning—and there is a constant risk of septic infection of the bladder.

Hæmorrhage may occur at any stage, but is most frequently met with after catheterisation at a time when the prostate is congested. The blood from the engorged mucous membrane

may pass the sphincter of the membranous urethra and escape by the meatus, sometimes in such quantity as to saturate the clothing; more frequently it passes back into the bladder and mixes with the urine. If there is much bleeding all the urine may be coloured and contain numerous clots; in moderate hæmorrhage the first portion is bloody, the greater part of the stream is only faintly tinged, and, lastly, when the bladder is nearly empty, it is again bloody as a result of the contraction of the neck of the bladder upon the congested prostate. The patient is often relieved by the hæmorrhage, and the prostate may afterwards be observed to have diminished in size.

Septic infection of the bladder also may occur at any stage, but is most frequent when there is stagnation of urine in a pouched bladder which is no longer capable of emptying itself. Although it usually follows the use of a catheter, it may develop apart from this. The phenomena may be those of acute cystitis; more commonly they are of the chronic variety, the chief feature being the appearance of pus in the last portion of urine passed. The urine may then decompose and lead to stone, and, if the patient live long enough, the infection ascends to the kidneys, and he succumbs to a combination of urinary and septic poisoning.

The *diagnosis* of enlarged prostate is usually easy from the age of the patient, his urinary history, and the condition of the organ as felt by the rectum. It should be noted that although the prostate be but little enlarged towards the rectum, an intra-vesical projection may cause marked urinary symptoms. In the majority of cases the prostate is felt as a spherical swelling immediately behind the pubic arch. It varies in consistence, and may be firm and fibrous, or elastic and yielding, according to the amount of blood and soft glandular tissue. If a catheter is passed, difficulty may be met with in entering the bladder, and the instrument passes beyond the normal length of the urethra before the urine flows. The cystoscope is of service in demonstrating the conditions within the bladder, but it should only be used as an immediate preliminary to operation.

Cancer of the prostate can usually be distinguished by the hardness of the organ as felt by the rectum, the irregularity of the enlargement, the bossing of its surface, and by the fact that there is often hæmorrhage or a discharge of blood-stained mucus from the urethra, although no instrument has been passed.

Treatment.—In the early stages attended with frequency of micturition, the patient is given directions to have the bowels emptied regularly, to avoid alcohol, red and spiced meats, ex-

posure to cold, and any excitement of the sexual functions. He should aim at emptying the bladder every three hours, and should take regular but moderate exercise. If the bladder is incapable of emptying itself, the urine should be drawn off once, twice, or thrice daily according to the amount of residual urine, and one of the occasions should be just before going to bed. If there is dribbling from overflow the catheter should be passed every four hours. If there is retention which does not readily yield to a hot bath, a catheter is passed, and if there has been difficulty in its introduction, it may be tied in and connected with a suction apparatus.

In many cases the constant use of the catheter is indispensable, and as the patient's health is dependent upon it he is said to have entered upon "catheter life."

Choice of Catheter.—A soft rubber catheter is the best; when this fails, a coudé or bi-coudé of gum-elastic material is selected. The elbow-bend was introduced by Mercier, its object being to keep the point of the instrument in contact with the anterior wall of the urethra. It has superseded the gum-elastic catheter, which depended for its curvature on the withdrawal of the wire stylet. In the case of retention the surgeon may have to fall back on a metal instrument; this should be of size No. 10 English, and of the sharply-curved short beak introduced by Chiene, which acts like a coudé, or of the wide-curved instrument known as the "prostatic catheter."

If a catheter is to be tied in, a soft rubber or gum-elastic instrument is to be preferred.

Puncture of the bladder above the pubes may tide the patient over an attack of acute retention when it is impossible to pass an instrument; it may be repeated twice daily for several days. If the urine is septic, however, the bladder must be washed out through the cannula before it is withdrawn, to avoid the risk of infecting the pre-vesical cellular tissue.

In cases of retention with septic urine, it is better to tie in a large catheter and connect it with a suction apparatus, washing out the bladder at intervals; or if the introduction of a catheter is difficult, to open the bladder above the pubes, insert a drainage tube, and connect it with the suction apparatus. In patients who are unsuited for prostatectomy, the suprapubic opening may be kept open; a full-sized rubber catheter, No. 16 or 18, is fixed in position and fitted with a stop-cock; the patient is able to go about, and may soon acquire a satisfactory continence (Annandale). The perineal route may be preferred for the permanent opening (Reginald Harrison).

Hæmorrhage from the congested prostate usually yields to hot baths, enemata, and full doses of ergot, but if it persist and give rise to difficult micturition as a result of clots in the bladder, a full-sized catheter should be passed and tied in for a few days. Obstructive clots may necessitate the use of the litholapaxy evacuator or suprapubic cystotomy.

Cystitis calls for the usual antibacterial measures, but when it resists these and interferes with the general health and prospects of life of the patient, the bladder should be opened and drained, or a radical operation considered.

Partial Prostatectomy. — This operation, with which the names of M'Gill and Bellfield are associated, consists in opening the bladder above the pubes and removing intra-vesical projections of the prostate by means of scissors or forceps. In cases in which the obstruction to micturition is due to the so-called middle lobe, it is followed by complete relief of the symptoms, which may be permanent.

Complete Prostatectomy.—In this operation an attempt is made to remove the entire prostate, either by the suprapubic or by the perineal route.

In *the suprapubic operation* (Freyer) the bladder is opened above the pubes, the forefinger is introduced, and the nail is made to tear through the mucous membrane and the film of condensed prostatic tissue over that portion of the organ which projects into the bladder. In the common form of enlargement, which is made up chiefly of adenomatous masses, the finger is easily able to enucleate these, the procedure being facilitated if two fingers of the other hand are inserted into the rectum so as to project its anterior wall and control the movements of the finger engaged in the enucleation. Finally, one or more tumour-like masses, which may or may not include the prostatic urethra, are displaced into the bladder, from which they are removed by forceps. If there are no independent adenomatous masses the organ itself is enucleated, but the process of separation is more difficult, the prostatic urethra is almost necessarily sacrificed, and portions of the ejaculatory ducts and of the membranous urethra may be found on examining the specimen after its removal. The bladder is irrigated with hot water and adrenalin (1-5000), a large drainage-tube is brought out at the wound and connected with a suction apparatus. At the end of a fortnight or three weeks the urine passes by the urethra, and the functions of the bladder speedily return to the normal. Whether or not the entire prostate is removed in the above operation is chiefly an academic question. We are inclined to agree with those who

maintain that the separation takes place within the outermost film of prostatic tissue, and have ourselves observed that when the specimen removed appeared to represent the entire organ, microscopical examination of the wall of the cavity left behind showed glandular spaces belonging to the prostate. So far as the patient is concerned the operation amounts to a complete prostatectomy.

In the perineal operation, advocated by Alexander, Parker Syms, Albarran, and others, the membranous urethra is opened on a median staff, the layer of fascia investing the prostate and the outermost film of prostatic tissue is torn through with the finger-nail, and the organ is enucleated as in the previous operation. The parts are brought nearer the finger if the bladder is pushed down by the other hand above the pubes; the prostatic urethra is less frequently sacrificed than in the suprapubic operation. A drainage-tube is inserted into the bladder, and is connected with a suction apparatus.

Castration.—From the fact that removal of the testes is sometimes followed by atrophy of the prostate, castration has been had recourse to as a method of treatment in enlargement of the organ (Ramm, White). In a proportion of cases this operation has been most successful, the enlargement of the prostate having entirely disappeared with recovery of normal micturition. As removal of the testes may be followed by psychical disturbances, amounting in some cases to actual insanity, and as it does not necessarily bring about recovery of the bladder functions, it is not to be recommended. Resection of a portion of the vasa deferentia—*vasectomy*—is even less certain in its results than castration.

Calculi in the Prostate.—Multiple small calculi composed of phosphate and carbonate of lime sometimes form in the gland follicles. If the intervening prostatic tissue become absorbed the calculi come to lie in a cyst-like cavity, and become faceted by mutual contact; the cavity may or may not communicate with the urethra. The clinical features are similar to those of tubercle of the prostate. If a rectal examination is made the stones may yield a grating or crepitus, especially if there is an instrument in the urethra. Suppuration may ensue and lead to extravasation of urine and the formation of one or more fistulæ in the perineum. Exploration of the fistula with a probe may demonstrate the presence of calculus.

Stone in the prostatic urethra is usually one which has partly escaped from the bladder and become enlarged from the subsequent deposition of lime salts. It usually presents an

hour-glass constriction corresponding to the junction of the bladder with the urethra, and the larger segment of the stone usually occupies the greatly dilated prostatic urethra. The clinical features are seldom characteristic; we have observed pain referred to the point of the penis, cramp-like contractions of the bladder, hæmaturia, and dribbling of urine. If an olivary headed gum-elastic bougie is passed it may yield a sensation of friction as it passes over the calculus.

Treatment.—The membranous urethra is opened from the perineum, and the stones are removed with an angled scoop or lithotomy forceps.

Malignant Disease.—*Cancer* is met with after middle life, either apart from or as a later development of an enlarged prostate. The clinical features are similar to those of the benign affection; the symptoms are, however, more rapidly progressive, and death usually occurs within twelve months of the onset. Hæmaturia appears early, is more constant, and occurs apart from the passage of instruments, and blood or bloody mucus may drip from the urethra apart from micturition and stain the underclothing. The patient is liable to sudden retention. On rectal examination the enlargement of the prostate is rarely uniform; it may chiefly involve one lobe, it is usually hard with a nodulated surface, and pressure on it may cause hæmorrhage from the urethra. A latent form of cancer which is unattended with any marked urinary symptoms, but which may give rise to multiple secondary growths, especially throughout the skeleton, is sometimes met with.

Various forms of *sarcoma* may originate in the prostate—sometimes in boys—and by their rapid growth fill up the bladder and project above the pubes; they may also project towards the perineum and rectum.

All that can be done is to relieve the symptoms by opening the bladder above the pubes and draining the organ by the suction apparatus. In spite of this the later stages of the disease are usually attended with great suffering, as the bladder becomes filled up with cancer and contracts at intervals in painful spasms. These are relieved by large doses of hyoscyamus or by inhalations of chloroform.

CHAPTER XXXV.

THE URETHRA.

Surgical anatomy—Methods of examination—Congenital malformations: *Occlusion; Hypospadias; Epispadias*—Injuries: *Wounds; Contusions; Rupture*—Urethral calculus—Foreign bodies—Urethritis: *Gonorrhœa and its complications; Gleet*—Stricture and its complications: *Retention; Peri-urethral cellulitis; Extravasation of urine; Fistulæ*—Urethral fistulæ—Retention of urine—Catheter or urinary fever.

Surgical Anatomy.—In the male the urethra averages about eight inches in length. That portion of the canal which extends from the meatus to the opening in the triangular ligament, a distance of about six inches, is spoken of as the *anterior urethra*. It is surrounded by the elastic erectile tissue of the corpus spongiosum, and may be subdivided from the clinical point of view into four parts: navicular, penile, scrotal, and bulbous. The navicular portion, so called because when distended it is elliptical or boat-shaped, corresponds to the glans penis; it is contracted at its junction with the penile portion, and also at the meatus, which is the narrowest portion of the entire urethra. In passing a fine instrument along this portion its point should be kept in contact with the floor to prevent it entering any of the pit-like recesses which are present in the roof. The penile portion is the most mobile and the most variable in length, and being superficial it is readily palpated through the skin on the under aspect of the penis, particularly when there is a stricture or when a stone or foreign body is lodged in its lumen. The scrotal portion is deeper and more fixed than the preceding portions, but is easily palpated when an instrument is passed into it. The bulbous portion is surrounded by the expanded posterior end of the corpus spongiosum, and is fixed to the anterior surface of the triangular ligament. It is the most dependent part of the urethra, is about half an inch in length, and is roomy and distensible; it cannot be palpated from the perineum unless a rigid instrument has been passed or its walls are indurated by fibrous tissue. It is the commonest seat of gonorrhœal stricture, and also of stricture resulting from a fall on the perineum. The junction of the anterior with the posterior urethra is represented by the opening in the triangular ligament, the most fixed and the lowest portion of the permanent urethral curve, and, next to the meatus, the narrowest part of the entire tube. In passing an instrument through it the point must be kept in contact with the roof of the canal, and the handle

depressed as soon as the resistance of the triangular ligament is encountered. False passages usually perforate the floor of the urethra at this point.

The *posterior or deep urethra* comprises the membranous and prostatic portions. The membranous urethra lies about one inch below the lower border of the symphysis between the two layers of the triangular ligament; it is about half an inch long, and is surrounded by the compressor urethræ—the "shut-off" muscle of American authors—which, when spasmodically contracted, may firmly grasp an instrument in the urethra. An instrument in the membranous urethra is easily felt by the rectum immediately anterior to the prostate. The prostatic urethra —an inch and a quarter in length—is very elastic, and is capable of considerable distension, even to the extent of admitting the finger; in the erect posture its direction is practically vertical, with a slight curve concave towards the pubes.

The urethra is lubricated by the secretion of the glands of the prostate and seminal vesicles which open into the prostatic urethra, of Cowper's glands which lie between the two layers of the triangular ligament and open into the floor of the bulbous portion, and of numerous minute mucous glands opening into the spongy urethra. All of these glands are more active during sexual excitement, and their secretion constitutes a considerable proportion of the seminal fluid.

The **examination** of a patient suffering from any affection of the urethra includes an inquiry into the history, with special reference to the frequency of micturition, the presence or absence of pain, the size and force of the stream, the characters of the urine, and the discharge of pus or blood from the meatus. When the discharge is scanty it may be demonstrated by compressing the urethra from behind forwards. The spongy urethra is accessible to palpation through the skin, and the membranous urethra by the rectum. The lining membrane may be inspected by the urethroscope or endoscope, which consists of a metal tube through which a beam of light is projected in line with the eye of the observer.

Congenital Malformations.—These include occlusions of the urethra, hypospadias, epispadias, and abnormal communications between the urethra and the rectum.

Occlusion of the urethra is usually due to a valvular fold or diaphragm which partly or completely closes the passage. The diaphragm may be at the external meatus, just behind the glans or in front of the prostate. It may be associated with escape of the urine from the bladder by some abnormal channel, such, for example, as a patent urachus.

Occlusion of the meatus is usually recognised shortly after birth, and is remedied by incising the diaphragm with a fine knife and maintaining the patency of the canal by the passage of bougies. Occlusion posterior to the glans is treated by external urethrotomy.

Hypospadias.—The floor of the urethra may be deficient to a greater or less degree as a result of defective fusion of the

lips of the uro-genital sinus, and the urine escapes through an abnormal opening on the inferior aspect.

In the slightest degree—*hypospadias of the glans*—the urethra opens in the situation of the frænum at the base of the glans penis; the frænum is absent, and the imperfectly developed prepuce overhangs the dorsal aspect of the glans like a hood. This variety is of little importance; the patient may have to lift up the penis by the prepuce in order to direct the stream of urine forwards, and in the treatment of urethral lesions it may inconvenience the surgeon, especially if the urethral orifice is unduly narrow, as it often is.

The second degree is that in which the urethra opens on the under surface of the body of the penis—*penile hypospadias*. In front of the urethral opening there is a shallow groove lined with mucous membrane representing the roof of the urethra. The penis is curved with the concavity downwards, and attempts to straighten it are resisted by tight, scar-like, fibrous bands on either side of the median groove. The curving of the penis makes it difficult for the patient to urinate without wetting his clothes, and to perform the sexual act; even if he succeed in the latter, the seminal fluid may not enter the vagina. This deformity, therefore, calls for surgical interference, and this should be resorted to between the ages of six and twelve.

The curve of the penis is redressed by cutting across the median groove and fibrous bands by a transverse incision which should be deep enough to extend into the septum between the corpora cavernosa. When the penis is straightened the wound becomes diamond shaped, and its edges are brought together so that they are parallel with the long axis of the penis. The penis is enveloped in gauze and strapped to the anterior abdominal wall. After an interval of some months an attempt is made to make a new floor to the urethra. To prevent the urine passing over the wound, the urethra is opened in the perineum and the bladder drained by means of a tube (Chiene). The floor of the urethra is fashioned from flaps derived from the scrotum or from the lateral aspects of the penis.

In the third degree the scrotum is cleft, and the urethra opens in the perineum—*scrotal* or *perineo-scrotal hypospadias*. The appearance of the external genitals resembles that in the female, and the determination of the sex of the infant may be difficult or impossible, especially if the testes have not descended. There are many cases on record in which the subject of complete hypospadias has been brought up as a female, and the condition has only been discovered accidentally in adult life.

In very exceptional instances it is associated with true hermaphroditism.

Epispadias—the reverse of hypospadias—is a condition in which the roof of the urethra is deficient, and the urine escapes through an abnormal opening on the upper aspect. It is rarely met with apart from extroversion of the bladder and arrested development of the external genitals. The urethra appears as an open gutter on the dorsum of the penis. When the deficiency is confined to the roof of the urethra it may be made good by an operation in which skin flaps are raised from the adjacent parts.

Injuries.—Wounds in the long axis of the urethra heal readily without any tendency to subsequent contraction of the tube. Wounds which cross the long axis of the urethra transversely or obliquely are very apt to lead to stricture, and may be followed by fistula. After passing a full-sized catheter into the bladder, the urethra is exposed at the site of the wound by a free longitudinal incision of the overlying skin and fascia. The cut edges of the urethra are then accurately united by fine catgut, the sutures being inserted by Lembert's method, avoiding the mucous membrane, and the fascia and skin are stitched in separate tiers. Full doses of bromides or trional are given to prevent nocturnal erections, which tend to reopen the wound; when healing is complete a bougie is passed at intervals to prevent contraction of the cicatrix in the urethra.

Contusion and rupture of the urethra are by no means uncommon injuries in boys and men from violence applied to the perineum, as by a kick or a fall astride a paling. The urethra is driven against the pubic arch and bruised or torn, usually at the junction of the bulbous and membranous portions, and the anterior layer of the triangular ligament is often torn at the same time. In fracture of the pelvis a displaced fragment of bone may lacerate the urethra, usually the membranous, but sometimes the prostatic portion, or the urethra may be actually torn away from the bladder.

Clinical Features.—If the urethra is merely contused there is tenderness and swelling, with or without ecchymosis in the perineum, and pain and difficulty in micturition, which pass off in the course of a few days. If the urethra is actually torn, there is free hæmorrhage from the mucous membrane and corpus spongiosum, and blood drips or flows from the meatus. This may be all that attracts the patient's attention, or there may be pain at the seat of injury and a considerable degree of shock. He is usually unable to make water and the bladder becomes

distended. The perineum is the seat of a tender swelling due to extravasated blood. The patient has sometimes passed water before being seen, without untoward result; or he may have attempted to do so, the attempt being attended with intense burning pain in the perineum, and increase of the swelling due to extravasation of urine. In cases of fracture of the pelvis in which the posterior urethra is torn, there is considerable shock, but bleeding from the meatus may be entirely absent, and swelling in the perineum little marked. The patient is unable to pass water and the bladder becomes distended.

Extravasation of Urine.—In the common site of rupture—in front of, or through the anterior layer of the triangular ligament—the urine infiltrates the cellular tissue of the anterior part of the perineum, the scrotum, penis, groins, and anterior abdominal wall. It is prevented from passing backwards by the attachment of the perineal fascia to the base of the triangular ligament, and from passing down the thigh by the attachment of the deep layer of the superficial fascia of the abdominal wall to the fascia lata along a line a little below Poupart's ligament.

In ruptures involving the posterior urethra, the urine fills up the compartment between the two layers of the triangular ligament, and then extends forwards or backwards according to which of these layers has been torn along with the urethra. If the posterior layer be torn the urine accumulates in the cellular tissue around the neck of the bladder, and extends upwards in front of this region into the space of Retzius and anterior abdominal wall between the fascia transversalis and the parietal peritoneum.

In cases which are left to nature the extravasated urine becomes the seat of septic infection, the clinical features slowly merge into those of a spreading cellulitis, resulting in suppuration, sinuses, and urinary fistulæ.

Diagnosis and Treatment.—A soft rubber catheter (No. 9 or 10, English) is sterilised and passed along the urethra. If it enters the bladder and draws off clear urine it should be tied in and left in position for a week or ten days. More commonly it is arrested at the site of rupture, in which case the patient should be anæsthetised to eliminate the contraction of the urethral muscles, and another attempt made. In the event of failure, the catheter should be made rigid by means of a stylet or fine bougie, and the point of the instrument kept in contact with the roof, while its movements are controlled by the left forefinger in the rectum.

Should these measures fail, the alternative procedure is to cut down on the ruptured urethra—*external urethrotomy*. The patient is placed in the lithotomy position, a large bougie or Wheelhouse's staff is passed as far as the seat of rupture, and the end of it cut down upon in the middle line of the perineum. The blood and clots are got rid of by a stream of hot saline solution, and the proximal end of the urethra is searched for with a probe; pressing over the bladder from above the pubes so as to expel urine may facilitate the recognition of the urethra. The point in the wound which bleeds most persistently is usually the stump of the urethra. Having found the central end, a rubber catheter is passed along the whole length of the canal, the torn urethra is stitched over it, and the perineal wound closed except a small opening left for drainage. The catheter is connected with a suction apparatus.

It should be stated that many authors, and among them Guyon, condemn the practice of merely tying in a catheter, on the ground that it does not necessarily prevent extravasation, and they recommend an immediate external urethrotomy in *all* cases. In cases seen soon after the injury, we are quite satisfied with tying in a catheter, but it is necessary to keep a watch on the swelling in the perineum, and be prepared to operate if extravasation occur.

In ruptured urethra *with fracture of the pelvis* it is often impossible to pass a catheter, and if it does enter the bladder the urine drawn off may be loaded with blood. It is nearly always necessary to perform perineal section, and it may be impossible to find the proximal end of the urethra. In this case the further procedure will depend on the general condition of the patient. If shock is severe the bladder may be aspirated above the pubes as a temporary measure. If the patient can stand the operation the canal of the urethra is reconstituted by "the retrograde" route, the bladder being opened above the pubes, the internal opening of the urethra identified with the tip of the left forefinger, a long bent probe passed through it and brought out at the rupture in the perineum. The outer end of a rubber catheter is then attached to the probe by a silk thread, and in its turn brought out in the perineum, the silk thread is then detached, and the catheter pushed along the anterior urethra until it emerges at the meatus. It is rarely possible to suture the rent in the deep urethra, the perineal wound should therefore be left open for drainage, but the opening in the bladder may be closed.

If extravasation have already taken place, an external urethrotomy is imperatively called for, and if there be already evidence

of superadded septic infection, multiple incisions are made throughout the whole area of extravasation, drainage-tubes inserted, and the cellular tissue irrigated with salt solution or peroxide of hydrogen.

Urethral Calculus.—A small stone which has come down from the kidney and passed through the bladder may become impacted in the urethra behind the triangular ligament, anywhere in the penile portion, or just within the meatus. The stone may be rounded and flattened like a lentil, or elongated and fusiform like a date stone. In children the impaction usually persists, whereas in adults violent efforts to pass water frequently succeed in expelling the stone. There may be a history of antecedent renal colic, or the first sign of trouble may be a sudden cutting pain during micturition, with arrest of the stream and subsequent retention, due partly to the mechanical obstruction and partly to spasm of the muscle fibres of the urethra. The retention may be absolute, or in the case of small stones may terminate in dribbling of urine which is tinged with blood, and at a later period may be mixed with pus from superadded septic urethritis. If left to nature a peri-urethral abscess forms, and may rupture into the urethra, exposing the patient to the risk of extravasation of urine, but more often it ruptures on the skin, and the condition terminates in a urinary fistula. In exceptional cases the stone does not cause retention, and comes to lie "latent" in the urethra. In course of time it increases in size by the deposition of phosphates until it may attain the dimensions of a pigeon's egg, distending the urethra or lodging in a diverticulum. The stone may be palpated through the skin, or may be recognised by passing a full-sized bougie along the urethra.

The stone may be passed if the spasm of the urethra be allayed by a hot bath, and the patient make forced attempts to micturate. Otherwise it should be removed without delay, in children under a general anæsthetic, in adults after cocainising the urethra. If the stone lie in the navicular fossa, the meatus is slit downwards, and the stone squeezed out or hooked forwards with a bent scoop or director. If it lie in the penile urethra the best plan is to expose it by a longitudinal incision through the floor of the urethra, as attempts to remove it with forceps by the meatus are liable to damage the mucous membrane and give rise later to stricture. If it lie in the posterior urethra, it may be gently pushed back into the bladder by means of a full-sized bougie, and then crushed with the lithotrite, or it may be cut down upon from the perineum and removed. The wound in the urethra is sutured as already described.

Foreign bodies, such as slate-pencils or hat-pins, are usually introduced through the meatus by the patient, and lodge in the anterior half of the penile urethra. The symptoms are painful micturition followed by hæmorrhage and a purulent discharge. The same complications may ensue as in calculus. Smooth bodies, such as slate pencils, are removed in the same way as calculi, while sharp, pointed objects require manipulations appropriate to the conditions present in each case. The urethroscope and the X-rays may be of service in this connection. Cutting methods are preferable to prolonged attempts to extract the body by forceps, because of the greater risk of damage to the urethra which these entail.

Inflammations of the Urethra — Urethritis. — Since the demonstration of the specific organism of gonorrhœa by Neisser in 1879, the pathology of urethritis has been rescued from the confusion which existed prior to that date. The examination of stained films of the discharge from the urethra enables us, in the majority of instances, to determine whether the case is one of gonorrhœa or not.

Urethritis of other than Gonorrhœal Origin.—The healthy urethra does not readily lend itself to infection with ordinary pyogenic organisms. It may, for instance, transmit in the urine pus organisms derived from the kidney or bladder, over long periods without becoming infected. When subjected to frequent catheterisation, when a catheter is tied in for a time, or when irritants are injected into its lumen, the urethra may become inflamed and discharge pus, but, when the traumatism ceases, the urethritis rapidly disappears without treatment. Contact with septic discharges from the vagina occasionally causes urethritis in the male, but this "spurious gonorrhœa," as it has been called, appears very soon after exposure to infection, the discharge is a thin muco-pus, there is little inflammatory reaction or pain on micturition, and the urethritis disappears spontaneously within a week of its origin. In stained films of the discharge various organisms are found, but no gonococci.

It was formerly believed that a fit of gout and certain alcoholic drinks and articles of diet might cause urethritis, but this only occurs if the patient is already the subject of a latent gonorrhœal infection.

Gonorrhœal Urethritis — Gonorrhœa. — The organism concerned — the *gonococcus* of Neisser — is a diplococcus, the individual cells being kidney-shaped and facing each other by their concave surfaces. In a stained film of the urethral discharge the cocci are found in the interior of the pus cells, to

a less extent in the epithelial cells and in the serum. They stain readily with aniline dyes and are decolorised by Gram's method. In a recent gonorrhœa they are found in pure culture, but in course of time other organisms make their appearance and increase in number as the gonococci become fewer. Gonococci, while almost always pyogenic in the urethra, do not necessarily lead to the formation of pus when transplanted to other tissues such as the synovial membrane of joints or the peritoneum.

Methods of Infection.—Infection practically always occurs during the sexual act, but it may result from contact with gonorrhœal pus on the seat of a lavatory, on underclothing, bed linen, towels, or sponges. The occurrence of gonorrhœa after connection with a woman who is apparently healthy, may be due to the lighting up afresh of a gonorrhœal infection which has long lain latent in the recesses of the male urethra. On the other hand gonococci may for long lie latent in the folds of the mucous membrane of the cervix uteri, and yet be capable of infecting the male. A latent gonorrhœa in the male may also be lighted up by alcoholic indulgence, or by the use of instruments, especially when the urethra is the seat of stricture.

Pathological Anatomy. — The cocci penetrate between the epithelial cells lining the urethra, and are taken up by leucocytes in the interior of which they readily multiply. The tissue changes consist in an acute catarrhal inflammation with shedding of epithelial cells, and infiltration of the subepithelial layers with serum and leucocytes, and are most marked in the glandular follicles opening into the urethra. The inflammatory changes may extend to all the coats of the urethra and involve the peri-urethral cellular tissue. The infection may spread to the prostate, seminal vesicles, epididymis, bladder, and kidney, and may be transferred to distant parts of the body, especially the joints, tendon sheaths, and endocardium. When suppuration occurs in the lymphatic glands of the groin it is probably due to the addition of other pus organisms.

Clinical Features.—The incubation period varies from three to five days, and rarely exceeds a week. There is heat and itching about the orifice of the urethra, and smarting or scalding on passing urine, and from the swollen lips of the meatus there escapes a discharge which is at first mucous, but rapidly becomes purulent. As the inflammation travels back towards the bulb all the symptoms become more marked; there is severe pain on micturition due to distension of the urethra; the discharge is more abundant, and consists of thick, greenish pus which stains the linen. The night's rest may be disturbed by painfu

erections—*chordee*—the pain being due to the infiltration and want of elasticity in the corpus spongiosum. The acute symptoms usually last for about ten days, after which they subside, but the purulent discharge from the urethra usually continues for a period of from five to eight weeks from its first appearance. It then becomes thinner and more watery, is perhaps only seen in the morning, until finally it ceases altogether; or it may persist indefinitely as a mucoid, milky discharge known as *gleet*.

It is difficult to say in what proportion of cases the infection spreads to the posterior urethra. It probably occurs only in the minority, and is sometimes due to unskilful injections made by the patient himself. When the posterior urethra is involved during the acute stage of a gonorrhœa, the discharge often diminishes in amount. There is a feeling of distension and weight in the perineum, increased frequency of micturition, the last few drops of urine cause pain and may be tinged with blood, and erections are distressing. If the urine be passed into two glasses both portions are cloudy and contain shreds of mucus and pus, whereas in urethritis confined to the anterior urethra the second portion is clear.

The patient must be warned of the infective character of the discharge, and especially of the danger of carrying the infection to the conjunctiva. All contaminated dressings should at once be destroyed by burning.

Treatment.—The patient should keep quiet, and if possible stay in bed during the first week or ten days. If this is not feasible, the scrotum and penis should be supported by a pad of wool held in position by bathing drawers. The bowels should be opened every day by saline laxatives, and the patient should drink as much diluent fluid as he possibly can,—for example, soda water, barley water, etc.,—not only to render the urine bland, but mechanically to flush out the urethra. The diet should be as light as possible; red meats, spices, coffee, asparagus, and all forms of alcohol are forbidden. Pain during micturition is relieved if the patient immerse the penis in hot water during the act. Chordee may be prevented by large doses of bromides or trional, and by elevating the foot of the bed. Medicines given by the mouth, with the object of being excreted in the urine and acting on the inflamed urethra, such as sandal-wood oil or cubebs, are of little, if any, value, and they tend to upset the stomach.

Local Treatment.—Difference of opinion exists as to whether or not local treatment should be employed at all, and if

employed, at what stage. This is especially the case with regard to the question of attempting to cut short the disease at the commencement—what is called the "abortive treatment" of gonorrhœa. Comparatively few patients come under treatment at the very onset of the disease. Iodoform bougies which melt in the urethra have been employed for this purpose. Irrigation of the urethra with a solution of permanganate of potash (Janet), if instituted within two days of the onset, rapidly cuts short the disease in many cases. This is carried out by means of a glass-barrelled syringe with a large acorn-shaped nozzle capable of plugging the meatus. The solution has been used in various strengths, 1 in 5000 being the most generally useful, and half a pint or more is required for each irrigation. The bladder having been emptied, a small amount of cocain is injected, and the first irrigation is confined to the anterior urethra; twelve hours later this is repeated and the posterior portion is also irrigated, the syringe being sufficiently powerful to overcome the resistance of the compressor urethræ. The discharge becomes thinner and smaller in amount, and may disappear in two or three days, while gonococci cannot be found after two or three irrigations. The irrigation is repeated twice daily until the discharge disappears, and then once daily for two or three days more. In our experience this method has yielded gratifying results in cases in which the treatment has been begun not later than the third day. Similar results may be obtained with the salts of silver, for example, protargol, argyrol, or argonin.

If the case is not seen within a day or two of its onset, we do not advise local injections as a routine measure during the early acute stage, because the benefits to be derived are far from certain, and the inflammation may even be aggravated, especially by injections carried out by the patient himself without proper precautions.

During the declining stage, that is, from about the tenth day onwards, there is no doubt that the efficient application of chemical agents to the inflamed urethra diminishes the amount of discharge and hastens its disappearance. The agents most generally employed are the various salts of silver, the sulphocarbolate and the chloride of zinc. Precautions must be taken to prevent additional pyogenic infection. The patient should pass water immediately before the injection is practised. A glass or rubber-ball syringe, provided with a urethral nozzle capable of plugging the meatus, is employed, and the solution is injected so that the different parts of the urethra are brought

under its influence one after another, and, finally, the lips of the meatus are pressed together so as to retain the fluid for two or three minutes. The injections are repeated twice daily or more frequently.

The irrigation of the posterior urethra should not be entrusted to the patient. More dilute solutions are employed, and the syringe must be powerful enough to overcome the resistance of the compressor urethræ, which is easily done if the urethra is cocainised to start with. We do not recommend irrigation by means of catheters with or without backward flow, as they are liable to be followed by prostatitis or epididymitis. All injections should be continued for several days after the discharge has entirely disappeared, and until the urine no longer contains thread-like filaments of pus.

The Continental test as to whether the disease is cured or not is the capacity of the patient to drink beer without causing a return of the discharge ; a more accurate test is to provoke a fresh discharge by an injection of nitrate of silver (1-100) or corrosive sublimate, and examine films for gonococci. Marriage must be forbidden until every trace of the infection has disappeared.

Complications of Gonorrhœa. — Gonorrhœal affections of the bladder, prostate, seminal vesicles, epididymis, prepuce, inguinal lymphatic glands, joints and tendon sheaths, are described elsewhere.

Peri-urethral abscess is the result of a superadded pyogenic infection of the glands opening into the urethra. When it occurs in relation to those opening into the fossa navicularis the local signs are obvious, and the abscess discharges into the urethra or is incised through the prepuce. In the penile urethra the abscess is easily palpated from the under surface of the penis, and should be opened early from this aspect to prevent urinary fistula. Abscess originating in Cowper's glands is a late complication, and tends to point towards the perineum ; if not treated by incision it may lead to a urinary fistula in the perineum.

Gonorrhœal pyæmia is a rare condition attended with severe and repeated rigors, and sometimes with endocarditis ; it is supposed to originate in a phlebitis of the veins of the corpora cavernosa or in those surrounding the prostate.

Gleet.—This term is applied to the condition in the male when a gonorrhœal discharge persists indefinitely. The discharge is small in amount, is observed chiefly in the morning, and consists of a clear or milky mucus or muco-pus. It is due to the persistence of gonorrhœal inflammation in localised areas

of the urethra, either in the region of the bulb, or at the junction of the prostatic and membranous portions. The local lesions of the mucous membrane may be seen with the endoscope or urethroscope, or their presence may be inferred if, on passing an olivary bougie, the patient complains of pain as the instrument comes into contact with or stretches the inflamed area of the tube. The discharge may be made to appear at the meatus by compressing the urethra from behind forwards. The condition is met with chiefly in neurotic patients, and its persistence appears to depend, in part at least, on the mental perturbation with which it is frequently associated.

Before concluding that the persistence of a urethral discharge is of the nature of gleet, the practitioner should make sure that the discharge does not result from chronic vesiculitis or from the urethritis which accompanies stricture.

Treatment is both general and local. The former consists in improving the bodily and mental health by tonics and open-air exercise. When the mental element predominates a sea voyage is often the best prescription. When definite lesions are found on urethroscopic examination they may be treated. Raw granular patches are swabbed with nitrate of silver in solutions of increasing strength at weekly intervals. If there is a tendency to cicatricial contraction of the tube and diminution of the stream of urine, full-sized bougies should be passed at intervals. The patient should be warned that the above procedures frequently set up an evanescent acute urethritis with marked increase in the amount of discharge.

Gonorrhœa in the female is met with in children as well as in adults, and assumes the characters of a vulvo-vaginitis with an abundant purulent discharge which irritates the adjacent parts. There is itching and burning pain, and scalding on micturition. The urethra is only infected in a small proportion of cases. The infection may lodge for long periods in the glands of Bartholin, and the gland may become the seat of abscess. The infection may spread from the vagina to the uterus, and thence through the Fallopian tube to the peritoneum and ovary, and in addition to giving rise to such important complications as pyosalpinx and peritonitis, is liable to result in chronic affections of the tubes and ovaries attended with sterility and prolonged ill health. Infection is liable also to lodge for an indefinite period in the recesses of the mucous membrane of the cervix uteri, and may thus be the means of imparting gonorrhœa to the male long after all traces of the disease have disappeared from the vulva and vagina.

Treatment.—Rest in bed, with frequent hip baths and vaginal douches, constitute the most important elements in treatment. In the intervals between the douches the opposed mucous surfaces are kept apart by gauze saturated in boro-glyceride, ichthyol, glycerine, or protargol solution. If the urethra is involved the measures employed in the male are indicated. When the cervix uteri is affected applications must be made directly to it.

Stricture of the Urethra.

The term stricture is applied to any condition in which the lumen of the urethra is narrowed. According to the nature and cause of the narrowing, a stricture is spoken of as spasmodic, congestive, or cicatricial.

Spasmodic stricture affects chiefly the membranous urethra, and is due to spasm of the compressor urethræ muscle. The spasm comes on suddenly, and may be excited by inflammation of the mucous membrane of the urethra itself, or reflexly by lesions at a distance, such, for example, as an operation for piles. Sometimes it is of central nervous origin, as in conditions of fright or hysteria. It causes retention of urine, which, although attended with discomfort and distress, is rarely followed by over-distension and paresis of the bladder.

The *treatment* is directed towards allaying the spasm by means of hot fomentations, hot baths, and rectal suppositories of morphin and belladonna. Failing relief, the water is drawn off with a soft rubber or black olivary catheter (No. 8-10); the instrument is first resisted and then firmly grasped by the urethral muscles, but by steady pressure it can be pushed on into the bladder.

Congestive or inflammatory stricture is met with chiefly in gonorrhœa when the infection has spread to the posterior urethra; the lumen of the urethra is encroached upon by the œdematous and congested mucous membrane, and this may be aggravated by spasm of the extrinsic muscles. As it is undesirable to pass a catheter because of the risk of carrying the infection to the bladder, an attempt should first be made to relieve the retention by rectal suppositories and hot baths, or by aspiration above the pubes.

Cicatricial or "Organic" Stricture.—This, by far the most important variety of stricture, is due to the formation and subsequent contraction of scar tissue in the wall of the urethra, causing narrowing of the lumen and rigidity of the affected

portion of the tube. While cicatricial contraction is the essential factor the narrowing is aggravated by congestion and spasm.

Traumatic cicatricial stricture results from injuries of the urethra, the scar tissue being formed during the process of repair. It may follow on the impaction of a stone or foreign body in the urethra, or on rough attempts to remove the same. When due to such causes the stricture usually affects the spongy portion, and may be far forwards near the meatus. When the urethra is completely torn across—for example, the membranous portion in fracture of the pelvis—the torn ends of the tube retract and become widely separated, and during the process of repair the interval comes to be occupied by scar tissue, the urine escaping by a fistula in the perineum. When the rupture is incomplete the continuity of the tube is maintained by part of the mucous membrane constituting a narrow channel in the centre of the scar tissue.

Inflammatory cicatricial stricture, while occasionally the result of a urethral chancre or of non-specific urethritis, is in the great majority of cases due to *gonorrhœa*. The gonorrhœa has usually been a persistent one, or there may have been more than one attack. The scar tissue causing the stricture may be placed superficially in the mucous membrane, or it may involve the submucous coat and the erectile tissue. The most common seat of the constriction is at the bulb, but it may affect the penile portion, even close up to the meatus, and there may be several strictures. The scar tissue may be formed chiefly in the floor of the tube, or may entirely surround it—the *annular or cylindrical* stricture; or it may form a band across the lumen—the *bridle* stricture. When the scar tissue is very dense and unyielding the stricture is described as *callous;* if it yields to dilatation, but quickly contracts again, it is described as *resilient*. If it is possible to pass an instrument through the stricture it is described as *permeable;* whereas a stricture through which nothing can be passed is said to be *impermeable*. When the urethra has been torn across or has sloughed the lumen may be entirely obliterated, all the urine passing by a fistulous opening in the perineum.

Secondary Changes and Complications.—Behind a stricture the lumen of the urethra and of the ducts and follicles opening into it are dilated, and pockets or diverticula in which secretions stagnate are formed. Favourable conditions are thus afforded for bacterial development, the mucous membrane becomes inflamed, and, with or without a breach of the surface, the infection may spread through at any time to the peri-urethral

cellular tissue, leading to cellulitis, abscess, and sometimes to gangrene. As a result of the destructive septic process the wall of the urethra is opened into, and extravasation of urine takes place, very much after the same fashion as in a septic wound a blood-vessel is opened into leading to secondary hæmorrhage. It was formerly believed that such extravasation was due to the urethra having burst as a result of violent efforts to pass water, but there is no proof of this, the evidence pointing to the extravasation being always preceded by an infective peri-urethritis. The urine leaks out drop by drop, and not in the form of a sudden gush, as is the case when the urethra is ruptured.

The bladder frequently shows hypertrophy with fasciculation and pouching of its walls, and this may be followed by atrophy and over-distension. In other cases, as a result of the almost inevitable septic infection and irritability of the organ, it may be contracted and of small capacity. The ureters and kidneys show the effects of backward pressure; the renal functions suffer as a result of chronic interstitial nephritis, and septic infection of the renal pelvis and kidney — pyelonephritis and pyonephrosis — is a frequent cause of death (Fig. 148).

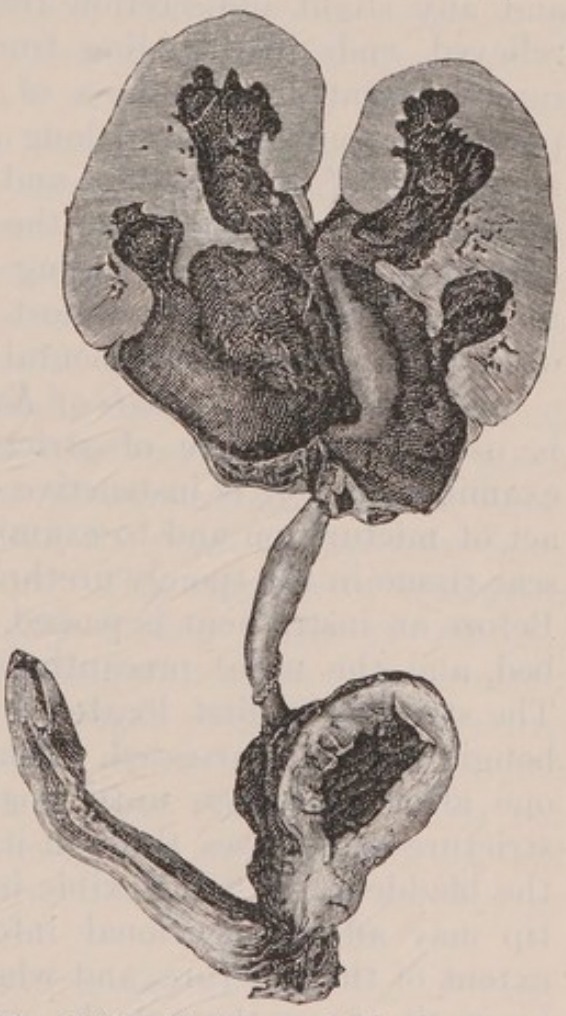


Fig. 148.—Stricture of Urethra complicated by Chronic Septic Cystitis, and followed by pyonephrosis which caused death.

Clinical Features.—The first thing to attract the attention of the patient is that the stream of urine diminishes in size and in force, and that he has some difficulty in starting the act. In some cases undue frequency of micturition is the first symptom complained of. The act of micturition is prolonged, is attended with straining, and urine trickles through the stricture after the effort is completed and wets the clothing. Twisting or forking of the stream is an inconstant and uncertain feature. A slight muco-purulent discharge from the meatus, due to the associated urethritis, is very common, and may have persisted from the

original gonorrhœa. The symptoms are greatly aggravated by exposure to cold or by the taking of alcohol, inducing congestion of the mucous membrane and spasm, and this combination of conditions is liable to bring about retention of urine.

In neglected cases the symptoms progress, the urine is voided with greater and greater difficulty, the bladder is incompletely emptied and micturition has to be repeated at frequent intervals, and any slight indiscretion results in retention, which, if unrelieved, ends in dribbling from overflow. Septic infection is rarely absent in strictures of long standing, and while comparatively unobtrusive so long as it is confined to the mucous membrane of the urethra and bladder, may at any time endanger life by spreading to the peri-urethral tissues and causing extravasation, or by ascending to the kidneys. Such lighting up of a long standing, almost dormant, infection is especially observed to follow instrumental or operative interference.

Diagnosis and Methods of Examination.—The clinical history is usually suggestive of stricture, but must be confirmed by examination. It is instructive to observe the patient during the act of micturition and to examine the urine. The induration of scar tissue in the spongy urethra may be recognised on palpation. Before an instrument is passed, the patient should be in a warm bed, and the usual precautions taken to avoid septic infection. The stricture is first located by passing a No. 10 or 12 metal bougie until it is arrested. Smaller instruments are then passed, one after the other, until finally one becomes engaged in the stricture and passes through it, the point being made to enter the bladder. A fine flexible instrument provided with an acorn tip may afford additional information as to the severity and extent of the stricture, and whether there is more than one; the acorn tip passes through the stricture with difficulty, and hitches against it on being withdrawn. By means of a urethrometer, such as that of Otis, the calibre of the stricture may be accurately determined.

Treatment of Uncomplicated Stricture.—The patient should abstain from alcohol and avoid exposure to cold, and the urine should be rendered bland by diluent drinks and occasional courses of urotropin.

Intermittent dilatation, the object of which is gradually to overstretch the scar tissue in the wall of the urethra, is carried out by the passage of bougies at intervals of two or three days. In tight strictures, filiform, horsehair, black olivary, or fine metal bougies are employed, and great care and patience must be exercised. If the urethra is sensitive and congested a solution of

eucain and adrenalin should be injected beforehand. The passage of instruments is often made easier if the urethra is distended with sterilised oil or glycerine. In difficult cases the entrance to the stricture may be found with the aid of the endoscope.

If the point of the bougie catches in the mucous membrane, it should be slightly withdrawn and then pushed on again, the urethra being kept on the stretch by making traction on the penis. In the case of steel bougies, when there is difficulty at the triangular ligament the left forefinger in the rectum controls the point of the instrument, and ensures its being kept in the middle line. It is in this region that "false passages" are most often made, the point of the instrument perforating the urethra, and being felt between the prostate and the wall of the rectum. If false passages already exist, dilatation is better deferred for two or three weeks. No force is permitted until the instrument is fairly engaged in the stricture and is felt to be grasped by it.

Above the size of No. 5 (English), conical metal bougies such as those of Lister or Chiene are most serviceable. The latter have a shorter curve (one-sixth of the circumference of a circle whose diameter is three inches), and the point is therefore more under the control of the surgeon. The amount of dilatation which should be carried out at each sitting varies in different cases; in some the full size (15-17 English scale) may be attained in one or two sittings, in others such rapid progress is inadvisable or impossible. The patient should always make water just before the instruments are passed, so that the bladder may not require to be emptied for some hours after, and a hot drink and a full dose of antipyrin or quinine should be given to prevent rigors.

If there is more than one stricture, the anterior one is fully dilated in the first instance. After the stricture has been dilated to the full size, it is most important that a bougie be passed at intervals, otherwise recontraction is almost certain to take place. These intervals are gradually lengthened till once a year may suffice. If the patient is to pass the instrument himself, he should use a black olivary bougie (size 9-13), and should be warned of the risk of continuing to use an instrument which has become rough, cracked, or brittle.

Continuous Dilatation.—The largest catheter that the stricture will admit is tied in for twenty-four hours, after which it is found to be quite loose, and a much larger instrument can then be passed. This "vital dilatation," as it was formerly called, depends partly on the exhaustion of muscular spasm, and partly on softening of the scar tissue. The method is not free from

risk, and in tight strictures with superadded septic infection it is liable to favour the development of peri-urethral cellulitis and extravasation.

Operative Methods.—The cutting of a stricture may be carried out by an instrument passed along the urethra—*internal urethrotomy*, or through an external wound—*external urethrotomy.*

Internal urethrotomy is most useful in resilient, valvular, and bridle strictures, especially of the penile urethra, when dilatation fails to make progress, or the urethra is so sensitive that the patient cannot bear it, or when, for some reason or another, a rapid cure is required. It should not be attempted if the septic element is prominent, and especially if there is any peri-urethral inflammation. The cutting instrument is known as a urethrotome, of which there are many patterns. Recontraction occurs unless prevented by the passage of a full-sized bougie at regular intervals.

External urethrotomy is especially called for when no instrument can be passed through the stricture, or when the latter is complicated with peri-urethral cellulitis or abscess, fistulæ, false passages, or extravasation of urine. Being more thorough than any of the preceding methods it may be employed when these have been tried and have failed. In traumatic strictures it is often the only feasible method.

Syme's operation is always to be preferred in cases in which an instrument can be passed through the stricture. If Syme's shouldered staff can be introduced the external operation is at once proceeded with, but if not, the stricture may first be dilated with bougies, or may be cut from within by Maisonneuve's urethrotome, the filiform guide of which can nearly always be got to pass. Syme's staff is then passed until the shoulder hitches against the face of the stricture; the patient is placed in the lithotomy position, and a median incision made in the perineum, exposing the shoulder of the staff; the point of the knife is then inserted into the groove in the narrow part of the staff beyond the shoulder, and made to cut the stricture from behind forwards. A full-sized rubber catheter is then passed from the meatus into the bladder, aided by the finger in the wound, and is tied in. A wooden plug may be fitted into the catheter and removed at intervals to empty the bladder, or the catheter may be fitted to a suction apparatus. In septic cases, the perineal wound is lightly packed with iodoform worsted; in others it is closed by tiers of sutures. Healing frequently takes place without a drop of urine having escaped from the wound. If the urine is ammoniacal the bladder must be washed out several times a day,

and the catheter is changed every second or third day, as it tends to become coated with phosphates. If there is such severe urethritis and cystitis that it is unwise to tie a catheter into the whole length of the urethra, the bladder should be drained through the perineal wound by means of Syme's S-shaped catheter. After the urethritis and cystitis have subsided, bougies are passed at intervals.

Perineal Section for Impermeable Stricture.—When an instrument cannot be passed into the bladder the urethra must be opened in front of the stricture. A staff, of the pattern introduced by Wheelhouse, is passed down to the stricture with its grooved surface looking towards the perineum. The patient is then placed in the lithotomy position, and the surgeon cuts down on the end of the staff in the middle line of the perineum, and opens the urethra by cutting on the groove in the staff. The edges of the opening are held aside by thread retractors, and the staff rotated so that the hook on the end of it projects through the opening, and then pulled up slightly so as to retract the upper angle of the opening and put the urethra on the stretch. With the aid of a probe-director the surgeon then searches for the lumen of the stricture, which can sometimes be demonstrated by expressing urine from the bladder. The director is passed through the stricture, which is then slit open along the floor throughout its whole length. The final steps of the operation and the after-treatment are the same as in Syme's operation.

If the surgeon fail to find the lumen of the stricture, recourse must be had to *the retrograde method*, the bladder being opened above the pubes, and a probe passed from the internal meatus and out at the wound in the perineum after the method described in ruptured urethra.

Resection of the strictured portion of the urethra has been successfully practised; the cut ends are stitched to each other over a rubber catheter; or if they are too widely separated for this, an attempt may be made to form a new urethra by means of a graft taken from the mucous membrane of the lower lip.

When the gap in the urethra is so extensive that it cannot be bridged, as in cases of complete rupture associated with fracture of the pelvis, or of destruction of the urethra by extensive sloughing, the patient may have to be content with a *permanent fistula in the perineum*. Urination is necessarily performed in the sitting posture, but is completely under control.

Complications of Stricture.—*Acute Retention.*—This nearly always follows exposure to cold after indulgence in alcohol, and is due to superadded congestion and spasm. Unless there is

great urgency, in which case the bladder should be aspirated above the pubes, it is best to temporise by using morphin and belladonna suppositories, and by placing the patient in a very hot bath. It is even better to repeat the aspiration than to pass instruments in the congested state of the urethra. Conditions may arise, however, in which it is imperative to get an instrument into the bladder; fine tapering metal bougies are passed through the stricture, if necessary under anæsthesia, until it is possible to introduce a No. 5 or 6 catheter, which is then tied in till the crisis is over.

Perineal section—in this connection often called *Cock's operation*—is the alternative. The patient is placed in the lithotomy position, and the left forefinger introduced into the rectum with its palmar surface upwards and its tip impinging against the apex of the prostate. A double-edged knife is then pushed into the middle line of the perineum about half an inch in front of the anus, towards the point of the finger in the rectum, the long axis of the knife being kept horizontal until the membranous urethra is opened. The knife having been withdrawn, a straight probe-pointed staff is passed into the bladder. A No. 14 rubber catheter is then passed along the staff, fixed in position, and connected with a suction apparatus. At the end of a week or ten days the catheter is withdrawn, and the stricture dilated in the ordinary way.

Peri-urethral Cellulitis and Extravasation of Urine.—The pathology of this complication has already been described. The *clinical features* are those of a grave infective lesion; there is high temperature with repeated rigors, and the perineum, scrotum, and penis become greatly swollen, brawny, and discoloured. In the worst cases, the cellulitis rapidly assumes the characters of a moist gangrene, and the patient dies of acute septic infection. In less severe cases, there is diffuse suppuration in the perineum and scrotum, extending on to the anterior abdominal wall. When incisions are made there exudes a quantity of foul pus mixed with decomposing urine, and, if the patient survive, extensive sloughs of the cellular tissue come away, leaving suppurating tracks through which the whole or the greater part of the urine escapes. Free incisions must be promptly made throughout the whole of the infected area, and the membranous urethra is opened in the middle line of the perineum to allow of the free escape of urine. Drainage-tubes are inserted in all directions, and are washed through with peroxide of hydrogen at frequent intervals. The treatment of the stricture itself may be deferred.

Peri-urethral abscess results from a localised form of cellulitis, usually occurring in the perineum, and sometimes originating in Cowper's glands. The abscess tends to rupture both externally and into the urethra, and to cause a urinary fistula. The abscess should be incised as soon as it is recognised, and a drainage-tube inserted and packed round with iodoform worsted. External urethrotomy may be performed at once, or is deferred for a few days.

Urinary fistulæ usually result from peri-urethral suppuration, as already described; they are most commonly situated in the perineum, and there may be only one, or there may be so many that when the urine escapes through them there is a suggestion of the rose perforation of a watering-can. The only way to bring about healing, is to open up thoroughly the associated stricture, and in the majority of cases this is most effectually carried out by external urethrotomy.

Urethral Fistulæ.—In addition to those met with as a complication of stricture, a urethral fistula may result from congenital malformations, from accidental wounds, from necrosis of tissue following circular constriction of the penis, from suppuration in relation to impacted foreign bodies and calculus, from the ulceration caused by a new growth, from abscess in the prostate, and after operations such as amputation of the penis or lithotomy. The fistula may open on the under surface of the penis, in the scrotum, the perineum, or the rectum, and it discharges urine or a mixture of urine and pus. The patient complains of burning pain on micturition, and of wetting of his clothes, and he is usually sterile. The fistula rarely closes of itself, because it acquires a lining of epithelium; when of long standing it may become the seat of cancer.

There is rarely any difficulty in diagnosis, although in the absence of escape of urine a perineal fistula might be mistaken for a tuberculous sinus.

Treatment is directed in the first instance to the removal of any condition which interferes with the flow of urine along the urethra. The fistula may then close of itself, or will do so after being laid open and having its edges pared. In recto-urethral fistula, the respective tubes must be separated from one another by dissection, the mucous membrane of each inverted, and the openings closed by sutures. In penile fistula resulting from sloughing of the urethra, it is often necessary to divert the stream of urine through an opening in the perineum before attempting to close the fistula. The edges of the opening are then pared, the respective layers separated by dissection, and like

stitched to like, or after having excised an area of skin around the fistula, the gap is filled in by means of a flap taken from the scrotum. The lumen of the urethra is maintained by tying in a catheter.

Retention of Urine.—It is instructive and clinically useful to resume the various conditions under which this is met with. It may be due to a want of expelling power, as in various forms of paralysis of the bladder, in peritonitis, conditions of shock, hysteria, the recumbent posture, after operations on the anus and rectum, and as a sequel to over-distension of the bladder.

The second group of conditions is that in which there is some obstruction to the outflow: in the infant, for example, from malformation of the urethra and prepuce; in the child, from impacted calculus or a string tied round the penis; in the young adult, from gonorrhœal prostatitis; and in the adult, from stricture, enlargement of the prostate, or pedunculated tumour of the bladder. In the female, retroversion of the gravid uterus may cause complete retention. The treatment is directed to the cause.

Catheter or Urinary Fever.—Attention was directed by the late Sir Andrew Clark to a form of fever or pyrexia which may develop suddenly after operations on the lower urinary organs, even the simple passage of a catheter. Within twelve or twenty-four hours there occurs a rigor or a succession of rigors, the temperature running up to 102° – 105° F., and then rapidly coming down again; the patient is soon well, and remains so until the catheterisation is repeated. By many the condition is attributed to septic infection, a view which is supported by the marvellous rapidity of absorption possessed by the urethral mucous membrane, and the prevalence of sepsis in all pathological conditions of the lower urinary organs. By others it is regarded as a reflex nervous phenomenon, an exaggeration of the slight shivering which may attend the act of micturition in perfectly healthy men. It is certainly more liable to occur in neurotic individuals, and its frequency of occurrence appears to bear no proportion to the degree of infection as determined by ordinary methods of examination. Moreover, the occurrence of such rigors can often be prevented by taking certain precautions, which, while allaying nervous susceptibility, could have little influence in preventing septic absorption, such, for example, as keeping the patient warm, the administration of antipyrin or quinine an hour beforehand, and the delaying of the act of micturition for as long as possible after the interference. The injection of two or three drams of

a 1 per cent. solution of nitrate of silver into the deep urethra is the most reliable method of preventing rigors in susceptible individuals.

Catheter fever is not to be confounded with the progressive septic poisoning which is met with in cases of advanced septic cystitis and pyelonephritis.

CHAPTER XXXVI.

THE MALE GENITAL ORGANS.

THE SCROTUM—Injuries—Diseases: *Acute cellulitis and gangrene; Eczema and prurigo; Elephantiasis; Lymph-scrotum; Œdema*—Scrotal fistulæ and sinuses—Tumours. THE TESTIS AND EPIDIDYMIS—Congenital abnormalities: *Abnormalities in transit of testis*—Injuries—Torsion of the spermatic cord—Inflammatory affections: *Acute epididymitis and orchitis; Varieties; Tuberculosis; Syphilitic affections*—Tumours: *Varieties*—Hydrocele of cord—Tumours of cord—Varicocele. THE SEMINAL VESICLES—Acute and chronic vesiculitis—Tuberculosis. THE TUNICA VAGINALIS—Hydrocele: *Varieties*—Hæmatocele. THE PENIS—Malformations—Preputial calculi—Paraphymosis—Injuries—Inflammatory affections—Tumours—Sterility and Impotence.

THE SCROTUM.

Surgical Anatomy.—The skin of the *scrotum* is thin and pigmented, and contains numerous sebaceous glands. It is rendered contractile by the presence in its deeper layers of a considerable quantity of non-striped muscular tissue—the *dartos* muscle. The skin and dartos together form a single sac, which is divided by a mesial septum or raphé into two compartments, each of which contains one of the testes and the corresponding spermatic cord.

Injuries.—All forms of *wounds* are met with in the scrotum. In lacerated wounds the tunica vaginalis may be opened and the testis prolapsed. In incised wounds, when primary union is aimed at, the stitches must be inserted with great care, as the dartos muscle tends to invert the edges. It is of great importance to arrest all bleeding and to provide for drainage.

Contusions of the scrotum may be followed by extensive infiltration of the subcutaneous connective tissue with blood, giving rise to a dark purple or blackish discoloration which may remain confined to one side of the scrotum, or may extend to the perineum, penis, groin, and anterior abdominal wall.

Frequently the effused blood forms a localised *hæmatoma* in

one or other of the connective tissue planes of the scrotum. It forms a tense, glistening, black or violet-coloured swelling which on palpation is found to be of semi-solid consistence, and to yield the peculiar soft crepitant sensation characteristic of blood-clot. The testis, which usually lies below and behind the scrotal swelling, is found to move independently of it—a point which serves to distinguish a hæmatoma of the scrotum from a hæmatocele of the tunica vaginalis.

For the *treatment* of these conditions rest in bed, the application of warm fomentations and of support to the scrotum, are the chief measures employed. If the swelling persists the patient should wear a suspensory bandage.

Diseases.—*Acute Cellulitis and Gangrene.*—The scrotum may be the seat of an acute phlegmonous inflammation, which, owing to the comparatively low vitality of the tissues, sometimes results in gangrene of considerable portions of the integument. It is important to distinguish this condition from an almost exactly similar one which ensues when urine is extravasated into the perineum and scrotum as a result of rupture of the urethra.

The skin becomes dusky red, tense, and glossy, and there is marked swelling from œdema, which may spread to the penis, the groin, and the anterior abdominal wall. As the inflammation progresses patches of the skin assume a violet and then a greenish colour, and finally undergo necrosis, forming irregular, sodden sloughs under which putrefactive gases are generated and give rise to emphysematous crackling. If the patient survive there is profuse suppuration, and when the sloughs are separated the testes are exposed. The testes may also slough, but as a rule after the inflammation subsides they are covered over with granulations, and the rapidity and completeness with which cicatrisation takes place under these conditions is often remarkable.

Treatment.—In the early stages the patient should be confined to bed with the pelvis and scrotum elevated, and have antiseptic fomentations applied. Suppuration and gangrene can often be prevented by making several free, longitudinal incisions through the skin and dartos. Such incisions are attended with comparatively little bleeding, but a copious oozing of inflammatory exudate usually continues for some time. When gangrene threatens or has actually taken place the incision should be carried through the discoloured patches. Charcoal poultices are useful in promoting the separation of the sloughs. As the sloughs separate they should be clipped away with scissors, and the raw surfaces covered with a mild antiseptic dressing. Owing

to the rapidity of healing plastic operations or skin grafting are seldom called for.

Eczema and prurigo of the scrotum, perineum, and thighs are sometimes induced by urine dribbling over the parts in children, and in elderly patients suffering from incontinence of urine or from urinary fistulæ.

A chronic form of eczema frequently affects the scrotum in chimney sweepers and in paraffin workers, and is liable to become the starting-point of cancer.

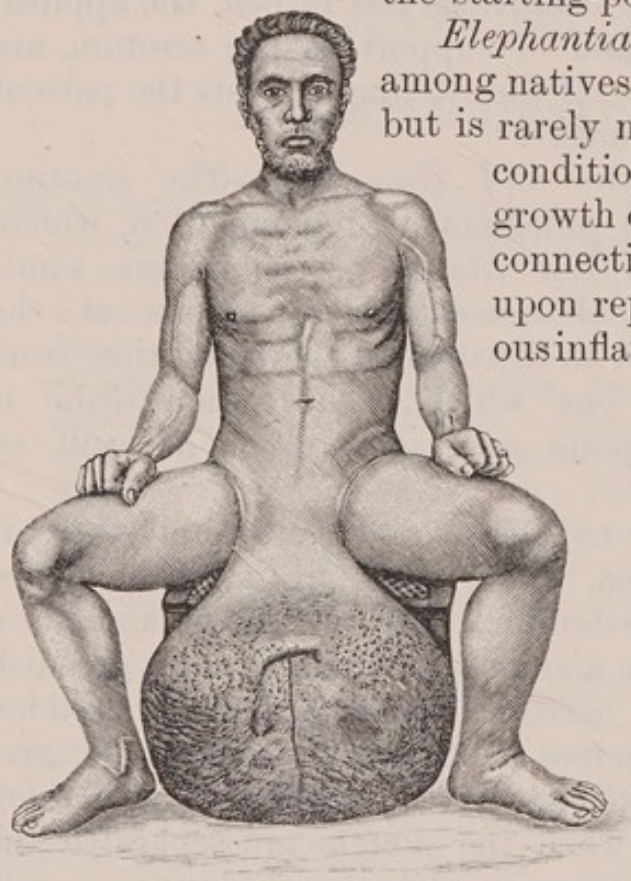


Fig. 149.—Tropical Elephantiasis of the Scrotum in a Native of Samoa.

Elephantiasis of the scrotum is common among natives in certain tropical countries, but is rarely met with in Europeans. The condition is due to œdema and overgrowth of the skin and subcutaneous connective tissue. It usually follows upon repeated attacks of erysipelatous inflammation, causing obstruction of the lymphatics of the scrotum. In many cases the lymphatic obstruction is attributable to the presence in the vessels of the filaria sanguinis hominis. The extent to which the scrotum may become enlarged is illustrated in Fig. 149. The only treatment is by removal of the growth. The penis and testes are isolated by dissection, an elastic ligature is applied round the base of the scrotum to control hæmorrhage, and the hypertrophied tissue removed.

In the condition known as *lymph-scrotum* the lymphatics are dilated and varicose, the scrotum becomes enlarged and nodular, and from its surface there oozes at intervals a milky fluid composed of lymph and chyle.

Œdema of the scrotum is often met with in general dropsy from cardiac or renal disease. When the œdema spreads to the penis this organ may assume a peculiar twisted appearance—the "ram's horn penis"—and the passage of urine may be impeded.

Scrotal fistulæ and sinuses are usually due to the bursting of abscesses in connection with stricture of the urethra, or with tuberculous disease of the testis.

Tumours, such as lipoma, fibroma, angioma, and sarcoma are so rare in the scrotum that they need only be mentioned. Sebaceous cysts are frequently met with. They are usually near the raphé, are multiple, and tend to undergo calcification. Dermoid cysts have also been met with in the raphé.

Epithelioma is induced by the prolonged irritation of such substances as coal-tar, paraffin, or soot. At one time the disease was comparatively common among chimney sweepers in England, and was known as "chimney sweep's cancer," but improved methods of cleaning chimneys and greater attention to personal cleanliness have rendered it comparatively rare. In the paraffin shale districts of Scotland the condition is frequently met with as a sequel to paraffin eczema, and is known as "paraffin cancer" (Fig. 150). It may begin as a scaly patch, a wart, or a horny excrescence on the skin; less frequently as a cauliflower-like papilloma. The progress of the disease is very slow, and the tumour may last for several years before ulceration takes place. In course of time it gradually assumes the characters of an ordinary epithelioma. The inguinal glands are not implicated till late in the disease. The treatment consists in excising the growth and removing the glands in the groin.

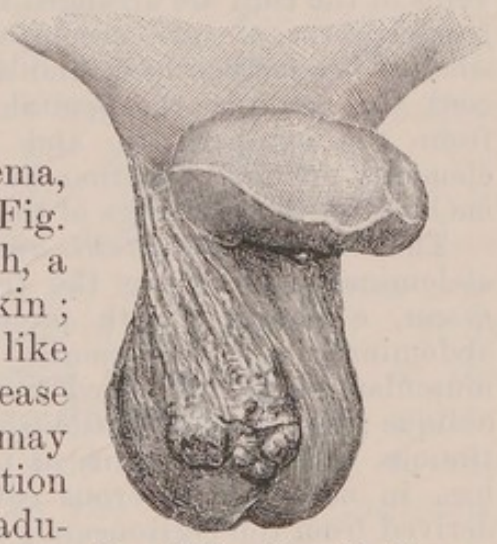


FIG. 150.—Paraffin Cancer of Scrotum in a shale-worker, æt. 60.

THE TESTIS AND EPIDIDYMIS.

Surgical Anatomy.—The secretory portion of the *testis* consists of a mass of convoluted seminiferous tubules held together by a quantity of loose connective tissue. The whole gland is enclosed in a firm fibrous capsule—the tunica albuginea—which is specially thick and strong at the posterior part, forming there the body of Highmore, from which numerous septa radiate to divide the gland into a series of compartments. The spermatozoa, which are formed from the epithelium lining the seminiferous tubules, leave the testis by the vasa efferentia and enter the *epididymis.* This structure is composed of a highly convoluted tube the coils of which are bound together by dense connective tissue. It lies on the posterior aspect of the body of the testis, and is divisible into three portions: an upper broad, rounded portion—the globus major or head; a narrower, intermediate portion—the body; and a lower, pointed portion—the globus minor or tail.

The *vas deferens* or excretory duct of the testis passes from the globus minor along the back of the testis and to the inner side of the epididymis.

It joins the other elements of the spermatic cord at the upper end of the epididymis, and after traversing the inguinal canal and entering the internal abdominal ring turns downwards into the pelvis. After running along the side of the bladder it reaches the base of the prostate gland, and is there joined by the duct from the corresponding seminal vesicle, the two forming the *common ejaculatory duct*, which after traversing the prostate gland opens into the floor of the prostatic urethra.

The *spermatic cord* extends from the testis to the internal abdominal ring. It is made up of the vas deferens—which lies towards the back of the cord, and is accompanied by the small artery to the vas, the spermatic artery which lies in front of the vas, and the cremasteric artery which ramifies in the superficial structures of the cord. The veins of the cord are arranged in two bundles, the larger of which—*the pampiniform plexus*—accompanies the spermatic artery, while the smaller lies farther back and accompanies the artery to the vas. The cord also contains the genital branch of the genito-crural nerve, twigs from the sympathetic, and numerous lymphatics. These various elements are held together by a quantity of connective tissue, and are enclosed in the coverings of the cord.

The *coverings of the testis and cord* are derived from the layers of the abdominal wall during the transit of the testis: the *inter-columnar fascia*, a fibrous sheath prolonged from the edges of the external abdominal ring; the *cremaster muscle and fascia*, composed of loops of muscular tissue prolonged from the lower, free edge of the internal oblique; and the *infundibuliform fascia*, a funnel-shaped process continuous with the margins of the internal abdominal ring. The testis has, in addition, a serous covering—the *tunica vaginalis*—originally derived from the peritoneum; one layer—the visceral—covers the outer aspect of the testis; the other—the parietal—lines the inner aspect of the infundibuliform fascia. Between the two layers is a serous space, the cavity of the tunica vaginalis.

Congenital Abnormalities.—*Development.*—The testis is developed from a mass of embryonic tissue—the genital eminence—which lies in front and to the inner side of the Wolffian body. As the genital eminence increases in size the Wolffian body diminishes and ultimately becomes the epididymis, its duct—the Wolffian duct—becoming the vas deferens. The testis, epididymis, and vas are therefore developed from three separate and distinct structures. Hence it comes that any one or all of them may be congenitally absent. In the fœtus the testis and epididymis, separated from one another by a narrow sulcus, lie in the extra-peritoneal tissue below and behind the permanent kidney. The Wolffian body is furnished with a fold of peritoneum which eventually becomes the mesorchium in which run the spermatic vessels. As the fœtus increases in length the space between the kidney and the testis is increased, and by the end of the sixth month the testis has come to lie near the brim of the pelvis.

The next stage in development is known as the *transit or descent of the testis*. During the seventh and eighth months the testis passes along the inguinal canal and through the external abdominal ring, and by the middle of the ninth month it has usually reached the bottom of the scrotum. Considerable difference of opinion exists as to how this transit is brought about, but it is generally conceded that the structure known as the *gubernaculum testis* plays an important part in the process. This structure is composed of a central fibrous cord, surrounded by muscular fibres derived from the layers of the abdominal wall, and a tubular sheath of peritoneum—the processus vaginalis. Above, the gubernaculum is attached to the testis, the epididymis, and the vas deferens as they lie on the brim of the pelvis. Its lower attachments are numerous and widespread, the strongest and most important being—(1) to the lower margins of the abdominal muscles in the region of the inguinal canal; (2) to the front of the pubes; (3) to the deep fascia of Scarpa's triangle near the sphenous opening; (4) to the perineum close by the anus; and (5) to the bottom of the scrotum. It is believed that the transit of the testis is largely due to the traction made upon it by the contractile tissue of the gubernaculum, and particularly by that band which passes to the bottom of the scrotum in relation to the processus vaginalis. When the action of this band predominates the testis passes to its normal position in the scrotum. It may happen, however, that one of the other bands controls the movement of the testis so that it passes into some abnormal position, and constitutes one of the varieties of ectopia testis to be presently described.

In considering the congenital abnormalities of the testis, it is necessary to distinguish between those which are due to interference with the development of the gland and its efferent ducts, and those related to its transit from the abdomen to the scrotum.

Abnormalities in Development.—The occurrence of more than two testes (*polyorchism*) is exceedingly rare. The existence of only one testis (*monorchism*) and the absence of both (*anorchism*) are also very rare abnormalities, and can only be diagnosed with certainty by dissection. In some cases the epididymis and vas deferens are normally developed while the body of the testis is absent. In a few cases of retained testis the two glands have been found to be fused (*synorchism*).

Abnormalities in the Transit of the Testis.—The descent of the testis may be *retarded*, the child being born with one or both glands still within the abdomen or in the inguinal canal. In the course of a few weeks or months, or it may be not till

puberty is approaching, the testes pass on and reach their normal position in the scrotum.

In other cases one or both testes are permanently *retained* within the abdominal cavity (*cryptorchism*) (Fig. 151), and may lie either in their original position below the kidney, or in the iliac fossa close to the internal abdominal ring. A retained testis is usually adherent to the peritoneum, and is not palpable through the abdominal parietes. When situated low down, however, it may be possible to elicit testicular sensation on making firm pressure over it.

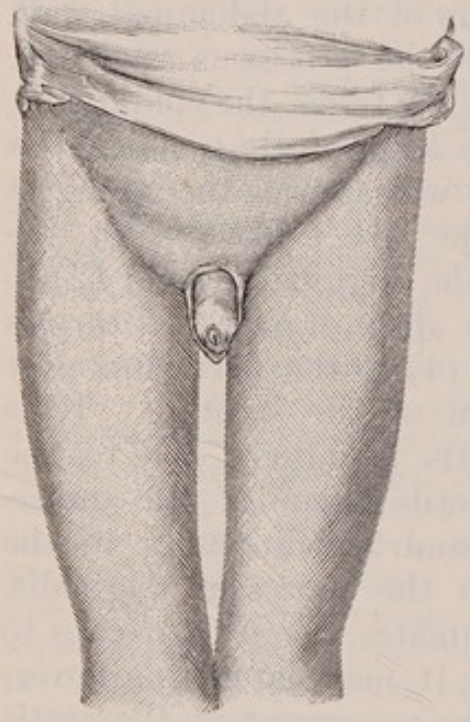


FIG. 151.—Retained Testis on left side, and imperfectly descended Testis on right, in a boy, æt. 13. The right testis forms a swelling in the line of the inguinal canal. The scrotum is contracted and empty.

When the gland becomes arrested at any point in its passage along the inguinal canal, the term *imperfectly descended testis* is applied. This is the most common of the congenital defects. It is sometimes found that the testis enjoys a fairly wide range of movement, being at one time within the internal abdominal ring, and at another well down the canal (Fig. 151). In some cases the arrest of the organ seems to be due to shortness of the spermatic cord, while in others the cord passes beyond the testis and hangs as a loop in the scrotum. The gland is easily recognised on palpation, and may be capable of being pushed back into the abdomen or downwards into the scrotum.

Sometimes the testis leaves its normal track altogether and comes to rest in some abnormal position, such as the perineum, the groin, the front of the pubes, or on the anterior abdominal wall. These abnormalities constitute the various forms of *misplaced testis or ectopia testis*. It is believed that the testis in these conditions is either dragged into its abnormal position by undue contraction of one or other of the fasciculi of the gubernaculum testis, or that it is pushed there by a hernia coming down behind it.

The most common variety of ectopia is the *perineal*, in which the testis lies in a pouch beneath the deep layer of the superficial fascia a little in front and to one side of the anus. The gland is surrounded by its tunica vaginalis, and the epididymis and

cord can usually be felt lying to its outer side. In the *pubic* form, the testis lies under the skin of the dorsum of the penis in front of the pubic bone; in the *crural* form, in the fold between the scrotum and the groin close to the saphenous opening; and in the *abdominal* form, on the surface of the aponeurosis of the external oblique.

Clinical Features.—These various abnormalities are usually unilateral, and occur on the right side more frequently than on the left. The scrotum on the affected side is found to be empty and is usually smaller than normal (Fig. 151). The processus vaginalis is usually present in the scrotum although the testis has not descended, and it may be occupied by a hernia. In cases of imperfectly descended and of misplaced testis the gland can be recognised by palpation. It is usually smaller and softer than normal, and the testicular sensation is retained. In some cases the chief complaint is of neuralgic pain referred to the line of the cord. In the majority of cases the gland is functionless, its secreting elements not having developed. It has been shown experimentally by Griffiths, that the testes do not develop perfectly unless they descend into the scrotum—hence the importance of treating these conditions in early life. A number of cases are on record, however, in which the testes, although undescended, attained their full functional development, and the patient was able to procreate—a point of medico-legal importance. So long as one testis is fully developed and normally placed, the patient preserves his masculine characteristics and retains his sexual power, but when both glands are imperfectly developed, there is usually marked interference with the physical growth and mental vigour. The patient may acquire certain feminine peculiarities, such as absence of hair on the face, enlargement of the breasts, plumpness of the figure, and sometimes a thin contralto voice. In addition he is usually impotent as well as sterile. These changes are probably due to the want of the "internal secretion" of the testis, which is supposed to be essential to full and perfect development.

Complications.—Hernia is the most common complication of an abnormally placed testis. It is estimated that in fully 50 per cent. of cases some form of congenital hernia coexists. The various forms of congenital hydrocele are also comparatively common.

An abnormally situated testis may become acutely inflamed, for example, as a result of infection from the urethra in gonorrhœa, and in the case of a testis retained in the abdomen the inflammation may spread to the peritoneum. When acute

inflammation attacks a testis arrested in the inguinal canal, the condition may closely simulate a hernia which has become strangulated. Considerable swelling of the gland, attended with œdema of the overlying skin and great pain, is liable to result from a blow or twist, or from repeated irritation from pressure caused by the contraction of the abdominal muscles. There is evidence for the statement that abnormally placed testes are prone to become the seat of malignant disease in adult life.

Treatment.—The treatment depends upon the position of the gland, the length of the cord, whether the condition is unilateral or bilateral, and the presence of complications such as hernia, hydrocele, or inflammation.

When the testis is arrested in its progress along the inguinal canal and there is no hernia, an attempt may be made to manipulate the gland into its proper position in the scrotum by systematically applying gentle pressure and traction so as to lengthen the cord. If this fail, the testis should be transplanted into the scrotum by operation. The inguinal canal should be opened up as in the operation for hernia, the coverings of the cord divided and separated, and the tissues of the cord, save the vas and its artery, divided, so far as they interfere with the placing of the testis in the scrotum. The testis is pulled into the scrotum, and its lower end made to project through a small opening at the lower part, where it is anchored by stitches passed through the remains of the gubernaculum and the edges of the scrotal wound. To maintain steady traction on the cord while the testis is becoming attached in its new position, the ends of the stitches may be passed through the skin of the inner aspect of the thigh, either of the same or of the opposite side. The processus vaginalis is then closed and the canal sutured, as in the radical operation for hernia. A similar operation may be performed for ectopia testis. Such operations should be performed before puberty if possible, in order that the testis may have a better chance of attaining complete development.

In adults, when the condition is unilateral and is complicated with hernia, it is usually advisable to remove the testis in order that the radical cure of the hernia may be satisfactorily effected. In view of the fact that an abnormally placed testis is usually functionless, and that it is liable to assume malignant characters in adult life, it is seldom advisable to return it to the abdomen.

Injuries.—In spite of its exposed position, the testis is comparatively seldom seriously injured, a fact which is explained by its free mobility in the pendulous scrotum. The most common

form of injury is a *contusion*, the result, for example, of a crush, a kick, or a blow.

The injury is accompanied by intense sickening pain radiating down the thigh and along the cord towards the loin, and it may be so severe as to cause syncope. There is always a considerable degree of shock, and in some cases this has proved fatal. The scrotum is discoloured, and the body of the testis is swollen and tender. In a considerable proportion of cases a severe contusion of the testis is followed by atrophy of the gland, which in the course of six or eight weeks may have shrivelled to the size of a haricot bean. The epididymis does not share in the atrophy. Severe neuralgia of the testis may follow a contusion, and it is not uncommon for tuberculosis of the gland to date from an injury of this kind.

Treatment.—The patient should be confined to bed with the scrotum elevated, and have warm antiseptic compresses or lead and opium fomentations applied to the parts.

Punctured wounds of the testis are occasionally produced during the tapping of a hydrocele. There is acute pain at the moment, and the fluid withdrawn may be blood-stained. So long as septic infection does not take place the accident is of no importance. *Incised and lacerated wounds*, being very liable to become infected, frequently lead to suppuration and destruction of the testis. In such cases it is best to excise the gland, because, even if the inflammation subsides, it is very liable to undergo atrophy.

Dislocation of the Testis.—The testis may be squeezed out of the scrotum by such violence as the passage of a wheel over the part, or it may be dragged out by forcible contractions of the cremaster muscle during violent muscular efforts. The gland may pass back into the inguinal canal, or on to the abdominal wall or front of the pubes. It may remain permanently in its new position, especially if adhesions form in connection with the injury, or it may eventually pass back into the scrotum. The treatment of acquired ectopia is carried out on the same lines as in the developmental form.

Injuries of the Spermatic Cord.—The spermatic cord may be contused by blows or sudden strains, as for example in falling with the legs widely apart. Violent efforts in coughing have been known to cause rupture of one of the spermatic veins in patients suffering from varicocele. These injuries are followed by effusion of blood into the connective tissue of the cord, and the extravasated blood may either collect in a limited space, or be widely diffused throughout its substance. A firm,

elongated, sausage-shaped swelling develops in the line of the cord, and may extend from the scrotum to the iliac fossa. There is discoloration in the line of this swelling and in the surrounding parts.

The *vas deferens* may be ruptured by such external injuries as the passage of a wheel over the groin, or sudden and forcible abduction of the thighs. The injury is usually accompanied by extravasation of blood into the cord, and in some cases blood escapes by the urethra. It is usually followed by atrophy of the testis.

Incised and lacerated wounds of the cord, including the vas, may be accidentally produced in the course of such operations as the radical cure of hernia or the excision of a hydrocele of the cord. They may also be inflicted in attempts at self-mutilation by lunatics. Severe hæmorrhage occurs in incised wounds, but lacerated wounds do not bleed much. Atrophy of the testis usually ensues.

Torsion of the Spermatic Cord.—The spermatic cord is liable to be suddenly twisted to such an extent that the vascular supply of the testis is interfered with. The causes of the torsion are obscure, but as the accident is most frequently met with in cases where the testis has not completely descended, and in which the epididymis and cord are included with the testis in the processus vaginalis, it is probable that these conditions, by increasing the mobility of the testis and its appendages, act as predisposing factors. The actual twisting is probably determined by a sudden congestion of its numerous tortuous veins, resulting, for example, from some sudden jar or strain, or from spasmodic contraction of the cremaster muscle. In some cases it has followed a direct injury or an attempt to reduce a hernia by taxis.

The degree of torsion varies from half a twist to a complete twist and a half, and its direction is usually from without inwards. The kinking of the vessels of the cord causes intense congestion of the testis, which becomes dark bluish-purple or black in colour, and assumes an appearance aptly compared to that of a ripe plum. The epididymis and cord are swollen and discoloured, and the processus vaginalis is filled with blood-stained serum.

Clinical Features.—The accident is most common about the age of puberty, but has been met with in infants and in old men. Its occurrence is indicated by the sudden onset of pain and swelling in the testis, accompanied by nausea and vomiting. The abdomen may be rigid and slightly distended, and the

thigh on the affected side is flexed. The temperature is usually raised. Above the testis, the twisted cord may be recognised as a lobulated swelling. The parts become hot, red, and œdematous, and the swelling is rounded, tense, and exceedingly tender. There is no impulse on coughing. If necrosis ensue, the pain becomes less severe.

In some cases the symptoms are less severe, the patient merely suffering from occasional attacks of sickening pain, which is relieved by gently stroking the testis. One of these attacks may, however, culminate in complete torsion.

Torsion of the cord is to be diagnosed from strangulated hernia, acute orchitis, and acute suppuration of a lymphatic gland. In many cases an exact diagnosis can only be made by means of an exploratory incision.

The *treatment* consists in exposing the testis by dissection. When situated in the inguinal canal the gland should be excised, as it is usually functionless, or is likely to become so as the result of the congestion. When situated in the scrotum it is sometimes possible to save the testis by undoing the twist. If necrosis has ensued the organ must be removed.

Inflammatory Affections of the Testis and its Appendages.

Any portion of the spermatic tract—testis, epididymis, vas deferens or seminal vesicles—may be the seat of inflammation, and, according to the cause and nature of the inflammatory process, it may remain confined to one or other of these structures, or may spread to adjacent parts. The term *orchitis* is applied when the body of the testis is chiefly involved, and *epididymitis* when the epididymis suffers most. When both are implicated, the term *epididymo-orchitis* is employed. Inflammation of the cord and vas deferens (*funiculitis*), or of the seminal vesicles (*vesiculitis*), seldom occurs apart from a similar affection of other segments of the tract.

The more acute inflammations are due to infection with some form of pyogenic bacteria, and particularly with the gonococcus, while the more chronic forms are usually tuberculous or syphilitic in nature.

Acute Epididymitis and Acute Orchitis.—In considering the acute inflammations of the epididymis and testis, it is convenient to distinguish between those varieties which are due to direct infection from the urethra, for example, in urethritis of gonorrheal origin, and those in which the infection takes place

through the blood-stream, as in mumps, typhoid fever, or general septic conditions, or in gout or rheumatism. In the former group the main incidence of the inflammation is on the epididymis, and *epididymitis* results, while in the latter the body of the testis is chiefly involved, constituting an *orchitis*.

Acute Epididymitis. — *Acute Epididymitis of Urethral Origin.* — The most common way in which an acute epididymitis originates from the urethra is by direct spread of an acute gonorrhœal urethritis along the ejaculatory duct and vas deferens. Other forms of urethritis, such as result, for example, from the passage of instruments, may give rise to acute epididymitis.

Gonorrhœal Epididymitis.—This, the most common form of acute epididymitis, occurs in about one in every ten cases of gonorrhœa. It is usually met with during the third, fourth, or fifth weeks of the gonorrhœa, but may occur at much later periods, and even after all urethral discharge has ceased. The condition is usually unilateral; when it is bilateral the second gland is attacked while the inflammation in the other is subsiding. Although essentially due to direct spread of infection from the posterior urethra, the attack may be determined by excessive exercise, such as a long walk or cycle ride, by exposure to cold or damp, or by injections into the posterior urethra.

Clinical Features. — The attack begins with swelling and tenderness of the spermatic cord, and an aching pain which shoots towards the inguinal region and pelvis. The temperature rises, sometimes with a rigor, and the patient feels feverish and ill. There may be sickness and vomiting, and the bowels are usually constipated. On palpation the cord is found to be thickened, as a result of swelling of the vas and œdema of the connective tissues, and, it may be, congestion and thrombosis of the veins. The globus minor of the epididymis next becomes enlarged and painful, and the swelling soon spreads to the body and globus major, with the result that there develops behind the body of the testis a crescentic or C-shaped swelling. The exact shape and disposition of this swelling is sometimes obscured clinically by an effusion of fluid into the cavity of the tunica vaginalis—*acute hydrocele*. The body of the testis is seldom implicated. The pain in the epididymis is severe and interferes with sleep, and handling of the parts causes a peculiar sickening sensation. With the onset of the epididymitis the urethral discharge ceases, and it remains absent as long as the inflammation lasts. On rectal examination, the seminal vesicle and lobe of the prostate on the affected side may be found

swollen and tender. The scrotum becomes red, shiny, and œdematous, and forms a swelling about the size of a closed fist. The symptoms increase in severity for four or five days, and, after remaining at their height for two or three days, gradually subside. It is usually two or three weeks before the patient is able to go about. As the inflammation subsides the urethral discharge returns.

Complications.—As a rule the inflammation subsides completely, and although the inflammatory exudate may take weeks or even months to disappear, it usually does so completely. In some cases, and particularly if the source of irritation in the deep urethra persists, the patient is liable to suffer from repeated mild attacks, first in the one epididymis, and then in the other —so-called *chronic*, or *relapsing*, or "*see-saw*" *epididymitis*. This may result in chronic induration of the epididymes and vasa deferentia, occluding the tubes and leading to sterility. Atrophy of the testis is a rare sequela of gonorrhœal inflammation. A small quantity of fluid may remain permanently in the tunica vaginalis, constituting one form of hydrocele. Suppuration is very rare.

Treatment.—The patient should be confined to bed with the scrotum elevated on a pillow. In the early stages, an ice-bag or evaporating lotions may be applied. When the tension in the scrotum is great, warm lead and opium or boracic fomentations are more soothing and less likely to induce sloughing of the integument. Leeches, cupping, or incision may be employed when the congestion is great and extreme tension threatens the vitality of the tissues.

After the acute inflammation subsides, the induration may be dispersed by inunctions of oleate of mercury ointment, or by strapping the testis. When the patient gets up, he should wear a suspensory bandage. The administration of iodide and bicarbonate of potassium is useful in promoting absorption of inflammatory products.

Epididymitis following injury of the urethra in its general features closely resembles that resulting from gonorrhœa, but is on the whole less severe. The symptoms usually come on two or three days after the passage of an instrument, but may appear suddenly within a few hours. In some cases the occurrence of these attacks interferes with the employment of the catheter in enlarged prostate. The testis is involved rather more frequently than in the gonorrhœal form, but sterility seldom ensues. The swelling subsides very slowly and recurrences are common.

Acute Orchitis.—In the course of certain acute infectious diseases, for example, mumps, scarlet fever, typhoid fever, influenza, tonsillitis, malaria, and pyæmia, the body of the testis is liable to become acutely inflamed. A similar condition is sometimes met with in gouty and rheumatic subjects.

Orchitis in Mumps.—Although this complication of mumps is met with chiefly in patients about the age of puberty, in them it is comparatively common. About the end of the first week of the parotitis the body of the testis suddenly becomes swollen and painful. The testis is firm, tense, and smooth, and extremely tender, the pain radiating along the cord to the loin. There is no enlargement of the epididymis or cord, nor is there any effusion into the tunica vaginalis. The scrotum becomes red and œdematous. The condition is usually unilateral, but when both glands are attacked, the swelling has usually subsided on one side before the other becomes affected. The inflammation lasts for about three or four days and then gradually abates. Suppuration is very rare. Atrophy of the testis, however, is not uncommon, and, when bilateral, renders the patient sterile.

The orchitis which occurs in the course of the other acute infectious diseases above mentioned closely resembles that associated with mumps, but is on the whole less acute, and the pain and other symptoms are less severe. As the swelling of the testis usually occurs when the fever is at its height, the local symptoms are usually overshadowed by those of the general disease, and the testicular condition, particularly in adults, may be overlooked or only discovered accidentally.

Orchitis in Gout.—Gouty orchitis usually occurs in patients over fifty years of age, who are subject to repeated attacks of arthritic gout, and usually manifests itself just before the onset of one of the regular attacks. The swelling is most marked in the body of the testis, but the epididymis often shares in the inflammation, and there is frequently an effusion into the tunica vaginalis. The condition is frequently bilateral, and relapses are common.

Treatment.—The treatment of these various forms of orchitis is carried out on the same lines as that for epididymitis, due attention being paid to any general disease which may be present. In the rare instances in which suppuration occurs the abscess must be opened; an attempt may be made to save the testis, but as it is almost certain subsequently to undergo atrophy, it is as a rule best to remove it.

Tuberculosis of the Testis and Epididymis.—*Acute tuberculosis* of the epididymis and testis is a rare affection, which,

in its mode of onset, closely simulates an acute gonorrhœal epididymitis. It may occur at any age, and is attended with pain and swelling of the parts and effusion into the tunica vaginalis. In the course of a few days the pain abates and the fluid in the tunica vaginalis disappears, but the testicular swelling persists, and the gland is usually destroyed by suppuration in two or three weeks.

Chronic tuberculous disease is much more common. It may be the first manifestation of tuberculosis exhibited by the patient, but is more frequently secondary, occurring in association with disease of the prostate, bladder or kidney, pulmonary phthisis, or some other tuberculous affection. In young children it occasionally occurs in association with tuberculous peritonitis, infection taking place along the processus vaginalis. Infection may take place from a distant focus of tubercle by way of the blood or lymph stream, or by direct spread from the urethra or prostate along the vas deferens. The disease may remain confined to the epididymis, but as a rule it spreads sooner or later to the body of the testis. In rare cases the body of the testis alone is involved.

Clinical Features.—The disease is most commonly met with in patients between twenty and thirty years of age, in whom there is either some active tuberculous disease, or some tendency to tubercle—inherited or acquired. It frequently occurs, however, in men of good physique who are otherwise perfectly healthy. There is often a history of some injury to the testis, or of a gonorrhœal urethritis. The affection usually attacks only one testis, but both may be involved consecutively.

The first evidence of the disease is the formation of a small, firm nodule, either in the globus minor or in the globus major, but this being painless is often overlooked or neglected. Other nodules form, and, after increasing in size, run together so that the epididymis becomes enlarged and nodulated and forms an irregular, crescentic swelling on the back of the testis. The individual nodules vary in size from a pea to a walnut. Some are firm, while others are soft and fluctuating.

When the body of the testis is invaded, the nodules form first at the hilum, and spread in lines which radiate into the substance of the gland. By the coalescence of adjacent nodules an irregular caseous mass is formed. The vas deferens may be thickened and infiltrated with tubercle throughout its whole length, but as a rule the disease is limited to its two extremities. On rectal examination the seminal vesicles may be found to be enlarged and nodular from the disease having spread to them.

There is often a moderate effusion of fluid into the tunica vaginalis, and, as adhesions are frequently present, the resulting hydrocele may be multilocular.

As the disease progresses the tubercle nodules run together, caseate and liquefy, and the softened parts form adhesions with the tunica vaginalis, the scrotal tissues, and finally with the skin. Over these adherent parts the skin is thinned out and assumes a characteristic bluish-red colour. Eventually it gives way, and from the sinuses which form there escape at first flakes of thick curdy debris, and later a thin yellow sero-purulent fluid. As the epididymis is the most common seat of disease, these tuberculous sinuses are usually situated on the lower and back parts of the scrotum. When they are met with on the front and upper parts of the scrotum, it usually indicates that the disease affects chiefly the body of the testis. Sometimes a considerable area of the skin of the scrotum is destroyed, and the testis, covered with granulations, projects on the surface, constituting one form of fungus or hernia testis.

These degenerative changes go on very slowly and insidiously, and are not necessarily attended with pain. The diseased parts, however, are tender, and testicular sensation is retained.

The destructive process may become arrested, and the diseased tissue either undergo calcification or be replaced by cicatricial tissue. As a rule, however, complete disorganisation of the gland takes place, and the disease spreads to other parts of the genito-urinary system, or generalised tuberculosis ensues.

Treatment.—In its earliest stages the disease may sometimes be arrested by placing the patient under the regime of a sanatorium or by sending him for a sea voyage. In hospital practice, the patients are seldom seen until the condition is too far advanced to yield to such general hygienic measures as are open to them. In the majority of cases, therefore, the only available treatment is by operation. When the disease is localised in one portion of the epididymis it may be excised or scraped, and painted with pure carbolic acid. If the whole of the epididymis is invaded, it may be excised, care being taken not to interfere unduly with the vascular supply to the body of the testis. When the body of the testis is implicated it is usually advisable to excise the testis and epididymis, and if the vas deferens is involved, to lay open the inguinal canal and remove as much of it as is diseased. Any sinuses which may exist should be completely dissected away.

Syphilitic Affections of the Testis and Epididymis.—Several manifestations of syphilis are met with in the testis, the most

common being a gummatous orchitis which occurs during the tertiary stage of acquired syphilis. A similar condition sometimes occurs in young children who have inherited the disease. A syphilitic form of epididymitis is occasionally met with as one of the early signs in the secondary stage.

Gummatous Orchitis.—Syphilitic Testis.—This may occur at any period during the tertiary stage of the disease. It may take the form of a diffuse interstitial sclerosis of the connective tissue between the tubules of the testis, or of a localised gumma in the substance of the gland, or these two conditions may be combined. When the sclerotic element predominates, it tends to destroy the secreting substance of the testis, whereas the gummatous tissue tends rather to caseate and break down, leading to ulceration of the scrotum and in some cases to the formation of one form of fungus or hernia testis.

Clinical Features.—The onset of the condition is slow and insidious, and is not attended with inflammatory symptoms. The swelling is often discovered accidentally, or the attention of the patient is drawn to it by a sensation of weight in the scrotum, or by a dragging pain in the line of the inguinal canal. As a rule only one testis is affected, but occasionally the two are involved consecutively.

The body of the testis slowly becomes enlarged till it is twice or three times its natural size. Its normal shape is retained, or it may be somewhat flattened from side to side. The surface is usually smooth, but there are sometimes small hard nodules scattered over it. These are due to localised thickenings in the tunica albuginea and the connective tissue immediately underlying it. The testis is hard and of a characteristically "wooden" consistence. There is neither pain nor tenderness, and testicular sensation is usually lost. For its bulk the swelling is unduly heavy.

The epididymis is not invaded by the disease, but is usually matted to the back of the testis by infiltration of the intervening connective tissue, so that it is difficult to distinguish between them. The vas deferens is intact, and if traced into the testicular swelling indicates the position of the epididymis. The seminal vesicles and prostate are also intact. Hydrocele is very common in the early stages of the disease, but as the swelling of the testis increases, the fluid usually disappears, and the two layers of the tunica vaginalis become adherent. The space may thus be completely obliterated, or it may be divided into compartments. The integument of the scrotum is slightly œdematous, and glides smoothly on the testis. It may be stretched and thinned, particu-

larly when a hydrocele is present. In the later stages, a breaking-down gumma may infiltrate the skin and fix it to the testis.

Progress and Results.—If the condition be allowed to progress untreated, it may end in *atrophy of the testis.* The gummatous tissue slowly disappears, cicatricial tissue takes its place and in contracting obliterates the tubules and blood-vessels of the gland. Eventually a small, indurated, fibrous nodule is left at the bottom of the scrotum. In other cases the gumma undergoes *caseation* and infiltrates the anterior aspect of the scrotum, which finally ulcerates, giving exit to a quantity of yellowish fluid, and exposing the surface of the testis covered by a greyish-yellow slough, aptly compared in appearance to a piece of wash-leather. This slough slowly breaks down and is cast off in shreds. The scrotum becomes œdematous, and in some cases is so densely infiltrated as to simulate elephantiasis.

When the testicular substance protrudes from the scrotum, the condition of fungus or hernia testis results. Suppuration in a syphilitic testis is exceedingly rare. When both testes undergo atrophy, or are destroyed by caseation sterility results.

Treatment.—The treatment is in the main constitutional, and as a rule the condition rapidly yields to antisyphilitic drugs. When the disease is a comparatively early manifestation of syphilis, mercury yields the best results, while in the late tertiary stages the iodides are most useful. As a rule the two drugs should be combined. The inunction of oleate of mercury ointment is often beneficial. When ulceration has occurred, mercurial lotions and dressings should be used. When a large surface of the scrotum is destroyed by ulceration and fungus testis has occurred, the testis should be removed.

In the *infantile form* of syphilitic testis the sclerotic element predominates. The condition is usually met with in children from two to six months old, and as a rule both testes are involved. The glands are about the size of a pigeon's egg, densely hard and painless.

The presence of other signs of congenital syphilis aids in the diagnosis, and the treatment is carried out on the usual lines, mercury in the form of grey powder being particularly useful.

Syphilitic epididymitis is a symptom of secondary syphilis, and usually occurs along with other secondary manifestations. A small hard nodule, varying in size from a pea to an almond, appears in the globus major, and is surrounded by some indurated connective tissue. It is very indolent, and is neither painful nor tender. The condition is often bilateral. The body of the

testis is seldom implicated. These swellings rapidly disappear under the influence of mercury.

Tumours of the Testis.

Tumours of the testis are exceedingly difficult to classify either on a pathological or on a clinical basis. This arises from the fact that some varieties are composed of several different histological elements, not one of which predominates sufficiently to characterise the growth, and that other varieties show a marked tendency to undergo cystic and other forms of degeneration, and so to lose their original characters. Another peculiarity of testicular tumours is that they are specially prone to malignant transformation, so that a tumour which is originally innocent may eventually infect adjacent glands and become disseminated in distant parts of the body.

Some of the varieties met with are so rare that it is not necessary to do more than name them here, for example, fibroma, myxoma, myoma, osteoma and teratoma. Others, such as the lymphadenoma and the different varieties of chondroma, seldom occur except in combination with sarcomatous elements, and are therefore most conveniently included among malignant growths. In all these varieties early removal is the treatment indicated.

Carcinoma and Sarcoma.—The soft, medullary or encephaloid carcinoma is, for all practical purposes, the only form of carcinoma of the testis which need be referred to. All varieties of sarcoma are met with, the soft, rapidly growing, cellular forms being the most common. As it is seldom possible to distinguish clinically between a carcinoma and a sarcoma, and as a microscopic examination of the growth does not always serve to remove the doubt, it is convenient to consider these two forms of malignant growth together. Opinions differ as to which is the more common.

Clinical Features.—These tumours may occur at any age, the majority being met with between the ages of twenty-five and forty-five. Sarcoma is not uncommon in children below the age of ten, but carcinoma is seldom, if ever, met with in patients so young. Sarcoma may affect both testes, while carcinoma is almost invariably unilateral.

The swelling of the testis may come on insidiously, without obvious cause, but not infrequently it is observed to follow an injury. The patient complains of a dragging pain along the line of the spermatic cord, but the testicular swelling is neither painful nor tender. Testicular sensation is soon lost. The

swelling increases rapidly and continuously until the testis may be three or four times its natural size. As long as the tunica albuginea remains intact, the normal shape of the gland is preserved, and the swelling is of uniform consistence; but when this capsule is perforated, the swelling becomes irregular in shape, bossy, and of varying consistence, some parts being soft and boggy, while others are firmer and more resistent.

The epididymis is usually incorporated in the tumour mass and cannot be differentiated from it. The spermatic cord becomes enlarged and thickened from congestion of its vessels, but is seldom directly invaded by the growth. In the early stages, the tunica vaginalis is distended by a clear, or more frequently blood-stained, fluid, but as the tumour increases in size the cavity becomes obliterated and the hydrocele disappears. Hæmorrhage may occur into the cavity of the tunica vaginalis and give rise to hæmatocele. A malignant tumour is considerably heavier bulk for bulk than most other forms of testicular swelling. The scrotum is free at first, but ultimately becomes invaded by the growth, which eats its way through the skin and so leads to the formation of one variety of fungus or hernia testis.

In both forms of tumour the iliac and lumbar glands are early and widely infected, and may be palpable above the brim of the pelvis. When the scrotum is invaded the inguinal glands become enlarged. These glandular masses, by pressing on the nerve roots, give rise to severe paroxysmal pain in the loins and back, and the pain may pass down the back of the thigh and simulate sciatica. The pressure on the pelvic veins causes congestion of the scrotum and cord, and œdema and venous congestion of the lower extremities. The bodies of the lumbar vertebræ are liable to become eroded, and complete paraplegia may suddenly ensue from pressure on the spinal cord. Secondary deposits commonly occur in the liver and lungs.

The *prognosis* is always grave on account of the early date at which the glands become infected and the rapidity with which the disease becomes generalised.

The *treatment* consists in performing castration as soon as the diagnosis is made. The whole gland, the cord as far as the internal abdominal ring, and any portion of the scrotum invaded by the tumour should be removed. The disease usually reappears in the glands or in the liver within a year, but the removal of the primary growth tends materially to prolong life and to diminish suffering.

Cystoma of the Testis.—Several different forms of tumour are included under the term cystic disease of the testis. Some are

comparatively benign, and are composed of numerous cysts, varying in size from a pea to a hazel-nut, with smooth walls and containing a clear, glairy fluid. The stroma consists of a varying amount of fibrous tissue in which nodules of cartilage are frequently present. Others are distinctly malignant, and are composed of a few irregular cysts into which papillary growths project. The fluid is usually brown or blood-stained. The stroma is composed of a mixture of cellular connective tissue, mucoid tissue, and often definitely sarcomatous tissue—hence the term cystic sarcoma which is sometimes applied to this variety.

No hard and fast line separates these varieties, and it is not uncommon for the innocent forms to take on malignant characters and become disseminated. These cystic growths appear to originate in the remnants of the Wolffian body—the organ of Giraldes—which lie at the hilum of the testis. The secreting substance of the testis is found flattened against the upper and anterior part of the tunica albuginea.

Clinical Features.—These growths usually appear in men of about thirty, and the symptoms vary with the malignancy of the growth. In the more innocent forms the swelling is painless, ovoid, smooth, and of a semi-solid consistence. There is no glandular enlargement, the cord is not implicated, and the general health of the patient is unaffected.

In the malignant forms the growth is more rapid, the swelling is irregular, bossy, and of unequal consistence, the pelvic and lumbar glands are early involved, and the patient exhibits the general signs of malignant disease.

Early removal of the testis is indicated in all forms of cystoma.

Cysts of the Epididymis: Encysted Hydrocele of the Epididymis.—Cystic tumours are occasionally met with in relation to the epididymis, and are probably due to dilatation and degeneration of one or other of the remnants of the Wolffian body which lie between the head of the epididymis and the testis. They are entirely outside the tunica vaginalis, and contain a limpid, alkaline, colourless or opalescent fluid which differs from that found in hydrocele of the tunica vaginalis in being of a lower specific gravity (about 1004) and practically free from albumin. Hæmorrhage may occur into the cavity—*encysted hæmatocele* of the epididymis. As the majority of these cysts contain spermatozoa—sometimes complete and motile, but more frequently immature—they have been termed *spermatoceles*. The condition is often bilateral, and is usually met

with in men above forty years of age. A tense rounded or pyriform swelling, varying in size from a hen's to a turkey's egg, can be recognised above and behind the testis, to which it is attached and with which it moves. The tumour grows slowly and insidiously, and in its earlier stages is liable to be mistaken for a supernumerary testis. It is, however, devoid of testicular sensation and may be translucent. Sometimes these growths give rise to severe and persistent neuralgic pains.

The *treatment* consists in tapping the swelling and applying pressure. If this fail the cyst should be excised.

Hydrocele of the Cord.—The most common form of hydrocele of the cord is the *encysted hydrocele*—a condition in which serous fluid accumulates in an unobliterated portion of the processus vaginalis. This process may be occluded only at its upper and lower ends, in which case the hydrocele forms a single cyst extending from near the internal abdominal ring almost to the top of the testis, and occupying the inguinal canal and upper part of the scrotum. When only a short segment of the process remains patent, the cyst is correspondingly circumscribed. Sometimes the obliteration is irregular and several small cysts develop.

As the right processus vaginalis closes later and less completely than the left, encysted hydrocele of the cord, like other conditions depending upon the non-closure of this peritoneal tube, is more common on the right than on the left side. It may develop at any age, but is most frequently met with in young children. The swelling is ovoid, smooth, tense and elastic. In some cases it may be shown to be translucent, but from its position inside the comparatively thick coverings of the cord this test is not of great value, particularly in fat children. By traction on the testis the swelling may be capable of being pulled down towards the scrotum, and pushed well into the inguinal canal, but it does not enter the abdominal cavity. It may receive an apparent impulse on coughing, and so simulate an inguinal hernia, an affection with which it is often confused. Not infrequently the two conditions are present together.

Treatment.—As the swelling frequently disappears spontaneously, no treatment is called for in young infants unless the cyst is increasing rapidly in size and giving rise to discomfort. Tapping the hydrocele and applying firm pressure frequently effects a cure. The most satisfactory method of treatment is complete excision of the cyst.

Diffuse Hydrocele of the Cord.—The connective tissue of the

cord is occasionally the seat of a diffuse œdema, which leads to the formation of a pyriform swelling in the line of the inguinal canal and upper part of the scrotum. To this rare condition the term *diffuse* or *infiltrated* hydrocele of the cord is applied. Its chief clinical importance lies in the fact that it is liable to be mistaken for an omental hernia.

Tumours of the Cord.—Several varieties of tumour have been met with in the cord. The only one which need be mentioned here is the pedunculated *lipoma*, which arises usually in the extra-peritoneal fat, and after being protruded through the internal abdominal ring, grows down along the cord, and may ultimately reach the scrotum. It forms a soft, almost fluctuating swelling in the line of the cord, irreducible and with little or no impulse on coughing. It closely simulates an omental hernia, and is usually only recognised during an operation for the radical cure of a supposed hernia. On dissection it is found to lie inside the coverings of the cord, but outside the peritoneum. These tumours are very liable to drag down with them a pouch of peritoneum, and so to form a sac into which a hernia may subsequently pass. Hence it is that they are often associated with hernia.

Varicocele. — The term varicocele is applied to a varicose condition of the veins of the spermatic cord. The varix may affect all the veins in the cord, but is usually confined to the vessels of the pampiniform plexus. These veins originate in the tunica vasculosa of the testis, and after perforating the tunica albuginea they accompany the spermatic artery, lying in the anterior part of the cord, in front of the vas deferens and its companion artery and veins. In the upper part of the scrotum the smaller vessels of the plexus combine to form two or three larger trunks which traverse the inguinal canal, and eventually unite to form the spermatic vein. On the right side the spermatic vein opens into the vena cava obliquely, and on the left enters the left renal vein at a right angle. In their course the spermatic veins communicate with branches belonging to the portal system. They are therefore liable to become engorged when, from any cause, the circulation in the portal system is obstructed.

Causes.—This particular form of varix is, so far as is known, due to the same causes as other forms, the most important of which is perhaps a congenital deficiency in the valves and in the strength of the walls of the veins. The length and tortuosity of the veins, the slight support they receive as they hang in the lax and pendulous scrotum, and the feeble *vis a tergo* of the blood-

stream in the comparatively long and small spermatic artery are probably additional predisposing factors. Among the determining causes may be mentioned prolonged or repeated backward pressure on the column of blood, resulting, for example, from habitual constipation, disease of the liver, repeated violent muscular efforts, and other causes. Varicocele frequently develops as an early symptom in patients suffering from malignant disease of the kidney.

Varicocele is an affection of puberty and early manhood. It tends to disappear in adult life, and is very rare in old age.

It is much more common on the left side than on the right (30 to 1). In about 7 per cent. of cases it is bilateral. The excessive frequency of left-sided varicocele has been attributed to various causes, the most probable of which is the obstruction offered to the blood as it enters the left renal vein at right angles to the stream.

In its *morbid anatomy* varicocele resembles ordinary varix of the superficial veins. The vessels are dilated, elongated, and tortuous, their walls irregularly thickened, with here and there fusiform or sacculated dilatations.

Clinical Features.—The condition usually develops insidiously and painlessly, and is often first observed when the patient applies for admission to one of the public services. The scrotum is usually abnormally lax and pendulous, its walls thin and transparent, and the dartos wanting in tone and contractility. The scrotum is occupied by a soft mass of distended veins, which on palpation feels like "a bag of worms." The dark blue vessels may be visible when the skin is put upon the stretch. The varicosity is most marked in the scrotal portion of the cord, and seldom extends into the inguinal canal. The testis is sometimes obscured by being enveloped in loops of varicose veins hanging down to the bottom of the scrotum. When the patient lies down, the veins slowly and gradually empty, and the swelling largely disappears. It reappears, however, when he stands up again, slowly increasing from below upwards. It can be rendered more prominent by compressing the veins against the pubes. A slight impulse is perceptible when the patient coughs.

If the condition begins about puberty, the development of the testis may be interfered with and the gland remain small and soft, but when it first appears in early manhood, the testis is normal and very seldom undergoes atrophy. Phlebitis and thrombosis, with the formation of phleboliths, are rare, and the varicose vessels seldom rupture.

In the majority of cases there is no discomfort beyond a

dragging sensation in the line of the cord, which gets worse towards evening, or after prolonged standing or walking. Nocturnal emissions are sometimes unduly frequent. In some cases the patient complains of severe neuralgic pain, and suffers from mental depression and sexual hypochondriasis, based on the fear that impotence and sterility may result.

Treatment.—The majority of cases only call for palliative treatment, which consists in regulating the bowels, administering general tonics, and wearing a suspensory bandage. The application of a cold spray to the scrotum and surrounding parts night and morning is useful in bracing up the scrotum. At the same time the patient should be assured that the condition is an unimportant one, which tends to pass off, and which is not liable to lead to any functional disability.

When the swelling increases and causes pain and discomfort, or when it is a bar to the patient entering one of the public services, it should be treated by operation. An incision, about two inches long, is made over the inguinal region in order to expose the cord just below the external abdominal ring. The vas and its accompanying vessels are first isolated and hooked aside. The spermatic veins are then dissected out, ligatured between forceps, and divided as they enter the inguinal canal. By traction on the lower segment the testis and cord can be pulled towards the wound, and the dilated veins of the pampiniform plexus exposed and isolated. A ligature is passed round the mass close to the epididymis, and the veins are then removed. The divided ends of the veins are then brought together in order to shorten the cord and allow the scrotum to contract. Some surgeons advise the removal of an elliptical portion of the scrotum when it is unusually long and lax, but this is seldom necessary. The patient should remain in bed for a fortnight or three weeks, and should wear a suspensory bandage for some months after the operation.

Neuralgia Testis.—In this condition the patient is liable to repeated attacks of paroxysmal pain referred to the testis. It may occur at puberty or in adult life, and is usually met with in men of a highly neurotic temperament. The condition may be a pure neuralgia, or may be attributable to inflammatory adhesions or cicatrices in the tunica vaginalis, the testis or vas deferens, to fibrous bodies in the tunica vaginalis, a small encysted hydrocele, a new growth, or a varicocele. In other cases the neuralgia is associated with such conditions as irritation of the prostatic urethra or neck of the bladder, the presence of a renal calculus, oxaluria, gout, persistent constipation or an anal fissure.

The *treatment* consists in removing the cause when this can be discovered, improving the general health of the patient, applying soothing applications during the attacks, and wearing a suspensory bandage. It is only in extreme cases which have resisted all other treatment that the testis should be removed.

Atrophy of one or both testes may result from injury of the gland, or from inflammatory conditions following gonorrhœa, syphilis, mumps, typhoid, or other infective diseases. It may also occur when the vascular or nerve supply of the organ is interfered with in any way, as for example in severe injuries of the spermatic cord. It is especially liable to occur if the vas is ruptured. The glandular elements degenerate and the stroma shrivels up, and the organ is merely represented by a small nodule of connective tissue. The epididymis and the structures of the cord may share in the atrophic process, or the epididymis may remain intact and be distinctly palpable behind the remains of the testis.

The Seminal Vesicles.

Surgical Anatomy.—These are hollow sacculated structures, about two inches in length, situated, one on either side of the middle line, between the bladder and rectum, and behind the prostate. Each vesicle is inclined from above downwards and inwards, forming an acute angle with its fellow. The upper and outer extremity is partly covered by peritoneum; the lower extremity becomes constricted to form a short duct which joins the vas deferens at an acute angle to form the common ejaculatory duct which opens into the floor of the prostatic urethra. The epithelial lining of the vesicle is columnar, and secretes a fluid having an opalescent appearance; the fluid nourishes the spermatozoa during their sojourn in the vesicle. The vesicle serves as a storehouse for the spermatic fluid, which is ejected during the sexual act into the posterior urethra by the contraction of the muscular fibres in its wall acting in unison with those of the prostate.

The seminal vesicles are palpated by the finger-tip pressed against that portion of the rectal wall which lies over them. The patient stands leaning over a chair in the attitude already described for the examination of the prostate. The extended forefinger is passed into the rectum, the other fingers are flexed into the palm, and their knuckles exert pressure on the perineum between the rami of the pubis, so as to enable the forefinger to penetrate more deeply. The other hand exerts counter pressure above the pubes. The vesicles are not easily identified by the finger unless they are distended with fluid, or are indurated by inflammation or tuberculous disease.

Inflammation—Vesiculitis.—This usually results from the extension of a gonorrhœal infection from the posterior urethra; gonococci alone may be concerned, or they may be associated with other pyogenic organisms. Both vesicles are commonly involved.

In the *acute variety* the urethral discharge ceases, there is considerable fever, with pain and tenderness above Poupart's ligament, rendering the patient unable to stand up or go about. There is pain on micturition and defecation, and there may be a good deal of urgency as well as frequency of micturition; the patient is wakened by painful erections. Rectal examination reveals a hot, throbbing, tender swelling in the position of the seminal vesicle on one or both sides. Resolution usually occurs with a free discharge of pus into the urethra, most of the pus escaping with the urine; rarely an abscess forms in the cellular tissue between the bladder and rectum, and still more rarely the inflammation spreads to the peritoneum, resulting in a local or general peritonitis.

The patient is confined to bed, the foot of which is raised; the bowels are emptied by repeated hot-water enemata. Pain is relieved by anodyne suppositories and by poultices applied to the perineum. No local treatment to the urethra should be employed. The patient is confined to bed for about three weeks.

In *chronic vesiculitis*, which may be a sequel of the acute variety or may develop insidiously, the vesicle becomes distended with fluid; its walls become sclerosed, and granulations which bleed readily may form on the mucous membrane. Faceted calculi composed of phosphate of lime have been observed in isolated cases. The clinical features resemble those of the acute variety, but are less marked. Pain is complained of after exertion, especially on horseback or cycle, after sexual excitement, or the passage of instruments. The patient is often concerned because of the persistence of discharge from the urethra, in spite of treatment directed to the latter; the discharge is specially noticed after straining at stool. In some cases there is a sensation of pain, weight, or discomfort referred to the penis, testicles, or scrotum, or of pains in the loin and thighs, described as lumbago or sciatica. The patient is often depressed and melancholy; he broods over his troubles, and is apprehensive of his sexual functions.

The *diagnosis* is made by rectal examination, when the distended and tender seminal vesicle is felt with the finger; if there is much distension, the contents are expressed into the urethra and escape at the meatus; it is watery like skim milk, muco-purulent, and is sometimes tinged with blood.

In the *treatment* of this affection it is often difficult to decide whether to trust entirely to the *vis medicatrix naturæ*, assisted by measures directed to improve the general and particularly the mental health, such as plain living, open-air exercise,

tonics, with the change of air and scene obtained by a sea voyage, or to have recourse to local measures such as those recommended by Eugene Fuller. The procedure called "stripping the vesicles" consists in emptying the distended sacs by means of the tip of the forefinger introduced into the rectum, the pressure being extended in a downward direction towards the termination of the vesicle in the ejaculatory duct. This is done several times until the vesicles are empty. The patient bends forwards at a right angle over the back of a chair; the vesicles are more easily reached if the bladder is full; the expressed discharge appears at the meatus. Benefit results not only from the mechanical emptying of the distended vesicle, but from the manipulation acting as massage. The procedure is repeated once a week or once a fortnight.

Tuberculous disease is commonly met with in young adults in association with tubercle in the prostate and epididymis. Unless complicated with gonorrhœal infection, the disease is chronic and painless, and is only recognised on rectal examination; the vesicle is so thickened that it resembles a solid cake-like mass, and is not at all tender on pressure. A cold abscess may form and burrow in various directions. Tuberculous peritonitis is an occasional complication.

Prognosis and treatment are influenced by the same considerations as in tuberculosis of the prostate. Surgical measures directed to the vesicular disease are rarely called for except in the case of abscess, which is attacked by the perineal route, the dissection being continued between the prostate and rectum until the abscess cavity is reached.

The Tunica Vaginalis.

Hydrocele.—The term hydrocele is used somewhat loosely to indicate a collection of fluid in relation to the testis, its appendages or its coverings. In a more restricted sense, it refers to a collection of serous fluid in the cavity of the tunica vaginalis.

Acute Hydrocele.—This term is applied to the serous effusion which takes place into the cavity of the tunica vaginalis in the course of inflammatory conditions of the testis and epididymis and after injuries of these organs. The fluid is an ordinary inflammatory exudate, and differs from that met with in chronic forms of hydrocele in being more rich in cells, more highly coagulable, and more liable to be followed by adhesions between the walls of the sac. The condition is apt to be overlooked

clinically, as its signs are overshadowed by those of the orchitis or epididymitis with which it is associated. As a rule the fluid disappears as the primary inflammation subsides, and no special treatment is called for. In some cases suppuration ensues and incision is necessary. In rare instances the effusion persists and constitutes a chronic hydrocele.

Chronic Hydrocele.—Several varieties of chronic hydrocele are recognised, according to the situation of the effused fluid. In the most common variety — the *ordinary or acquired hydrocele* — the fluid occupies and distends the cavity of the normal tunica vaginalis. In the *congenital hydrocele*, the fluid distends the tunica vaginalis and communicates with the peritoneal cavity through the processus vaginalis, which remains unobliterated. When the upper end of the processus vaginalis is occluded, and the fluid is confined to the tunica vaginalis and the unobliterated lower portion of the process, the condition is known as *infantile hydrocele.* The term *inguinal hydrocele* is applied when fluid collects in the tunica vaginalis of an imperfectly descended testis.

The *fluid* in a chronic hydrocele is serous in character, contains about 6 per cent. of albumin and a small quantity of fibrinogen, and has a specific gravity of from 1022 to 1025. It does not coagulate spontaneously. It may be clear and watery, or of a pale straw or greenish colour. It often presents a glistening appearance from the presence of numerous shiny cholesterin crystals. According to the size of the hydrocele the quantity of fluid varies from a few ounces to several pints. Sometimes fat or chyle is present in the fluid, and gives it a white, milky appearance—*chylous hydrocele.* This may be due to the presence of the *filaria sanguinis hominis.*

The *etiology* of hydrocele is obscure. In a certain number of cases the fluid develops in association with some obvious disease of the testis or epididymis, such as syphilis, tubercle, or other form of chronic inflammation, but in the great majority it occurs apart from any such condition. It is probably of the nature of a passive effusion resulting from some abnormality in the vascular or lymphatic arrangements of the parts. Most French authors incline to the belief that it is invariably of inflammatory origin, but the evidence for this view is not convincing. In some cases, calcareous plates are found scattered over the walls of the sac, or the whole of the tunica vaginalis may be calcified and rigid. In other cases, numerous pedunculated fibrous bodies project from the tunica vaginalis into the cavity of the hydrocele. It is doubtful whether these changes are the cause or the result of the hydrocele.

The *ordinary or acquired hydrocele of the tunica vaginalis* comes on insidiously in middle-aged men, and forms a pyriform, rounded or oblong swelling which begins in the lower part of the scrotum, and gradually enlarges from below upwards. It is smooth on the surface, uniform in outline, tense and elastic in consistence, and stands out prominently in the scrotum (Fig. 152). When the walls of the sac are calcified, a sensation of egg-shell cracking may be elicited on squeezing the swelling. On percussion it is dull and may yield a peculiar thrill. In early cases the swelling may be translucent, but too much weight must not be attached to this sign, as thickening of the wall of the sac, the presence of adhesions, discoloration of the contained fluid, or other causes may render it opaque. There is no true impulse on coughing, but the contraction of the abdominal walls may give an apparent impulse. The fluid does not leave the scrotum when the patient lies down, and cannot be reduced into the abdominal cavity by pressure.

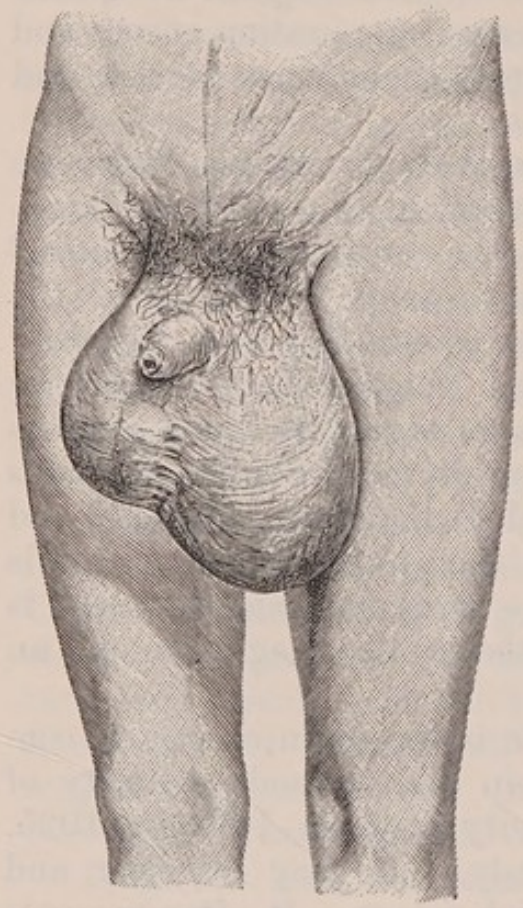


FIG. 152.—Large Hydrocele of left Tunica Vaginalis in a man æt. 45. Subsequently treated by excision.

There is no pain, but the weight of the fluid causes a dragging sensation along the line of the cord. The testis can usually be palpated behind the hydrocele, sometimes at the lower part of the scrotum, sometimes about halfway down (Fig. 153). The two sides are affected with about equal frequency, but sometimes the condition is bilateral, and in such cases the stretching of the skin of the scrotum may bury the penis. Under these conditions the urine may irritate the skin of the scrotum and produce eczema or excoriations.

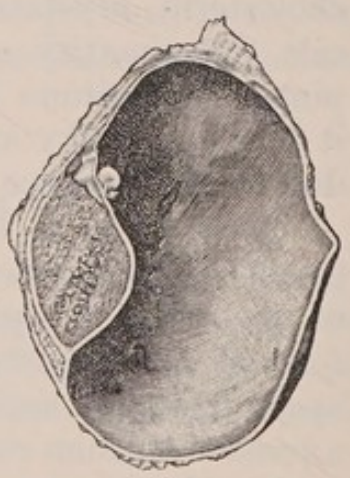


FIG. 153. — Moderate-sized Hydrocele of the Tunica Vaginalis, showing the relation of the Testis to the Hydrocele.

The swelling is usually confined to the scrotum, but a funnel-shaped process sometimes passes towards the inguinal canal and

gives an appearance which simulates a hernia. Sometimes a marked constriction exists about the middle of the sac, dividing it into two compartments—*bilocular hydrocele* or *hydrocele en bissac.* As a result of adhesions the cavity may be multilocular.

Diagnosis.—A careful analysis of the signs and symptoms will usually enable an ordinary hydrocele to be diagnosed from a scrotal hernia, a tumour of the testis or epididymis, a hæmatocele, or from other forms of hydrocele. It is to be borne in mind that hydrocele may be complicated by hernia, and that more than one form of hydrocele may coexist.

Treatment.—As spontaneous cure seldom occurs in adults, and as the swelling by its size, weight, and unsightliness is a source of annoyance to the patient, an attempt should be made to cure the condition.

Tapping.—Simple tapping of a hydrocele is seldom curative in adults, although sometimes successful in children. The skin of the scrotum having been carefully purified, the patient is seated on the edge of a chair, and the surgeon grasps the swelling in such a way as to render the front of the hydrocele prominent and tense. A fine trocar and cannula is then thrust in a backward and upward direction into the swelling a little below its middle. Care is taken to avoid injuring the testis or any of the larger veins of the scrotum. The trocar is now withdrawn and the cannula pushed well into the cavity, and pressure is kept up till all the fluid has escaped, after which the cannula is quickly withdrawn. The puncture is sealed with collodion, a pad of wool applied over the scrotum, and pressure exerted by an ordinary or a suspensory bandage. The patient should rest for some hours after the tapping.

Injection.—The object in the injection method of treatment is to produce an irritation of the tunica vaginalis which will result in the formation of adhesions between its two layers, and so obliterate the sac. The fluid most commonly employed is the Edinburgh tincture of iodine, which is twice as strong as the pharmacopœial tincture. As the injection is painful, it is well, after having emptied the sac, to inject into it about two drams of a 5 per cent. solution of cocain or eucain. This is brought into contact with the whole of the inner surface of the sac by shaking the scrotum, and the excess allowed to escape, and after it has had time to act, from two to four drams of the iodine are injected and similarly distributed. As the cannula is withdrawn the tissues around it should be firmly grasped to prevent the iodine escaping into the connective tissue planes of the scrotum. The patient is confined to bed, with the

scrotum supported on a pillow placed between the thighs. Next day the scrotum is usually swollen, hot and painful, being distended with the exudate induced by the iodine. Under lead and opium fomentations this swelling gradually subsides, and the patient is able to get out of bed in from seven to ten days. The fluid has usually entirely disappeared by the end of a month.

Some surgeons prefer to inject about a dram of pure carbolic acid liquefied in glycerine. It is said to be as efficacious as iodine and less painful.

Operative Treatment.—Incision and drainage or partial excision of the tunica vaginalis is indicated in large hydroceles with thickened or calcified walls, in cases where loose or pedunculated bodies are present, where there is reason to believe that the hydrocele communicates with the peritoneal cavity or with the sac of a hernia, and in cases which have resisted other methods of treatment.

Incision and Drainage.—This method is best adapted to cases in which the walls of the hydrocele are markedly thickened. An incision about two inches long is made on the anterior aspect of the scrotum towards the lower end of the swelling. The parietal layer of the tunica vaginalis is stitched to the edges of the skin incision, and the cavity packed with iodoform gauze, or drained by means of a tube. Before the drain is introduced, the surface of the sac may be swabbed over with pure carbolic acid, iodine, or other irritant. The cavity is usually obliterated by granulation in from two to three weeks.

Partial Excision of the Tunica Vaginalis.—The incision usually employed in this operation is the same as that just described. The parietal layer of the tunica vaginalis is separated from the scrotum, and as much of it as possible clipped away with scissors. The wound is then closed, a drainage tube being left in at the lowest part. Owing to the difficulty of keeping scrotal wounds aseptic, we prefer one or other of the following operations which we have employed for several years. A transverse incision is made over the external abdominal ring, exposing the cord. The upper end of the hydrocele is cleared and having been made to project towards the wound is opened and emptied. The collapsed sac, together with the testis, is then withdrawn from the scrotum, and the whole of the parietal layer either cut away with scissors, or turned inside out, the edges of the sac in the latter case being sutured along the back of the epididymis and testis with catgut. All bleeding points are secured with ligatures, and the testis restored to the scrotum. A small

drainage-tube is introduced through a puncture made at the bottom of the scrotum. This is removed at the first dressing. The inguinal incision is completely closed, and firm pressure is exerted on the scrotum by means of a St. Andrew's cross bandage.

Congenital hydrocele is usually met with in infants. It presents the same general characters as the ordinary hydrocele of adults, but as the processus vaginalis is patent, the fluid flows into the peritoneal cavity when the patient lies down, or can be slowly pressed back by squeezing the swelling. It differs from a congenital hernia in being dull on percussion, and in the slow and gradual way in which it is reduced without gurgling or sudden jerk. The swelling resembles a hernia in becoming tense when the patient cries or coughs. The diagnostic value of translucency is diminished by the fact that a hernia of small intestine in young children may also transmit light.

Treatment.—In many cases the fluid disappears spontaneously or after a truss has been worn for some months. Simple tapping is seldom of benefit. In persistent cases an operation should be performed, with the double object of curing the hydrocele and preventing the development of a hernia along the open processus vaginalis.

Infantile hydrocele resembles the ordinary acquired hydrocele of adults, save that the sac extends further towards the abdominal cavity, as only the upper end of the processus vaginalis is occluded. In some cases a constriction exists where the tunica vaginalis and the funicular process join, and the upper compartment of the sac becomes greatly distended and bulges, either up between the abdominal muscles and the peritoneum, forming a salient fluid swelling which may reach to the umbilicus, or into the iliac fossa and pelvis, where it may displace the pelvic viscera and be palpable from the rectum. This constitutes one of the forms of *bilocular* hydrocele or *hydrocele en bissac.* It is treated by excising as much as possible of the sac.

A condition comparable to infantile hydrocele is produced when fluid collects in a hernial sac emptied of its contents and occluded at its upper end—*hydrocele of a hernial sac.*

Hæmatocele of the Tunica Vaginalis.—An extravasation of blood into the cavity of the tunica vaginalis is spoken of as a *hæmatocele.* The blood may be effused into a previously healthy or a chronically inflamed tunica vaginalis, or into a pre-existing hydrocele (*hydro-hæmatocele*). Hæmatocele may also develop in association with malignant disease of the testis. The hæmorrhage is almost always due to trauma, for example, a blow

or kick over the scrotum, a sudden strain or twist, or a punctured wound as in tapping a hydrocele. In the last instance the bleeding may result from wounding a blood-vessel of the scrotum, tunica vaginalis or testis.

Clinical Features.—The physical signs of a hæmatocele resemble in a general way those of hydrocele, but being traumatic in origin the swelling usually develops suddenly. The tunica vaginalis rapidly becomes filled by the extravasated blood, forming a tense oval swelling which distends the scrotum and obscures the outline of the testis. The position of the gland can usually be ascertained by eliciting testicular sensation. It usually occupies the lower and posterior part of the scrotum. With the onset of the swelling the patient experiences a sickening pain, but there are no other signs of inflammation. The scrotum may become discoloured at once from extravasation taking place into its tissues, or some days later from the deposition of blood pigment. The swelling is at first uniform in outline, soft and fluctuating, but in the course of a few days the blood coagulates, and it becomes irregular in shape and consistence.

Still later it becomes firm from thickening of its walls by the deposit on them of fibrin and laminated clot. The cavity of the tunica vaginalis is occupied by a dark brown sanious fluid into which project shreddy masses of coagulum. An old standing hæmatocele may simulate a solid tumour of the testis, and calcareous plates may develop in its walls.

When the hæmorrhage occurs into a pre-existing hydrocele, the swelling suddenly becomes larger, firmer and heavier, and loses its translucency.

Suppuration sometimes occurs either from infection from without, as in tapping a hydrocele, or through the blood-stream. When the hæmatocele is of long standing, the testis may undergo atrophy.

Treatment.—In recent cases, the patient should remain in bed with the scrotum elevated on a pillow placed between the thighs, and evaporating lotions or lead and opium fomentations should be applied. If the swelling is very tense and the vitality of the scrotum is threatened, the tension should be relieved by puncture or incision. In old standing cases an operation similar to that recommended for the radical treatment of hydrocele should be performed. When suppuration occurs, free incision and drainage are called for, and if the testis is atrophied its removal is indicated.

THE PENIS.

Surgical Anatomy.—The penis is composed of the two *corpora cavernosa*, which lie towards the dorsum, and the *corpus spongiosum*, which occupies the groove on the ventral aspect of the corpora cavernosa, and is traversed by the urethra. These different elements are enclosed by a fibrous sheath. The conical end of the penis—the expanded anterior end of the corpus spongiosum—is known as the *glans*, and the redundant fold of skin which covers it as the *prepuce*.

The *lymphatics of the external genitals* drain chiefly into the group of inguinal glands which run parallel with Poupart's ligament.

Malformations—Phimosis.—The most common malformation of the penis is phimosis, a condition in which the prepuce, owing to the small size of its orifice, cannot be retracted over the glans. Phimosis may be congenital or acquired.

In *congenital phimosis*, the prepuce, in addition to having an unduly small orifice, is usually unnaturally long and pointed, and the slight adhesions which, at birth, normally exist between the prepuce and the glans persist to a greater or less extent. Sometimes the prepuce is shorter than normal and is tightly stretched over the glans, to which it is usually intimately adherent. In the sulcus round the corona there is an accumulation of inspissated smegma which forms a white putty-like mass, or may be moulded into small rounded concretions.

During childhood the main trouble caused by phimosis is interference with micturition. When the prepuce is long and not adherent, and its orifice is smaller than the urinary meatus, during micturition the urine collects in the preputial pouch and distends it. Dilatation of the urethra and bladder, and even of the ureters and renal pelvis, is said to have resulted from the backward pressure in extreme cases. Nocturnal incontinence is sometimes attributable to phimosis, particularly when the prepuce is adherent to the glans. Inflammation of the sac of the prepuce—*balanitis*—is a frequent complication, and the itching and pain which result cause the child to rub and pull the penis, and the habit of masturbation may be thus acquired. The constant straining during micturition tends to the production of inguinal hernia or of prolapsus ani. Convulsions, epilepsy, paraplegia, and numerous other nerve disturbances have been rightly or wrongly attributed to phimosis, and in some cases these have disappeared after circumcision.

In adult life, the existence of phimosis renders the patient specially liable to acquire venereal disease if exposed to infection, the preputial pouch forming a favourable site for the lodgment

and growth of the organisms. When it is associated with chronic balanitis, it would appear to favour the development of cancer of the penis. The condition may interfere with coitus, the semen being retained in the preputial pouch.

Acquired phimosis is usually met with in adults, and is due to œdematous swelling and congestion of the prepuce resulting, as a rule, from such inflammatory conditions as gonorrhœa, soft sores, hard chancre, eczema, or herpes preputialis. It may also occur in diabetic patients from the irritation caused by fermentation of sugar-containing urine. It is most likely to develop in those who have naturally a long and narrow prepuce, and is therefore rather an aggravation of a congenital phimosis than a new condition.

FIG. 154.—Preputial Calculi.

(From Professor Annandale's collection.)

Preputial Calculi.—Calculi composed of uric acid, urates, and phosphates are occasionally met with in the preputial sac of adults who suffer from marked degrees of phimosis. They are due to the deposit of salts from the urine which stagnates in the pouch, and the nucleus of the calculus may be a mass of inspissated smegma or mucus, or a small stone which has passed from the kidney or bladder and become lodged behind the prepuce. They may be single or multiple, varying in size from a pea to a walnut or even larger, and are usually smooth and faceted (Fig. 154).

Treatment.—As the slighter degrees of congenital phimosis tend to disappear spontaneously, treatment is only called for in childhood when the condition gives rise to symptoms. After puberty the condition tends to get worse rather than better and operation is always indicated. The only method of treatment that need be considered is *circumcision*. The glans is pushed back, and the prepuce grasped with a pair of dressing forceps applied to it obliquely from above downwards and forwards. The tissue in front of the blades of the forceps is then cut off with a long bistoury. Care must be taken to remove just enough skin to enable the glans to be completely exposed, and yet to leave a covering for the sensitive papillæ of the corona. If after removal of the forceps it is found that the lining membrane of the prepuce is still redundant, the excess must be cut away with scissors. The bleeding is arrested by torsion or

by fine catgut ligatures, special attention being paid to the vessels in the vicinity of the frenum. The cut edges of the outer and inner layers of the prepuce are then stitched together by a series of interrupted catgut stitches. In adults, full doses of bromides should be given to prevent erections which, besides causing pain, are liable to tear the stitches and so interfere with primary union.

Paraphimosis.—This term is applied to the condition which results when the glans penis is strangulated by a tight prepuce which has been drawn back and cannot be pulled forward again. The constriction of the glans is sufficient to prevent the venous return without arresting the arterial supply. The result is that the part becomes intensely congested and œdematous. The constricting band is formed by the margin of the orifice of the prepuce, and the chief swelling is formed by its inner layer, which is in a marked state of œdema (Fig. 155).

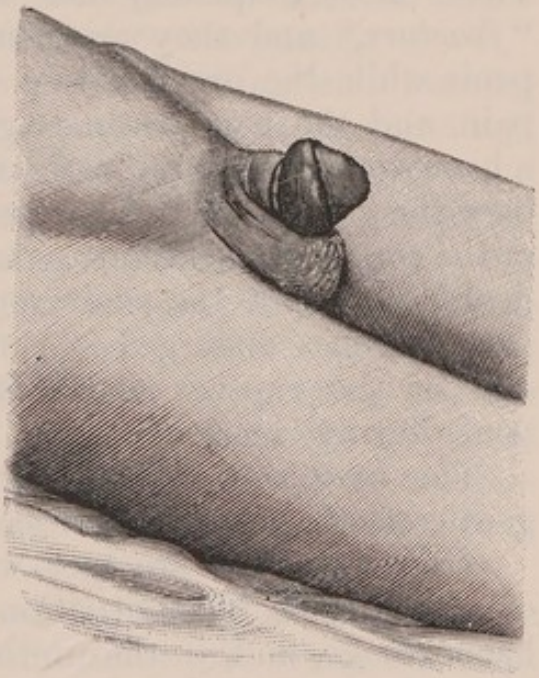


FIG. 155.—Paraphimosis in a boy, æt. 6.

(From a photograph lent by Mr. Stiles.)

The condition is attended with severe pain which is often aggravated by repeated or persistent erection of the penis. The point of the penis is greatly altered in shape by the œdema, and the whole organ may become tortuous. The flow of urine is sometimes interfered with. Ulceration eventually occurs at the upper part of the ring on the dorsal aspect of the penis, and to some extent relieves the strangulation. In some cases, however, gangrene of the prepuce and glans has occurred.

Treatment.—In most cases the glans can be reduced by applying steady and firm pressure to the parts. A piece of lint soaked in a 5 per cent. solution of cocain is laid over the end of the penis and covered with a thick pad of cotton-wool. A narrow elastic bandage is then evenly and firmly applied, and the penis supported in a vertical position. In the course of ten or fifteen minutes the glans is thoroughly lubricated with vaseline and the penis grasped between the index and middle fingers of both hands, while steady pressure is made on the glans with both thumbs. With a little manipulation

reduction is usually readily effected. If these measures fail, it is necessary to divide the constricting band on the dorsum of the penis, and leave things to settle down, after which circumcision is performed.

The **other malformations** of the penis which occur are total absence, double penis, inclusion of the penis in a web of skin which binds it to the front of the scrotum, torsion of the penis and congenital fistula. These conditions are all rare and need not be referred to further.

Injuries. — Injuries of the penis are comparatively rare. Those most frequently met with are *contusion* and *rupture or "fracture,"* and they are usually produced by bending of the penis while the organ is in a state of erection. There is severe pain, and the part becomes greatly swollen and ecchymosed, or a hæmatoma may form in the tissues. The discoloration extends over the greater part of the penis and scrotum. When the fibres of the corpus cavernosum are lacerated, erection is incomplete, the distal portion of the penis remaining flaccid while the proximal part becomes engorged. A fibrous nodule may persist at the seat of the rupture and subsequently cause deviation of the penis during erection.

The *treatment* consists in applying evaporating lotions, or gentle elastic pressure, and securing absolute rest.

Incised wounds are met with chiefly in lunatics as a result of attempts at self-mutilation. They are attended with severe hæmorrhage, and, if the urethra is implicated, may be followed by stricture. Treatment is directed towards arresting the bleeding, and restoring the continuity of the urethra, a catheter being passed into the bladder and retained in position during the healing of the wound. When a portion of the penis has been completely separated, the end of the urethra should be split open and stitched to the cut edges of the skin.

Strangulation of the penis may be produced by metal rings, elastic bands, or cords applied round the penis. The distal part of the organ becomes œdematous, congested, and finally gangrenous. The constricting object is buried out of sight in the swollen tissues and may escape notice. The urethra becomes occluded, and extravasation of urine may occur leading to the formation of urinary fistulæ.

The *treatment* consists in removing the tight band by scissors, cutting forceps, or a file, and in attempting to preserve the vitality of the strangulated tissue. When necrosis occurs, the gangrenous portions are covered with mild antiseptic dressings and the sloughs are clipped away as they become loose. Plastic

operations may be required to restore the shape and function of the organ.

Inflammatory Affections—*Balanitis.*—The term balanitis is applied to an inflammation of the skin lining the prepuce and covering the glans. It is most common in patients who suffer from phimosis, and is due to septic infection and decomposition of accumulated smegma and epithelial debris retained in the preputial pouch. In gouty and diabetic patients, urine retained in the pouch may undergo decomposition and cause balanitis. The most severe forms occur in cases of gonorrhœa and sub-preputial chancre. After middle life a chronic form of balanitis sometimes occurs, and is liable to be followed by carcinoma.

Clinical Features.—There is persistent itching and burning pain in the prepuce and glans, and these parts become red, swollen, and œdematous, and from the orifice there escapes a peculiarly offensive discharge of yellow muco-purulent fluid. When the prepuce is tight the mucous membrane may become excoriated or even ulcerated. During micturition there is smarting pain in the prepuce. The inguinal glands are seldom enlarged. There is often some difficulty in determining whether the pus comes from the urethra or merely from the preputial pouch, and in such cases it may be necessary to slit up the prepuce to settle the diagnosis between balanitis, gonorrhœa, and sub-preputial chancre.

The *treatment* consists in thorough cleansing of the parts, the pouch being syringed out with a mild antiseptic lotion and kept clean and dry. Circumcision is often advisable to admit of thorough purification and to prevent recurrence.

Lymphangitis of the penis sometimes results from balanitis—particularly of venereal origin. The lymphatic vessels become red, distended and swollen, and the main trunks stand out as firm cords on the dorsal aspect of the penis.

Cellulitis may also result from balanitis, or may occur after injuries or operations on the penis, for example circumcision. It may spread to the scrotum and abdomen, and has in some cases proved fatal.

Gangrene of the penis may result from such conditions as paraphimosis, phagadænic chancres, or septic infection of accidental or operation wounds. It is also met with in elderly men suffering from enlarged prostate or stricture, with septic changes in the urethra, and may occur as a sequel of acute infective fevers, such as typhoid or smallpox. In some cases, only the skin becomes gangrenous, but in others the whole thickness of the organ undergoes necrosis, and the distal portion is cast off

as a slough. The gangrene is usually of the moist type, and the clinical features and principles of treatment are the same as in gangrene of the extremities. After the separation of the slough care must be taken to prevent stenosis of the urethral orifice.

Herpetic eruptions are frequently met with on the prepuce and glans, and are liable to be mistaken for soft sores. They are usually associated with syphilis or with gout, but are sometimes met with independently of these diseases. They are very liable to recur at intervals.

Chronic Induration of the Penis.—Hard fibrous nodules are occasionally met with in the substance of the penis in patients over forty years of age. They may result from injury, from chronic gonorrhœal inflammation spreading to the connective tissue of the penis, or may be of the nature of syphilitic gummata. In these cases the nodule is in the substance of the corpus cavernosum. In a considerable proportion of cases, however, the nodule is in the fibrous sheath which surrounds the corpora cavernosa, and is associated with gout, rheumatism, or diabetes. When met with under these conditions, the fibrous thickening is to be regarded as of the same nature as the induration of the palmar fascia in Dupuytren's contraction, or the changes in the ligaments met with in arthritis deformans. The swelling is usually about the size and shape of an almond, is smooth on the surface, is not attached to the skin, but is adherent to the erectile elements of the penis. It is painless, and only gives trouble by causing the penis to become curved during erection, thus interfering with coitus and ejaculation. Sexual hypochondriasis is often induced. The *treatment* varies with the cause, but as a rule the condition is very intractable. Most benefit has been derived from repeated blistering and from electrolysis.

Tumours.—*Papillomatous tumours* or warts are usually met with on the glans and inner aspect of the prepuce as a result of venereal infection. They form red, vascular, cauliflower-like masses, more or less pedunculated, and exude a foul-smelling discharge. The treatment is described in vol. i. p. 352.

Dermoid and sebaceous cysts are occasionally met with on the under aspect of the prepuce.

Horns sometimes form, particularly in old men, either in relation to a sebaceous cyst or a hard wart. As they are liable to lead to the development of carcinoma they should be excised.

Carcinoma of the penis is comparatively rare. The tumour is almost always a squamous epithelioma, and commences usually on the dorsal aspect of the glans, less frequently at the reflection of the prepuce, and rarely on the inner aspect or at the orifice of

the prepuce. In a few cases it has commenced in the urethra, and in others on the external skin either near the point or near the root of the penis. From the frequency with which phimosis and chronic balanitis precede the development of epithelioma of the penis these conditions would appear to be important predisposing factors.

Clinical Features.—This disease is most common after the age of fifty, but has been met with in patients under thirty-five. It may begin as a wart, a fissure or excoriation, or a patch of leucoplakia. Occasionally the growth has commenced in an old cicatrix. The tumour usually assumes the form of an irregular cauliflower-like excrescence which attains some size before ulceration occurs (Fig. 156). The base is hard, and the tumour is fixed to the glans and body of the penis. When ulceration begins the part becomes painful, the tumour bleeds readily and exudes a copious and peculiarly offensive discharge. The fibrous sheath of the corpus cavernosum resists the spread of the growth for a time, but is ultimately perforated, and the tumour then infiltrates the erectile tissue in the substance of which secondary nodules may be detected. The inguinal and pelvic glands on both sides are early and widely implicated. The urethra is seldom invaded, and there is rarely any interference with micturition. In some cases a urinary fistula has developed through the prepuce.

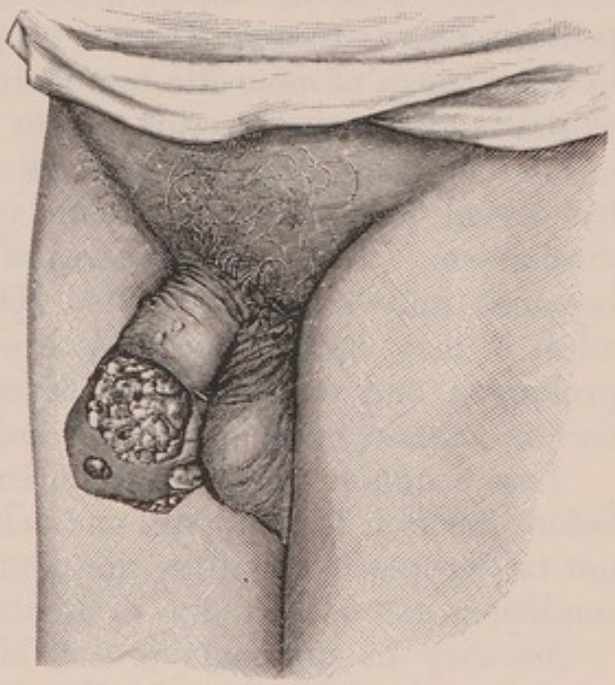


FIG. 156.—Cancer of the Penis.

(Mr. F. M. Caird's case.)

It is most important to recognise the condition in its earliest stages before glandular invasion has occurred, and at this stage it is liable to be confused with an indurated wart, or a hard chancre under cover of a tight prepuce.

Treatment.—In all doubtful cases the growth should be freely removed as early as possible to prevent lymphatic invasion. The amount of the penis to be amputated depends on the stage and extent of the disease. Enlarged glands should be removed at the same time.

Functional Disturbances of the Male Sexual Organs.—In considering this question, it is necessary to distinguish between *impotence*, which is the inability to perform the sexual act, and *sterility*, which is the inability to beget children. The two conditions may be associated.

Impotence may be due to anatomical deformities of the sexual organs, such as marked degrees of hypospadias or epispadias, or to some mechanical obstacle to coitus, such as curvature of the penis during erection from the presence of scar tissue in the erectile tissue. Apart from these conditions the main cause of impotence is incompleteness or absence of erection of the penis. This is frequently due to psychical causes, for example, in young men of neurotic temperament, the inhibitory influence of the brain on the erection centre in the spinal cord preventing normal erection. In other cases it is due to over-stimulation by sexual excitement resulting in exhaustion of the nervous mechanism. In certain diseases of the spinal cord also, erection becomes impossible, and after removal of both testes in the adult it may become incomplete or may even be absent. The prolonged and excessive use of certain drugs, such as opium, cocain, arsenic, camphor, or alcohol, may induce impotence.

Less common causes of impotence are premature ejaculation before erection is complete, and delayed ejaculation, the emission not taking place till after the penis has become flaccid. These conditions are usually due to mental excitement.

Sterility in the male is due either to absence of semen or to abnormal composition of the fluid. In some cases no spermatozoa are present in the seminal fluid ejaculated—*azoöspermia*. This may be due to the testes not forming spermatozoa, as a result of atrophy or disease ; or to some interference with the flow of the fluid through the seminal channels, for example, as a result of gonorrhœal or syphilitic affections of the vas deferens, the seminal vesicles, or the ejaculatory ducts. In some cases of cryptorchism spermatozoa are absent from the semen, but in others they are abundant. Azoöspermia may be temporary or permanent according to the condition to which it is due.

In other cases, although the sexual act is performed, no seminal fluid is ejaculated—*aspermia*. This is usually due to some obstruction in the seminal tract, for example, obliteration of the vas deferens or ejaculatory duct from gonorrhœal inflammation or from the presence of concretions, or to stricture of the urethra or enlarged prostate. This condition may exist temporarily as a result of congestive or inflammatory conditions in the ducts or urethra, or from psychical causes.

The presence of a tight stricture of the urethra with fistulæ behind it through which the semen escapes also involves sterility.

The *prognosis* and *treatment* of these conditions vary with their cause. When due to gross anatomical defects or to organic lesions either of the sexual organs or of the central nervous system, they are for the most part permanent and incurable. When they result from psychical and moral causes, the functions may be restored by general treatment directed towards the neurasthenia. The patient should be encouraged by the assurance that his condition is temporary and curable. Electrical treatment, and the use of such drugs as strychnin, cantharides, and phosphorus are often beneficial. All forms of local treatment are to be avoided, and the patient should abstain from intercourse for a time. When the condition is due to drug habits, recovery ensues if the habit is broken.

APPENDIX.

ANÆSTHETICS.

The term "anæsthesia" was suggested by Oliver Wendell Holmes when, in 1846, Morton first demonstrated that the inhalation of ether abolished consciousness and the sensation of pain.

General anæsthesia may be defined as a state of unconsciousness and of insensibility to external impressions, which will allow of a surgical operation being performed painlessly; while *local anæsthesia* is a condition of insensibility to painful stimuli in a restricted portion of the body, and unaccompanied by loss of consciousness.

General Anæsthesia.

The general anæsthetics most frequently employed for prolonged operations are chloroform, ether, and certain mixtures of these. The mixture we have found most useful has been one part of chloroform and two of ether, for convenience spoken of as the CE. mixture. For brief operations inhalations of nitrous oxide, chloride of ethyl, or the mixture of the latter with bromide of ethyl, known as "somnoform," are commonly employed.

Preparation of the Patient for a General Anæsthetic.—Except in cases of emergency the patient should be prepared for the anæsthetic by having his diet and general mode of living regulated for a few days. When it is possible, he should be kept at rest in hospital or in a nursing home for two or three days, although he need not be confined to bed during the whole of this period. A purgative should be administered about thirty-six hours before the operation, and the lower bowel cleared out with an enema some hours before its actual performance. No solid food should be given within twenty-four hours, but it is well to give the patient a cup of beef-tea or clear soup three or four hours before. Starving is often overdone, especially in delicate

patients. If the patient is very feeble or collapsed, a nutrient enema containing an ounce of brandy may be administered with advantage half an hour before the operation, or the brandy may be given in a similar quantity of water by the mouth. As milk coagulates in the stomach, forming an indigestible mass, it is to be regarded as solid food. In cases of dilatation of the stomach, and of acute intestinal obstruction, it is an advantage to wash out the stomach immediately prior to giving the anæsthetic, to prevent the sudden regurgitation of stomach contents which may enter the air-passages.

The preliminary administration of one-third of a grain of morphin and one-hundredth of a grain of atropin is sometimes practised, but as a matter of routine it is better avoided, as the symptoms of over-narcosis may be masked by these drugs. It may be of service, however, in operations on the brain or when dealing with alcoholic or maniacal patients. In some cases, and especially where the patient is collapsed before operation, from five to ten minims of liquor strychnin injected hypodermically is of service, and this may be repeated if necessary. Inquiry must be made as to the presence in the mouth of artificial teeth or other loose bodies, such as sweets in the case of children, and pieces of tobacco in male hospital patients; if present they must be removed, as they are liable to fall back into the throat and cause choking. As a rule, it is advisable to place the patient on the operating table before beginning to administer the anæsthetic, and it is well to allow him to lie in the position in which he is most comfortable; the position can be altered if necessary as soon as he is unconscious.

The Choice of the Anæsthetic.—In selecting the anæsthetic for any given case, the following points require to be taken into consideration:—the age and general condition of the patient; the nature and probable duration of the operation; and the position of the patient during its performance. Chloroform and ether mixture is, as a rule, to be preferred in children under five and in adults over sixty. In vigorous adults from eighteen to forty-five, it is advisable to induce anæsthesia with some other anæsthetic than chloroform, as there is some risk during the struggling stage. For this purpose ethyl chloride is well adapted, and it may be followed by chloroform, ether, or a mixture of these according to circumstances. In organic heart disease, if compensation is present, chloroform is often remarkably well borne; if compensation is failing, CE. mixture should be used, and it is very important to maintain complete anæsthesia throughout. For patients with renal disease, the choice

of the anæsthetic presents some difficulty, but, generally, chloroform or CE. mixture answers best.

In patients suffering from phthisis the CE. mixture is to be preferred, as either chloroform or ether alone is not well borne. In the presence of bronchitis, chloroform is best given alone.

The widely spread idea that ether is frequently followed by bronchitis, even when skilfully administered to healthy persons, is, in our opinion, a mistaken one.

Fat, short-necked patients do best with a mixture of chloroform and ether. Anæsthesia should be induced with CE. mixture and maintained with chloroform in intra-cranial operations, and in those within the mouth and pharynx. For operations on the rectum and genito-urinary organs, amputations, and excision of joints, ether may be used with advantage. For operations on the abdomen most surgeons prefer chloroform, but where the operation is a prolonged one, and likely to be followed by shock, ether may be substituted.

As regards position, if the operation necessitates that the patient's head and shoulders be raised to any extent, chloroform should not be given under any circumstances. It is extremely difficult to administer ether if the patient is to lie on his face.

The following articles should be in readiness before undertaking any anæsthesia :—

A four-ounce bottle of chloroform; a six-ounce bottle of ether; a napkin, or Schimmelbusch mask covered with two layers of lint; a wooden wedge for forcing open the jaws; a strong gag, such as Mason's or Fergusson's; two hypodermic syringes; a 1 per cent. solution of strychnin; a few ounces of brandy; a pair of tongue forceps; a rough towel; a small basin; some form of ether inhaler; and a tracheotomy tube and the instruments necessary for performing tracheotomy.

Chloroform.

The anæsthetic properties of chloroform were discovered by James Young Simpson in 1847. Chloroform can be prepared from pure ethyl alcohol or from methyl alcohol. Some authorities consider that methyl chloroform is unsuitable for anæsthetic purposes, but Ogston and others, with whom we agree, consider it to be as good in every way as chloroform made from ethyl alcohol.

Administration.—Chloroform may be administered by means of a Schimmelbusch mask, or with a napkin or towel folded like a ridge tile. The lint on the mask should be put on with the

smooth side outwards. The chloroform is sprinkled on the inside of the mask or towel from a drop bottle, which is readily improvised by fitting an ordinary medicine phial with the sprinkler of a scent bottle. A half-dram should be sprinkled on the mask every sixty seconds until anæsthesia is complete. An important point in the induction of chloroform anæsthesia is to increase the strength of the vapour gradually until the patient gets accustomed to it, but after the first two minutes when he is losing consciousness, if he shows no tendency to resist the process, the sooner anæsthesia is established the better. If struggling occurs, the chloroform must be withdrawn until it has subsided as it is dangerous to push the drug during its continuance; six minutes may be considered a fairly reasonable time in which to induce full anæsthesia. A space of about half an inch should always be allowed to intervene between the mask and the patient's face to allow free airway, and the chloroform should never be poured on in such quantities as to saturate the lint and cause dripping.

No absolute rule can be given, but for the majority of operations proper anæsthesia cannot be considered present unless the following signs are observed:—(1) The breathing is automatic, like that of a person asleep, with a soft, quiet snore; (2) the conjunctival reflex is abolished; (3) the pupil is contracted and fixed, or sluggishly mobile to light; (4) muscular relaxation is complete; (5) the cough and vomiting reflexes are abolished.

Ether.

There are two distinct methods of administering this anæsthetic—the *open* and the *close* methods.

The *open method* is only to be adopted in exceptional cases in which it is desirable to afford the patient easy conditions of respiration, or when there is no inhaler for the close method available, and the use of chloroform is strongly contra-indicated. Unless morphin has been injected beforehand a large amount of ether is consumed, the greater part being wasted by evaporation. A cone of felt enveloped in waterproof, or a Rendal's mask, is most frequently used as the inhaler, but for children Schimmelbusch's mask does quite well, two coverings of lint being used.

The close method.—To administer ether by the close method involves the use of an inhaler consisting of—(1) a face-piece with a pneumatic pad or cushion; (2) an ether chamber; (3) a rubber bag of about one gallon capacity. There are a variety of inhalers in use, of which Clover's and Ormsby's may be taken as the two

types. In the first-named the ether lies entirely in a special reservoir situated between the face-piece and the bag. In the latter, the ether lies partly in the bag and partly on a sponge which is placed between the face-piece and the bag.

Mode of Administration.—An ounce and a half of ether is placed in the chamber of the inhaler, or in the bag, according to the type of inhaler used. The face-piece is brought within about an inch of the patient's face (which has been turned to one side), and he is requested to breathe regularly. In a few seconds the face-piece is brought nearer, and finally closely adapted to the face, care being taken to catch a few expirations, and so have some air in the bag to mix with the ether vapour.

If the inhaler is of the Clover type, the ether is slowly turned on by rotation of the chamber around its own axis; if of the Ormsby type, by slowly raising the bag containing the ether and sprinkling the anæsthetic over the sponge. As the ether is added, the patient may cough and choke a little, but if no attempt is made to make him inhale a strong vapour before he is at least semi-unconscious, this will generally pass off and, if the administration is judiciously conducted, anæsthesia will be complete in about five minutes. When the patient is once under, less ether need be given, and a breath of air—one inspiration—should be allowed in every five breaths, the ensuing expiration being caught in the bag so as to maintain a supply of air which is not carbonised. The inhaler can be kept applied by means of one hand, the thumb and forefinger of that hand grasping the face-piece, while the remaining fingers lie over the vertical ramus of the patient's jaw, drawing it forwards.

Mixtures of Ether and Chloroform.

The use of a mixture of alcohol, chloroform, and ether, known as ACE., has been much advocated as a substitute for chloroform or ether alone, but this combination cannot be considered an ideal one, as the alcohol evaporates at a much slower rate than chloroform or ether, and the lint or sponge becomes saturated with it, and refuses to take up any chloroform or ether. The most useful mixture is chloroform, one part, and ether, two parts, which, for convenience, may be called CE. mixture. It is an excellent anæsthetic for all classes of patients except the worst of alcoholics and drug takers. It is best given on a Rendal's mask made of celluloid, or a cone of metal, like Blake's inhaler, with flannel or sponge inside to take up the anæsthetic.

The signs of anæsthesia are almost identical with those where chloroform is employed, except that the breathing is more vigorous in type. It is important to bear in mind, however, that the mixture is weak chloroform and not strong ether, and that it must on no account be given in a close inhaler with the bag. It is quite permissible, however, to give it in a Clover's inhaler *without* the bag, and this method has been largely used.

Ethyl Chloride.

In 1896 Carlson of Gothenburg drew attention to the fact that ethyl chloride possesses general as well as local anæsthetic properties. Since then it has been increasingly used for general anæsthesia, and is now regarded as a safe and reliable anæsthetic for minor operations. It is sold under such names as "Kelene," "Narcotile," and "Somnoform," this last being a mixture of ethyl and methyl chloride with 4 per cent. of ethyl bromide, but a pure preparation of ethyl chloride is best. The dose varies from three to seven cubic centimetres according to circumstances. It can be administered by spraying it into the bag of a Clover's inhaler and attaching the face-piece, or one of the numerous special inhalers may be employed. Anæsthesia is induced in about sixty seconds, and lasts for from one to two minutes after a single administration, but the anæsthesia can be kept up by frequently repeated doses. The drug is a very rapidly acting anæsthetic, and has a not unpleasant odour. It compares favourably with nitrous oxide in these respects, and cyanosis is not a necessary accompaniment. It is a useful anæsthetic for all brief operations, and for inducing anæsthesia prior to the administration of chloroform for prolonged operations.

Difficulties arising during Anæsthesia.—The difficulties arising during the administration of an anæsthetic are due either to depression or failure of the circulation, or to embarrassment of the respiration. Frequently these conditions co-exist, but it will be convenient to consider them separately.

Circulatory depression or failure may be due to the toxic action of the anæsthetic, or to some extrinsic cause, and not directly to overdose. For example, *syncope* may occur during the early stages of anæsthesia, and more particularly of chloroform anæsthesia, from cardiac inhibition due to reflex stimulation of the vagus from the use of too concentrated a vapour. Or syncope may occur later from absorption of an overdose which

causes paralysis of the cardiac centre in the medulla, and of the heart itself.

On the other hand cardiac failure may arise from purely extrinsic causes, the most important of which are—(1) fright, for example, at the very commencement of the administration; (2) sitting the patient up during the operation, or before he is quite free from the influence of chloroform; (3) reflex effect of nausea, or threatened vomiting; (4) shock from the operation, especially where the patient is already in an enfeebled condition.

The most prominent symptoms are pallor, often appearing very suddenly, rapid failure of the pulse and respiration, and wide dilatation of the pupils. The pulse and respiration may fail simultaneously or within a few seconds of one another. In the syncope which occurs during the early stages of anæsthesia, the onset is extremely rapid and recovery is rare. That which occurs later, after the operation is in progress, comes on more gradually, and treatment is more frequently successful.

Respiratory difficulty may be due to the toxic effect of the anæsthetic, that is to overdose, and is then often associated with cardiac failure. It may also be due to obstruction of the respiratory passages, for example, from—(1) spasm of the muscles at the base of the tongue, or falling back of the tongue; (2) spasm of the muscles of the jaw and neck; (3) spasm of the ary-epiglottic folds of the larynx; (4) general spasm of the respiratory muscles, including the intercostals; (5) the position of the patient, for example, the completely prone position; (6) foreign bodies entering the air-passages, such as vomited matter, blood-clot, accumulated mucus, or artificial dentures.

The characteristic symptoms are: increasingly stertorous breathing, duskiness of the lips, ears, and face, increasing to cyanosis. The chest continues to heave without air entering or leaving it, and unless the cause of obstruction be removed the patient becomes completely asphyxiated; the heart usually continues beating after the respiration has ceased.

Treatment.—From the point of view of treatment, patients in the conditions described above may be divided clinically into those who become pale, and those who become cyanosed.

In dealing with patients who have become *pale* from a circulatory failure or a combination of this with respiratory failure, the head should be lowered, and, in the case of children, the body may be completely inverted; the tongue is drawn out with forceps and held by an assistant, while artificial respiration is promptly carried out.

The movements must not be made more rapidly than in

normal respiration, that is, about eighteen or twenty to the minute. Care must be taken that the chest is firmly contracted by pressing the patient's elbows well into his sides, and then fully expanded by carrying the arms well above the head; an assistant or nurse should administer a hypodermic injection of strychnin, which may be supplemented with a dram of ether, while the introduction of about a pint of hot water into the rectum is often of great service. Rubbing the lips with a dry towel has a stimulating effect on the circulation and is useful in mild cases.

The application of the interrupted current has been of service. A flat plate electrode is placed under the nape of the neck, and a button or wire-brush electrode between the heads of the sterno-mastoid muscles. Actual puncture of the heart with a needle electrode has been suggested. In abdominal operations, if the abdomen has already been opened, the surgeon may pass in his hand and massage the heart through the diaphragm. The direct mechanical stimulation thus applied has sometimes been followed by good results. In desperate cases portions of the third and fourth ribs have been resected, exposing the pericardium, and through the opening thus made direct massage has been applied to the heart. In cases in which this has been employed the benefit has been only temporary.

Patients who *become blue or cyanosed* during anæsthesia do so as a rule from respiratory obstruction. A failing pulse may coexist: in the later stages and in more serious cases it always does. The cyanosis is more marked in the lips, ears, and malar prominences, and there is frequently masseteric spasm. The first thing to be done is to open the patient's mouth with a wooden wedge or a gag, and pull out the tongue. If this does not clear the air-way the finger should be swept round the fauces to ascertain if any solid matter be lying there. If there is nothing to be found, and if rhythmical traction on the tongue and compression of the chest fail to improve the respiration, tracheotomy or laryngotomy should be performed, and artificial respiration carried out by Sylvester's method. This should be kept up for over an hour, even if no signs of returning animation are evinced, and it may be supplemented with the hypodermic injection of ether or strychnin, and rectal injection of hot saline solution. Hot cloths applied over the heart may be of service, but we have known severe scalds to have been caused by using these at too high a temperature.

Local Anæsthesia.

Local anæsthesia may be employed in the great majority of minor operations, and for such operations as gastrostomy, colostomy, or herniotomy, where, on account of the weakness of the patient, it is deemed inadvisable to employ a general anæsthetic.

The methods of producing local anæsthesia are: by the application of drugs which produce analgesia by acting on the nerve endings; and by freezing the part.

The Local Application of Drugs.—Cocain, eucain (alpha and beta), tropa-cocain, and acoin, have all been used for this purpose, and it has been found that the addition of adrenalin to any of these intensifies and prolongs the local action, and diminishes the risk of absorption of the drug. Cocain hydrochlorate is that most commonly employed, but great care is always required in using it. Patients vary widely in their tolerance of the drug, and some regions of the body are much more absorptive than others and will only stand weak solutions. For instance, for the bladder the solution should not be stronger than 2 per cent.; for the urethra 4 per cent.; for the female genital organs or rectum 5 per cent. For the eye a solution of from 1 to 5 per cent. may be employed; for the nose and tonsils 2 to 20 per cent., and for the buccal mucous membrane 5 to 10 per cent. Not more than one-third of a grain of cocain should be injected into any region at one time, and not more than two-thirds of a grain applied to any mucous membrane.

The methods of application commonly used are—(1) instillation, for the eye or ear; (2) spraying, for example, into the throat or mouth, (3) painting or swabbing may also be used in these regions. (4) Endermic and hypodermic injection is probably the method most generally employed, and that from which the most satisfactory results are obtained.

The endermic or *infiltration method of Schleich* consists in the injection of a very dilute solution of cocain, usually combined with morphin and adrenalin, into the true skin, but not beneath it. In this way, by repeatedly inserting and reinserting the needle, the drug is brought into direct contact with the nerve filaments over a large area of skin, and practically no constitutional effect is produced.

A solution of medium strength, consisting of 1 grain of cocain hydrochlorate, $\frac{1}{5}$ grain of morphin hydrochlorate, and 2 grains of sodium chloride, with two ounces of distilled water, is that found most generally useful.

The skin having been thoroughly purified, the needle of a strong hypodermic syringe, charged with the solution, is entered obliquely, and carried for its entire length into the Malpighian layer. A few drops of the solution are forced out, and a white wheal like a mosquito bite about half an inch in diameter is formed, and the area occupied by the wheal at once becomes analgesic. At the margin, the needle is reinserted, more fluid injected, and the process repeated until the whole area is infiltrated.

The skin remains analgesic for about twenty minutes. Fasciæ, muscles, and periosteum can be rendered insensitive in the same way. In dealing with an abscess, the injection must be made into the abscess wall, not into the cavity.

Oberst's regional anæsthesia is well adapted for operations on the fingers, toes, and extremities generally. It consists in first arresting the circulation of the part by a rubber band, and then injecting a 1 per cent. solution of cocain or eucain round the nerves of supply, so that the whole part is rendered completely anæsthetic and the constitutional effects are avoided.

The symptoms of cocain poisoning are headache, vertigo, pallor, cold, clammy skin, feeble, rapid pulse, slow, shallow breathing, nausea and vomiting, tremors in the limbs, and loss of consciousness. If these symptoms appear the patient must be placed in the supine position and artificial respiration be carried out. An alcoholic stimulant should be administered, and the patient surrounded with hot bottles.

Local Anæsthesia produced by the Application of Intense Cold.—This is most commonly done at the present day by means of the ethyl chloride spray, and the method is a very rapid and convenient one. For this purpose the drug is put up in glass or metal cylinders, the exit of which is of a finer bore than that of the cylinders employed for general anæsthesia. Ethyl chloride for local anæsthesia is commonly mixed with a proportion of methyl chloride which renders it more volatile.

Mode of Application.—The cylinder is held at a distance of from eight to ten inches from the patient's skin, and a fine spray projected on to the area of skin to be incised. After a few seconds the skin becomes hard and white in round patches which coalesce as it freezes, and it remains insensitive for some three or four minutes. Only short operations can be carried out under the anæsthesia provided by this method, for example, the incision of an abscess or whitlow, or the insertion of an aspirator needle.

INDEX.

Abdominal abscess, 474
viscera, subcutaneous injuries of, 310. *See also* individual viscera
wall, abscess of, 315
contusion of, 310
fibroma of, 316
hæmatoma of, 310
inflammation of, 314
lipoma of, 315
rupture of muscles of, 310
stabs of, 313
surgical anatomy of, 307
Abducens nerve, 62
Abnormal anus, 449
Abscess. *See also* individual regions and organs
abdominal, 474
alveolar, 142
cold, of belly, 331
dorsal, 94
ischio-rectal, 515
lumbar, 95
pelvi-rectal, 516
perianal, 514
perinephric, 315, 576
psoas, 95
retropharyngeal, 92, 139, 140, 177
subgluteal, 95
subphrenic, 335, 347, 402
tropical, of liver, 458
ACE. mixture, 698
Acoin-anæsthesia, 702
Actinomycosis. *See* individual regions and organs
Adenoids, 136, 208
Adrenal tumours, 578
Adrenalin in anæsthesia, 702
Air sinuses, accessory, affections of, 206
Albuminuria, 541
Alcoholic poisoning, 23
Alveolar abscess, 142
process, tumours of, 146
Amazia, 286
Anæsthesia, general, 694
local, 694, 702
freezing, 703
Anæsthetics, 694
choice of, 695. *See also* individual anæsthetics
preparation of patient for, 694
Anal canal, 501
absence of, 503
development of, 502
malformations of, 503
fissure, 521
Aneurysms. *See* individual regions and organs
Angina Ludovici, 161, 178, 222
Ano-rectal fistulæ, 517
syphiloma, 510
Anorchism, 655
Anosmia, 207
Antrum of Highmore, suppuration in, 206
Anuria, 541
calculous, 572
Anus, 501
abnormal, 449
abscesses, 573
artificial, 449
epithelioma of, 535
imperforate, 504, 505
occlusion of, 503
surgical anatomy of, 501
Aphonia, 253
Apoplexy, 23
traumatic, 25

Appendicitis, 340
abscess in, 343, 346, 347
clinical features of, 345
colic in, 353
concretions in, 341
foudroyant, 347
fulminating, 347
operation for, 349
pathological anatomy of, 341
pelvic, 340, 346
peritonitis, diffuse in, 344, 347
peritonitis, localised in, 343, 345, 346
recurrent, 352
retro-cæcal, 340, 346
within hernial sac, 386
Appendicular colic, 353
concretions, 341
Appendix, vermiform, acting as a band, 422
hernia of, 374, 385
surgical anatomy of, 340
Arthritis deformans. *See* individual Joints
Ascites, operation for, 462
tuberculous, 330
Aspermia, 692
Athelia, 286
Atlo-axoid disease, 92
Auditory nerve, 64
Aural polypi, 186
Auricular appendages, 188
Avulsion of scalp, 4
Azoöspermia, 692

Bacteriuria, 541
Balanitis, 685, 689
Ballooned rectum, 512
Bands, peritoneal, 332, 421
Basedow's disease, 234
Bell's paralysis, 63
Bezold's mastoiditis, 194
Bilateral abductor paralysis, 65, 256
Bile-duct, common, obstruction of, 470
Bile-ducts, 456, 463
cancer of, 476
operations on, 468, 472, 474
stricture of, 473
surgical anatomy of, 463
Bilharzia hæmatobia, 611
Biliary calculi, 465
Biliary colic, 324, 348, 466
recurrent, 467
Biliary fistulæ, 317, 474
Black-eye, 41, 122
Bladder, 583
animal parasites, 610
cancer of, 608
cysts of, 610
dermoid cysts of, 610
diverticula of, 610
drainage of, 595, 597
examination of, 584
cystoscopic, 543
extroversion of, 585
fasciculated, 593
foreign bodies in, 590
functional disturbances of, 611
hernia of, 386, 388
hydatid cysts of, 610
hysterical affections of, 612
inflammation of, 591. *See also* Cystitis
instillation of, 597
irrigation of, 597
malformations of, 585
neuropathic affections of, 611
over-distended, 585
papilloma of, 607
penetrating wounds of, 590
pouches of, 610
rupture of, 311
extra-peritoneal, 588
intra-peritoneal, 587
sarcoma of, 609
sounding for stone, 603
"stammering," 612
surgical anatomy of, 583
suture of, 590
tuberculosis of, 598
tumours of, 607, 608
villous growth of, 607
Blepharospasm, 64
Bougies, 642, 643
iodoform, 636
Brachial plexus, injuries of, 218, 222
Brain, abscess, pathology of, 44
clinical features of, 47
anatomy of, 9
compression of, 16, 20
concussion of, 16
contusion of, 24
diseases of, 43
functions of, 9
laceration of, 24
membranes of, 8
pyogenic diseases of, 43

Brain, tumours, 58
wounds of, 29
Branchial carcinoma, 214, 225
cysts, 214, 223
fistulæ, 213
Breast, 284
abscesses, 290, 291, 592
actinomycosis of, 295
areola. *See* Nipple
cancer. *See* Tumours of breast
cysts of, 296
diffuse hypertrophy of, 286
examination of, 285
excision of, 304
inflammation of. *See* Mastitis
lymphatics of, 285
malformations of, 286
milk engorgement, 289
multiple cystic disease, 293
neuralgia of, 295
nipple. *See* Nipple
physiological engorgement of, 289
surgical anatomy of, 284
tuberculosis of, 294
tumours of, 304
cancer, acute, 304
adeno-carcinoma, 304
colloid, 303
encephaloid, 304
en cuirasse, 303
medullary, 304
öophorectomy in, 306
carcinoma, 300
cysto-adenoma, 297
proliferous, 297
duct papilloma, 299
fibro-adenoma, 297
irremovable, 305
sarcoma, 299
scirrhus, 300
atrophic, 303
Bronchi, 249
foreign bodies in, 260
Bronchiectasis, 279
Bronchocele, 228
Bronchoscopy, 250, 261
Bubonocele, 367

Cachexia strumipriva, 232
Cæcum, hernia of, 374, 385
Calculus, anuria from, 572
biliary, 465
in bladder. *See* Calculus, vesical
cutting for stone, 606
Calculus, cystin, 566
in kidney, 565, 568, 572
latent, 568
mulberry, 566, 601
oxalate of lime, 566, 601
pancreatic, 481, 484
phosphatic, 566, 600
preputial, 686
prostatic, 624
renal, bilateral, 572
secondary, 565, 603
urates, 566
in ureter, 565
urethral, 624, 632
uric acid, 566, 600
urinary, 565, 600
vesical, 600
encysted, 602
examination for, 603
on foreign body, 591
hour-glass, 601
operations for, 604
recurrent, 607
sounding for, 603
X-rays in diagnosis of, 570, 591, 604
Cancer. *See* individual regions and organs
Cancer en cuirasse, 303
Castration for enlarged prostate, 624
Cathcart's bladder drainage apparatus, 595
Catheter fever, 648
life, 622
Catheters, 585
prostatic, 622
Cephal-hæmatoma, 2
Cephal-hydrocele, traumatic, 56
Cephaloceles, 54
Cerebellar abscess, 45, 50, 51
Cerebral abscess, 44, 45
embolism, 23
hyperpyrexia, 20
irritation, 19, 24
localisation, 12
œdema, 29
softening, 30
tumours, 58
Cerebro-spinal fluid, 9
Cervical auricles, 214
caries, 92
fascia, 213
ribs, 225
sympathetic, 66, 235

Chest, 262
surgical anatomy of, 262
thoracic viscera, injuries of, 267
wall, cold abscess of, 272
contusions of, 263
diseases of, 272
fractures of, 263
gummata of, 272
injuries of, 263
sinuses in, 272
tumours of, 272
wounds of, 263
Cholæmia, 457
Cholangitis, 471
Cholecyst-enterostomy, 474
Cholecystectomy, 468
Cholecystitis, 467, 468, 470
Cholecystotomy, 468
Choledoch-enterostomy, 474
Choledochotomy, 472
Cholelithiasis, 465
Cholesteatoma, 193
Chloroform, 696
CE. mixture, 698
Chordee, 635
Circumcision, 686
Cirsoid aneurysm scalp, 7
Cleft palate, 114-116
Clergyman's throat, 134
Closure of jaw, 158
Cocain-anæsthesia, 702
poisoning, 703
Coccygodynia, 100
Coin-catcher, 240
Colectomy, 412
Colic, appendicular, 353
biliary, 324, 348, 466
renal, 324, 348, 568
Colitis, intractable, 447
Colon "idiopathic dilatation" of, 436
pelvic, 425
Colopexy, 414, 539
Colostomy, 412, 535
Coma, 23
Compression of brain, 16, 20
Concussion of brain, 16
of spinal cord, 72
Constriction groove, intestine, 360
Contusions. *See* individual regions and organs
Cord. *See* Spinal cord and Spermatic cord
Coryza caseosa, 204
Costal cartilages, fracture of, 265
Cranial nerves, affections of, 60. *See* individual nerves
Cranium, 8. *See* Skull
Crateriform ulcer, 302
Cretinism, 227
Cryoscopy, 545
Cryptorchism, 656
Cut-throat, 219
Cystic duct, cancer of, 476
fistula of, 475
stones in, 466
stricture of, 473
Cystitis, 591
gangrenous, 593
gonorrhœal, 598
in lesions of spinal cord, 598
membranous, 593
tuberculous, 598
typhoid, 598
Cystocele, 386
vaginal, 388
Cystoscope, 543
Cystotomy, 597
Cysts. *See* individual regions and organs
Czerny-Lembert suture, 391

"Dangerous area" of scalp, 3
Deafness, 182, 183
Decortication of lung, 278
Deformities. *See* individual regions
Dental caries, 141
Dentigerous cyst, 150
Dermoid cysts. *See* individual regions and organs
Diabetic coma, 23
Diaphragm, injuries of, 281
perforations of, 282
subphrenic abscess, 335
Diaphragmatic hernia, 420
pleurisy, 282, 325, 348
Diphtheria of larynx, 254
Diplacusis, 183
Dislocation of ribs, 265
of testis, 659
Divarication of recti muscles, 381
Diverticula of bladder, 610
Diverticulum, Meckel's, 316
Dorsal abscess, 94
Duodeno-choledochotomy, 472
Duodenum, surgical anatomy of, 390, 410
ulcer of, 348, 396
Dysentery, 446

Dysphagia, 245, 254

Ear, 182
auricular appendages, 188
cardinal symptoms of disease of, 183
earache, 183
external, eczema of, 190
deformities of, 188
tumours of, 189
foreign bodies in, 191
furunculosis of, 191
hæmatoma auris, 189
hearing tests, 185
impairment of hearing, 183
inspection of, 185
middle, acute inflammation of, 192
chronic suppuration in, 193
inflation of, 186
rupture of membrane, 192
noises in, 183
otorrhœa, 185
outstanding, 188
surgical anatomy of, 182
vertigo, 184
wax in, 189
Earache, 183
Echinococcus hominis, 611
Ectopia testis, 656
vesicæ, 585
Ectopic gestation, 325, 348, 495
rupture of, 495, 497
Elephantiasis of scrotum, 652
Emphysema of scalp, 7
surgical, 268, 270
Empyema, 274
bilateral, 277
chronic, 277
encysted, 274
of gall-bladder, 469
mixed infections in, 275
old standing, 277
pneumococcal, 275
pyogenic, 274
with sinuses, 277
streptococcal, 275
tuberculous, 277
Encephalitis, 44
Encephalocele, 55
Ensiform cartilage, fracture of, 266
Enterectomy, 412, 436
Entero-anastomosis, 412, 436
Enterocele, 356
Enteropexy, 414
Enteroplasty, 414, 435
Enteroptosis, 454
Enterostomy, 412, 436
Entero-teratoma, 316
Enterotome, 452
Enterotomy, 411
Enterotribe, 413
Enuresis, 612
Epididymis, 653. *See also* Testis
atrophy of, 676.
cysts of, 671
hæmatocele, encysted, 671
hydrocele, encysted, 671
surgical anatomy of, 653
syphilitic affections of, 666
tuberculosis of, 664
Epididymitis, 661
acute, 661, 662
chronic, 663
gonorrhœal, 662
relapsing, 663
"see-saw," 663
syphilitic, 668
following injury of urethra, 663
Epididymo-orchitis, 661
Epigastric hernia, 381
Epilepsy, Jacksonian, 30
traumatic, 30
Epileptic coma, 23
Epiplocele, 356
Epispadias, 586, 629
Epistaxis, 205
Epulis, 146
Erectile swelling in nose, 202
Erysipelas of scalp, 5
Estländer-Schede operation, 278
Ether, 697
Ethmoid cells, suppuration in, 207
Ethyl chloride, 699
Eucain-anæsthesia, 702
Eustachian catheter, 187
Eventration of bowel, 326
Exclusion of intestine, 413
Extra-uterine gestation, 325, 348, 495
rupture of, 495, 497
Extravasation of urine, 630, 647
Eyeball, foreign bodies in, 124
injuries of, 123

Face, cicatricial contraction, 121
congenital malformations, 113, 120
development of, 113
injuries of, 120
tumours of, 121

Facial cleft, 120
nerve, 63
paralysis, 63, 193
spasm, 64
Fæcal accumulation, 443
fistula, 318, 332, 347, 351, 449
Fat necrosis, 479
Fauces, 133
epithelioma of, 138
tuberculosis of, 138
Femoral hernia. *See* Hernia
Fibroids, uterine, 498
Filaria sanguinis hominis, 610, 679
Fissure, anal, 521
Fistula-in-ano, 517
Fistula, biliary, 317, 474
branchial, 213
fæcal, 318, 332, 347, 351, 449
gastric, 401
internal, 453
intestinal, 449
recto-urethral, 505
recto-vaginal, 505
recto-vesical, 505
umbilical, 317
urethral, 647
urinary, 317, 647
Fixation of jaw, 158
Foreign bodies. *See* individual regions and organs
Four-tailed bandage, 154
Fracture, costal cartilages, 265
ensiform cartilage, 266
hyoid, 218
laryngeal cartilages, 218
nasal bones, 197
penis, 688
ribs, 263
spine, 82
sternum, 265
tracheal cartilages, 219
Freezing-point of blood, 545
Frog-face, 210
Frontal sinus, suppuration in, 207
Fungus testis, 666, 668, 670
Funiculitis, 661
Furunculosis of ear, 191

Galactocele, 296
Gall-bladder, 463
adhesions, 473
cancer of, 476
distension of, 475
empyema of, 469
Gall-bladder, inflammation of, 467, 468, 470
injuries of, 464
operations on, 468, 472, 474
purulent catarrh of, 469
stones in, 466
surgical anatomy of, 463
Gall-stone colic, 466
ileus, 432, 474
Gall-stones, affections due to, 465
Gangrene of lung, 279
Gastrectasis, 409
Gastrectomy, 407
Gastric fistula, 401
ulcer, 348, 396
perforation of, 398
operation for, 400
Gastro-anastomosis, 404
Gastro-duodenostomy, 393
Gastro-enterostomy, 393
Gastro-jejunostomy, 393
Gastropexy, 408
Gastroplasty, 404
Gastroplication, 409
Gastroptosis, 408
Gastrorrhagia, 397
Gastrostomy, 392
Gastrotomy, 391
Genital organs, female, 488
male, 650
functional disturbances of, 692
Gingivitis, 142
Girdle pain, 78
Gleet, 635, 637
Glénard's disease, 454, 462
Glossitis. *See* Tongue
Glosso-pharyngeal nerve, 64
Goitre, 228
adenomatous, 232
exophthalmic, 234
intra-thoracic, 229, 231
malignant, 233
parenchymatous, 229
thyroidectomy for, 231
Gonococcus, 633
Gonorrhœa, 633
abortive treatment of, 636
complications of, 637
cystitis in, 598
in female, 638
prostatitis in, 615
pyæmia in, 637
spurious, 633
Gouty orchitis, 664

Grave's disease, 234
Gravitation paraplegia, 74
Gubernaculum testis, 655
Gums, epithelioma of, 143
epulis, 146
gum-boil, 142
hypertrophy of, 143
inflammation of, 142
polypus of, 143
pyorrhœa alveolaris, 143
Gunshot wounds. *See* individual regions and organs
Gynecology, 488
Gynecomastia, 287
Gynecomazia, 287

Hæmatocele, 683
Hæmatoma auris, 189
of scalp, 2
Hæmatomyelia, 75
Hæmatorrachis, 74
Hæmaturia, 541, 581
Hæmophilia, renal, 581
Hæmoptysis, 253, 268
Hæmorrhage. *See* individual regions and organs
Hæmorrhoids, 522. *See also* Piles
Hæmothorax, 267, 270
Hahn's operation, 403
Hair-balls in stomach, 395
Hammer nose, 199
Hammond's splint, 154
Hare-lip, 114
Head injuries, 15
after-effects of, 30
Heart, injuries of, 280
Hemi-glossitis, 161
Hepatic abscess, 347
duct, cancer of, 476
Hepatopexy, 462
Hepatoptosis, 462
Hernia, 355
of appendix, 374, 385
of bladder, 386
of cæcum, 374, 385
in canal of Nuck, 370
cerebri, 53
congenital, 356, 369
crural, 375
diaphragmatic, 420
encysted, 370
epigastric, 381
extra-parietal, 373
false reduction of, 364
Hernia, femoral, 375
surgical anatomy of, 375
hydrocele of sac, 356
incarcerated, 359
infantile, 370
inflamed, 359
inguinal, 367
in children, 374
direct, 367, 371
external, 367
into funicular process, 369
internal, 367
oblique, 367, 368
surgical anatomy of, 367
internal, diaphragmatic, 420
intersigmoid, 421
into foramen of Winslow, 421
into fossa duodeno-jejunalis, 421
pericæcal,
inter-parietal, 373
interstitial, 373
intra-parietal, 373
irreducible, 358
labial, 367, 369
in linea alba, 381
in linea semilunaris, 382
Littré's, 356
lumbar, 383
of lung, 271
obstructed, 359
obturator, 384
of omentum, 361, 363
operative treatment of, 365, 372, 381
of ovary, 386
pro-peritoneal, 373
radical cure of, 372
reducible, 357
reduction "*en bloc*," 364
with retention of testis, 370
Richter's, 356, 362, 377
scrotal, 367
of sigmoid flexure, 386
strangulated, 359, 375, 377, 385, 420
testis, 666, 668, 670
tuberculosis of sac, 375
umbilical, 378
of adults, 379
of cord, 378
of infants, 379
operation for, 381
ventral, 332, 351, 381, 382
Herniotomy, 365

Histrionic spasm, 64
Hoarseness, 253
Hospital sore-throat, 133
Hour-glass stomach, 403
Hydatid cysts. *See* individual regions and organs
Hydrencephalocele, 55
Hydrocele, 678
  acquired, 679, 680
  acute, 662, 678
  bilocular, 681, 683
  of canal of Nuck, 369
  chylous, 679
  chronic, 679
  congenital, 679, 683
  en bissac, 681, 683
  fluid, 679
  of hernial sac, 356, 683
  infantile, 679, 683
  of neck, 224
Hydrocephalus, 56
Hydro-hæmatocele, 683
Hydronephrosis, 555
  closed, 557, 558
  infected, 563
  intermittent, 556, 559
  open, 557
  permanent, 556
  traumatic, 555
Hydro-pneumothorax, 274
Hydrothorax, 273
Hygroma of neck, 224
Hyoid, fracture of, 219
Hyperæsthesia acustica, 183
Hypoglossal nerve, 66
Hypospadias, 627
Hysterectomy, 500
Hysterical aphonia, 253
  spine, 98
  wry-neck, 217
Hystero-myomectomy, 500

Ileo-cæcal tumour, tuberculous, 447
Ileostomy, 412
Ileum, osteomyelitis of, 348
Ileus, 415
Impotence, 692
Incontinence of urine, nocturnal, 612
Indian operation, 199
Inflammation. *See* individual regions and organs
Inguinal hernia. *See* Hernia
Insanity, traumatic, 32
Internal fistulæ, 453
Intestinal fistulæ, 449
  obstruction, 415
    acute, 417
    chronic, 418
    chronic ending acutely, 419
  sutures, 390
Intestine, 410
  actinomycosis of, 449
  adenoma of, 453
  bacteriology of, 411
  carcinoma of, 437
  congenital malformations of, 436
  constriction groove, 360
  dysentery, 446
  end-to-end suture of, 412
  eventration, 326
  examination of, 411
  exclusion of, 413
  fæcal accumulation in, 443
  fibroma of, 454
  gall-stone ileus, 432
  Glénard's disease, 454
  injuries of, 414
  intractable colitis, 447
  lateral anastomosis of, 413
  lipoma of, 454
  obstruction by adhesions, 424
    from foreign bodies, 432
    by kinking, 424
    by contraction of mesentery, 425
    by pressure, 442
  operations on 411. *See also* individual portions of intestine
  perforation of typhoid ulcer, 445
  polypus of, 453
  rupture of, 311
  sarcoma of, 442
  short-circuiting of, 413
  stenosis of, 366
  strangulation through apertures 421, 423
    by bands, 421
  stricture, malignant, 437
    simple, 360, 434
    tuberculous, 447
  surgical anatomy of, 410
  tuberculosis of, 447
  tumours of, 453
Intubation of larynx, 252
  of œsophagus, 243, 245
Intussusception, 427
  acute, 429
  chronic, 431
  in adults, 432

Intussusception, ileo-cæcal, 348
inflation in, 430
operation for, 430
varieties of, 427
Involution cysts of breast, 296
Ischio-rectal abscess, 515
Ischuria paradoxa, 611
Italian operation, 199

Jaw, lower. *See also* Temporo-maxillary articulation
dentigerous cyst of, 150
dislocation of, 155
epithelioma of, 151
excision of, 151
fixation of, 158
fracture of, 153
mandibular cleft, 120
myeloma of, 150
sarcoma of, 150
tumours, simple, of, 150
upper, carcinoma of, 149
excision of, 148
fracture of, 152
sarcoma of, 147
tumours, simple, of, 150
Jaws, 143
actinomycosis of, 145
acute osteomyelitis of, 144
alveolar process, tumours of, 146
cancrum oris, 144
inflammation of, 143
injuries of, 152
necrosis of, 145
phosphorus necrosis of, 144
syphilis of, 145
tuberculosis of, 145
Jejunostomy, 412

Kidney, 540
absence of, 546
accessory adrenal tumours, 578
arrested development of, 546
calculous diseases of, 565
cancer of, 577
colic, 568
congenital anomalies of, 546
contusion of, 551
cystic degeneration of, 580
cysts of, 577
hydatid, 581, 611
solitary, 579
displacement of, 546, 547
dystopia, 546
Kidney, examination of, 541
fibro-lipomatous, 567
floating, 547
fœtal lobulation of, 546
functional adequacy of, 545
gunshot wounds of, 314
horse-shoe, 546
inflammation of, 581
innocent tumours of, 577
movable, 547
"one-kidney urine," 543
operations on, 545, 546, 550, 561, 571, 576
pelvis, tumours of, 579
polycystic, 580
pyogenic infections of, 561
resection of, 545
rupture of, 551
sarcoma of, 577
stone in, 565
surgical, 562
surgical anatomy of, 540
tuberculosis of, 573
tumours of, 577
wandering, 547
wounds of, 554
Kraske's operation, 533
Kryoscopy, 545
Kyphosis, 111

Laminectomy, 71
Laryngectomy, 252
Laryngitis, 254
Laryngotomy, 251
Laryngo-tracheotomy, 252
Larynx, 249
artificial, 253
cancer of, 258
cardinal symptoms of affections of, 253
diphtheria of, 254
examination of, 249
excision of, 252
foreign bodies in, 259
fracture of, 218
inflammation of, 254
intubation of, 252
œdema of, 255
papilloma of, 257
sarcoma of, 259
syphilitic affections of, 256
tuberculosis of, 257
tumours of, 257
Lembert's suture, 391

Lepto-meningitis, 44
Leucocythæmia, spleen in, 486
Leuco-keratosis, 162
Leucoplakia, 162, 691
Lingual nerve, resection of, 170
Lip, chancre of, 127
  epithelioma of, 129
  hare-lip, 114
  macrocheilia, 128
  mucous cysts of, 129
  strumous, 127
  tumours of, 128
Lipoma nasi, 200
Lipomatosis of neck, 225
Lipopædion, 496
Lithopædion, 496
Litholapaxy, 604, 606
Lithotomy, 606
  lateral, 607
  perineal, 607
  supra-pubic, 606
Lithotrite, 605
Lithotrity, perineal, 606
Littré's hernia, 356
Liver, 456
  abscess of, 458
  cancer of, 461
  cirrhosis, operation for, 462
  deformities of, 461
  dislocated, 462
  displacements of, 461
  gumma of, 461
  gunshot wounds of, 314
  hydatids of, 460
  injuries of, 457
  operations on, 462
  polycystic disease of, 580
  prolapse of, 462
  rupture of, 311, 457
  sarcoma of, 461
  surgical anatomy of, 456
  tumours, innocent, of, 461
  wandering, 462
  wounds of, 457
Lordosis, 112
Loreta's operation, 403
Lumbar abscess, 95
  hernia, 383
Lung, abscess of, 279
  cavities, 278
  contusion of, 269
  decortication of, 278
  gangrene of, 279
  hernia of, 271
Lung, hydatid cysts of, 279
  injuries of, 269
  laceration of, 269
  operations on, 279
  wounds of, 269, 270
Luschka's tonsil, 208

M'Burney's point, 340
Macrocheilia, 128
Macroglossia, 172
Macrostoma, 120
Malarial spleen, 486
Malformations. *See* individual regions and organs
Mamma. *See* Breast
Mandibular cleft, 120
Mastitis of adolescents, 289
  chronic circumscribed, 293
    interstitial, 292
    lobular, 293
  neonatorum, 289
  of pregnancy, 289
  puerperal, 290
Mastodynia, 295
Mastoid operations, 195
  suppuration, 194
Mastoiditis, acute, 194
  Bezold's, 194
Maxilla, inferior. *See* Jaw, lower
  superior. *See* Jaw, upper
Meckel's diverticulum, 316, 356, 422
Mediastinitis, 282
Meninges, diseases of, 43
Meningitis, pathology of, 44
  clinical features of, 47
Meningocele, 55
  spinal, 101
Meningo-myelocele, 102
Mercurial stomatitis, 132, 162
Mesenteric blood-vessels, thrombosis of, 444
  cysts, 334
  glands, abscess of, 335
    tuberculous, 335
  tumours, 333
Mesentery, prolapse of, 357
  rupture of, 311
Microcephalus, 58
Micromazia, 286
Microstoma, 120
Middle ear disease. *See* Ear, middle
Middle meningeal hæmorrhage, 26
Monorchism, 655
Motor areas, 9

Mouth, affections of roof of, 132
epithelioma of, 138
inflammation of, 131
Mumps, 176
orchitis in, 664
Myelitis, 89
Myelocele, 102
Myomectomy, 500
Myxœdema, 227, 232

Nasal affections. *See* Nose
bones, fracture of, 197
Naso-pharyngeal tonsil, 208
tumours, 210
Naso-pharynx, 197
Neck, 212
actinomycosis of, 223
boils, 223
branchial carcinoma, 214, 225
bursal swellings, 224
carbuncles, 223
cellulitis, diffuse, 161, 178, 222
cervical auricles, 214
cicatricial contraction, 217
contusion of, 218
cystic lymphangioma, 224
cysts, blood, 224
branchial, 214, 223
fracture of hyoid, etc., 218
hydrocele of, 224
hygroma of, 224
injuries of, 218
lipomatosis of, 225
malformations of, 213
surgical anatomy of, 212
tumours of, 224
wry, 214
Necrosis, phosphorus, of jaw, 144
Nephrectasis, 555
Nephrectomy, 546
subcapsular, 576
Nephritis, operative treatment of, 582
surgical aspects of, 581
Nephro-lithiasis, 565
Nephro-lithotomy, 546, 571
Nephropexy, 545, 550
Nephroptosis, 547
Nephrorraphy, 545
Nephrostomy, 545, 561
Nephrotomy, 545
Nerve roots, injuries of, 79
Nerves. *See* individual nerves
Neuralgia, testis, 675
of tongue, 172
Nipple, absence of, 286
cracks of, 287
depressed, 287
fissures of, 287
Paget's disease of, 288
primary chancre of, 288
supernumerary, 286
tumours of, 289
Nocturnal incontinence of urine, 612
Nose, 197
accessory air sinuses of, 206
anomalies of smell, 207
bleeding from, 205
calculi in, 204
carcinoma of, 203
cardinal symptoms of nasal affections, 201
deformities of, 198
discharge from, 203
erectile swelling, 202
examination of, 200
foreign bodies in, 204
fracture of, 197
hammer, 199
lipoma nasi, 200
obstruction of, 201
ozæna, 204, 205
polypi of, 202
potato, 199
saddle, 197, 198
sarcoma of, 203
septum, deviations of, 203
hæmatoma of, 203
spines and ridges of, 203

Oberst's anæsthesia, 703
Obturator artery, aberrant, 376
hernia, 384
Oculo-motor nerve, 62
Odontoma, 142
O'Dwyer's intubation tubes, 252
Œsophageal bougies, 237
Œsophagismus, 246
Œsophagitis, 241
Œsophagoscope, 237
Œsophagotomy, 241
internal, 243
mediastinal, 241
Œsophagus, 236
dilatation of, 247
diverticula of, 247
effects of caustics on, 238
examination of, 236
foreign bodies in, 239

Œsophagus, inflammation of, 241
intubation of, 243, 245
malformations of, 247
paralysis of, 247
rupture of, 241
spasm of, 246
"stammering," 246
stricture, cicatricial, 242
malignant, 244
spasmodic, 246
surgical anatomy of, 236
syphilitic affections of, 242
tuberculosis of, 241
tumours of, 246
varix of, 242
wounds of, 237
Oïdium albicans, 131
Olfactory nerve, 61
Oliguria, 541
Omental tumours, 334
Omentum, rupture of, 311
Öophorectomy in cancer of breast, 306
Opium poisoning, 23
Optic nerve, 61
Orbit, cellulitis of, 124
injuries of, 122
tumours of, 125
Orchitis, 661
acute, 661, 664
in gout, 664
gummatous, 667
in mumps, 664
Otitis media, 192
Otorrhœa, 185
Ovarian cyst, 330, 488
inflammation of, 490
rotation of pedicle of, 490
rupture of, 490
suppuration in, 490
tumours, 488
Ovariotomy, 491
Ovary, cyst-adenoma of, 488
dermoid cyst of, 489
hernia of, 386
papillary tumours of, 490
parovarian cysts, 489
Ozæna, 204, 205

Pachydermatocele, 6
Pachymeningitis, 44, 89
Paget's disease, 288
Palate, abscess, 132
cleft, 114-116
epithelioma, 138
Palate, gumma, 132
simple tumours, 133
tuberculosis, 133
Palpitis, 141
Pancreas, 478
calculi in, 481, 484
cancer of, 484
cysts of, 481
functions of, 478
inflammation of, 479
injuries of, 478
surgical anatomy of, 478
Pancreatitis, 325, 479
Paracusis of Willis, 183
Paraffin injection, 199
Paraphimosis, 687
Parosmia, 208
Parotid, carcinoma, 180
endothelioma, 179
fistula, 175
injuries, 174
mixed tumours of, 179
parotitis, 176, 177
sarcoma, 180
surgical anatomy, 174
tuberculosis, 178
Parotitis, 347
Parovarian cyst, 489
Patheticus nerve, 62
Pelvic colon, 425
Pelvi-rectal abscess, 516
Pelvis, 307
Penis, 685
balanitis, 689
cancer of, 690
cellulitis of, 689
chronic induration of, 690
cysts of, 690
fracture of, 688
gangrene of, 689
herpetic eruptions, 690
horns, 690
injuries of, 688
leucoplakia, 691
lymphangitis, 689
malformations of, 685, 688
papilloma of, 690
paraphimosis, 687
phimosis, 685
"ram's horn," 652
strangulation of, 688
surgical anatomy of, 685
Perianal abscess, 514
Pericardial effusions, 281

Pericystitis, 600
Perigastric abscess, 401
adhesions, 402
Perineal section, 645, 646
Perinephric abscess, 315, 376
Perinephritis, 576
Periodontitis, 141
Peri-œsophagitis, 241
Periproctitis, 509
Peritoneal bands and adhesions, 332, 342
septicæmia, 320-322
Peritoneum, 319
actinomycosis, 332
hydatid cysts, 334
malignant disease, 334
mesenteric cysts, 334
tumours, 333
omental tumours, 334
properties of, 308
retro-peritoneal tumours, 333
sensibility of, 309
surgical anatomy, 307
tumours of, 333
Peritonism, 345, 415
Peritonitis, 329
aseptic, 319
chronic, 329
cold abscess of belly, 331
diffuse, 321, 344, 347
generalised, 321
gonococcal, 328
"idiopathic," 321
localised, 327, 343, 345-346
pelvic, 329
pneumococcal, 328, 348
septic, 320
tuberculous, 329, 348
ascites, 330
Peri-urethral abscess, 637, 647
cellulitis, 646
Phantom tumours, 491
Pharyngitis, acute, 135
chronic, 134
Pharyngotomy, sub-hyoid, 250
Pharynx, 133
carcinoma, 244
epithelioma, 138
foreign bodies in, 239, 259
Phimosis, acquired, 686
congenital, 685
Phleboliths, 523
Phosphorus necrosis of jaw, 144
Phthisical cavities, lung, 279
Piles, 522, 525
"attack of," 525, 526
connective tissue, 528
clamp and cautery for, 527
dog-ear, 528
excision of, 526
external, 527
internal, 523
inflammation of, 525
strangulation of, 525
ligature of, 526
mixed, 523
sentinel, 521, 528
thrombotic, 528
venous, 528
Pleura, injuries of, 268
traumatic pleurisy, 269
Pleural effusions, 273
Pleurisy, 347
diaphragmatic, 282, 325, 348
Pneumatocele capitis, 7
Pneumogastric nerve, 65
Pneumonectomy, 279
Pneumothorax, 267, 270
Pneumotomy, 279
Politzer's infection of ear, 187
Polymastia, 286
Polymazia, 286
Polyorchism, 655
Polypus. *See* individual regions and organs
Polythelia, 286
Polyuria, 541
Post-anal dimple, 104
Potato nose, 199
Pott's disease of spine, 87
puffy tumour, 67
Preputial calculi, 686
Procidentia recti, 536
Proctectomy, 533
Proctitis, 508
Proctotomy, 513
Prolapse. *See* individual organs
Prostate, 614
abscess of, 615
calculi in, 624
cancer of, 625
enlargement of, 617
operations for, 624
examination of, 615
inflammation of, 615
injuries of, 615
middle lobe of, 618
sarcoma of, 625

Prostate, senile hypertrophy of, 617
surgical anatomy of, 614
tuberculous, 616
Prostatectomy, 623, 624
Prostatic catheters, 622
retention, 620
Prostatitis, 615, 616
Prostatorrhœa, 616
Psoas abscess, 95
Pulmonary abscess, 279
cavities, 278
Purse-string suture, 391
Pyæmia, gonorrhœal, 637
Pyelitis, 561
calculous, 571
Pyelo-nephritis, 561, 562
tuberculous, 573
Pyelophlebitis, 471
Pyelo-plication, 561
Pyelotomy, 545
Pylorectomy, 407
Pyloroplasty, 397, 403
Pylorus, obstruction of infants, 408
stenosis of, 403
surgical anatomy, 389
Pyonephrosis, 561, 563
calculous, 563-571
Pyorrhœa alveolaris, 143
Pyosalpinx, 348, 492

Quinsy, 135

"Railway spine," 73
Ranula, 179
Recto-urethral fistula, 505
Recto-vaginal fistula, 505
Recto-vesical fistula, 505
Rectum, 501
abscesses, 513
absence of, 504
adenoma of, 529
carcinoma of, 530
development of, 502
examination of, 502
excision of, 533
fistulæ, 517, 519
foreign bodies in, 507, 514
inflammation of, 508
injuries of, 506
malformations of, 503
malignant adenoma of, 530
papilloma of, 530
polypi of, 529
prolapse of, 536
Rectum, sarcoma of, 535
stricture of, 511
surgical anatomy of, 501
ulceration of, 509
dysenteric, 509
syphilitic, 510
tuberculous, 510
tumours of, 528
villous tumour of, 530
Recurrent fibroid of Paget, 316
Renal colic, 324, 348, 568
phthisis, 573
retention, 555
Retention of urine, 645, 648
Retro-peritoneal tumours, 333
Retro-pharyngeal abscess, 92, 139, 140, 177
Retzius, space of, 584
Rheumatic spondylitis, 98
Rhinitis, atrophic, 204, 205
Rhinoliths, 204
Rhinophyma, 199
Rhinoscopy, 200, 201
Ribs, dislocation of, 265
fracture of, 263
pyogenic diseases of, 272
tumours of, 273
Richter's hernia, 356
Risus sardonicus, 282
Rodent cancer, scalp, 7
Rupture. *See* Hernia

Sacral hygroma, 105
Sacro-coccygeal tumours, 104
Sacro-iliac disease, 96
Saddle nose, 197, 198
Salivary calculi, 176
fistula, 175
glands, cysts of, 179
surgical anatomy of, 174
tuberculosis of, 178
Salpingitis, 492
Salpingo-öophorectomy, 495
Saphena vein, pouching of, 377
Sarcoma. *See* individual regions and organs
Scalp, 1
aneurysms of, 7
avulsion of, 4
cephal-hæmatoma, 2
cirsoid aneurysm of, 7
cysts of, 6
"dangerous area," 3
diseases of, 5

Scalp, emphysema of, 7
erysipelas of, 5
hæmatoma of, 2
injuries of, 2
surgical anatomy of, 1
tumours of, 6
wounds of, 3
Schleich's anæsthesia, 702
Schwartze's operation, 194
Scoliosis, 106
Scrotum, 650
cancer of, 653
cellulitis of, 651
contusions of, 650
cysts of, 653
eczema of, 652
elephantiasis of, 652
fistulæ of, 652
gangrene of, 651
hæmatoma of, 650
lymph, 652
œdema of, 652
sinuses in, 652
surgical anatomy of, 650
tumours of, 653
wounds of, 650
Seminal vesicles, 676
inflammation of, 661, 676
"stripping" of, 678
surgical anatomy of, 676
tuberculosis of, 678
Septicæmia, peritoneal, 320, 322, 347
Sinus phlebitis, 46, 51
of individual sinuses, 51
thrombosis, 46, 51
of individual sinuses, 51
Skull, contusion of, 33
diseases of, 67
fractures of, 33
base of, 38
comminuted, 37
by *contre-coup*, 34
depressed, 37
fissured, 35
gutter, 37
indentation, 37
pond, 37
punctured, 36
of vault, 33
injuries of, 33
osteo-myelitis of, 67
periostitis of, 67
surgical anatomy of, 8
Skull, syphilis of, 68
tuberculosis of, 68
tumours of, 69
Smell, anomalies of, 207
Smoker's patch of tongue, 163
Socia parotidis, 174
Spastic paraplegia, 100
Speech centres, 12
Spermatic cord, 654. *See also* Vas deferens
atrophy of, 676
hydrocele of, 672
injuries of, 659
surgical anatomy of, 654
torsion of, 660
tumours of, 673
Spermatocele, 671
Sphenoidal cells, suppuration in, 207
Spina bifida, 101
occulta, 104
Spinal accessory nerve, 65
Spinal column. *See* spine
cord, 70
anatomy of, 11, 70
concussion of, 72
functions of 11, 71
injuries of, 72, 75
at different levels, 76
membranes of, 71
tumours of, 100
Spinal hæmorrhage, 74
meningocele, 101
nerves, 71
surgical anatomy of, 71
Spine, actinomycosis of, 98
acute osteo-myelitis of, 98
arthritis deformans of, 99
congenital deformities of, 101
deviations of, 106
diseases of, 87
dislocations of, 81, 85
fracture of, 82
dislocation of, 84
hydatid disease of, 98
hysterical, 98
injuries of, 80
kyphosis, 111
lordosis, 112
Pott's disease of, 87
"railway," 73
rheumatic, 98
scoliosis, 106
spondylitis deformans, 112
sprains of, 80

Spine, surgical anatomy of, 70
syphilitic disease of, 97
tuberculous disease of, 87
tumours of, 97
wounds, penetrating, of, 86
Splanchnoptosis, 454, 462
Spleen, 484
abscess of, 485
actinomycosis of, 486
dislocated, 486
enlargements of, 486
floating, 486
functions of, 484
gunshot wounds of, 314
hydatids of, 486
hypertrophy of, 486
in leucocythemia, 486
malarial, 486
operations on, 485, 486
polycystic disease of, 580
removal of, 485
rupture of, 311, 484
sarcoma of, 486
surgical anatomy of, 484
tuberculosis of, 486
wandering, 486
wounds of, 485
Splenectomy, 485
Splenomegaly, 486
Splenopexy, 486
Spondylitis deformans, 112
rheumatic, 98
traumatic, 83
Sprengel pump apparatus, 595
Stäcke's operation, 195
Staphylorraphy, 119
Status epilepticus, 31
Stenson's duct, 174
fistula of, 175
injuries of, 175
Stercoraceous vomiting, 362
Sterility, 692
Sternum, fracture of, 265
pyogenic diseases of, 272
tumours of, 273
Stomach, 389
carcinoma of, 405
contusion of, 393
dilatation of, 409
effects of caustics on, 395
fistula, 401
foreign bodies in, 395
hair-balls in, 395
hour-glass contraction of, 403
Stomach, operations on, 391, 404, 407, 408, 409
penetrating wounds of, 394
perigastric abscess, 401
adhesions, 402
prolapse of, 408
rupture of, 393
surgical anatomy of, 389
tumours of, 408
ulcer of, 396
ulcer-cancer of, 405
Stomatitis, 131
Stone. *See* Calculus
Strangulated hernia. *See* Hernia
Stricture of intestine, 434, 437
of œsophagus, 242, 244, 246
of urethra, 639
annular, 640
bridle, 640
callous, 640
cicatricial, 639
complications of, 645
congestive, 639
cylindrical, 640
dilatation of, continuous, 643
intermittent, 642
vital, 643
examination of, 642
gonorrhœal, 640
impermeable, 640, 645
inflammatory, 639
operative treatment of, 644
organic, 639
permeable, 640
resection of, 645
resilient, 640
spasmodic, 639
Subconjunctival ecchymosis, 40
Subgluteal abscess, 95
Sublingual gland, 174, 181
inflammation of, 178
ranula, 179
Submaxillary gland, 174
calculi in, 176
inflammation of, 178
periadenitis of, 178
tuberculosis of, 179
tumours of, 181
Subphrenic abscess, 335, 347, 402
Suction apparatus for bladder, 595
Sunken-bridge nose, 198
Supra-meatal triangle, 195
Surgical anatomy. *See* individual regions and organs

Sutures, intestinal, 390
Syme's excision of tongue, 169
Symond's intubation tube, 243, 246
Synorchism, 655
Syphilitic affections. *See* individual regions and organs
Syringo-myelocele, 102

Tabes mesenterica, 335
Tagliacotian operation, 199
Taste, anomalies of, 207
Taxis, 357, 363
Teeth, caries of, 141
  fracture of, 154
  periodontitis, 141
  pulpitis, 141
  tumours of, 142
Temporal bone, necrosis of, 193
Temporo-maxillary articulation, 155
  arthritis of, 157
  dislocation of, 155
  fixation of, 158
  subluxation of, 157
Temporo-sphenoidal abscess, 49, 50
Testis, 653. *See also* Epididymis
  atrophy of, 177, 676
  carcinoma of, 669
  congenital abnormalities of, 654
  contusion of, 659
  cystoma of, 670
  descent of, 655
  development of, 654
  dislocation of, 659
  hernia or fungus, 666, 668, 670
  imperfectly descended, 656
  injuries of, 658
  inflammatory affections of, 661
  internal secretion of, 657
  misplaced, 656
  neuralgia of, 675
  retained, 656
  retarded descent of, 655
  sarcoma of, 669, 671
  surgical anatomy of, 653
  syphilitic affections of, 666
  transit of, 655
  tuberculosis of, 664
  tumours of, 669, 671
  wounds of, 659
Tetany, 227, 232
Thoracic duct, injuries of, 222
  viscera, injuries of, 267
Thoracoplasty, 278
Thorax. *See* Chest
Thrush, 131
Thymus gland, 212
Thyro-glossal cysts, 170
  tumours, 170
Thyroid, 227. *See also* Goitre
  accessory, 227
  acute inflammation of, 228
  physiological hyperæmia, 227
  surgical anatomy of, 227
  syphilis of, 228
  tuberculosis of, 228
Thyroidectomy, 231
Thyroidism, acute, 232
Thyrotomy, 250
Tinnitus aurium, 183
Tongue, 160
  absence of, 171
  atrophy of, 172
  bifid, 171
  carcinoma of, 166
  cysts of, 170
  excessive length of, 172
  excision of, 168
  fissures of, 165
  gangrene of, 162
  glossitis, 161, 162, 165
  gummata of, 165
  hemiglossitis, acute, 161
  inflammation of, 161, 162, 165
  leucoplakia of, 162
  macroglossia, 172
  mucous patches, 164
  neuralgia of, 172
  papilloma of, 170
  paralysis of, 173
  primary sore on, 164
  sarcoma of, 170
  smoker's patch, 163
  spasm of, 173
  tongue-tie, 171
  tuberculosis of, 163
  tumours of, 166, 170
  ulcers of, 165
  wounds of, 160
Tonsil, 133
  calculi in, 136, 137
  hypertrophy of, 136
  inflammation of, 135
  Luschka's, 208
  naso-pharyngeal, 208
  syphilis of, 137
  tuberculosis of, 138
  tumours of, 138
Tonsillitis, 135

Tonsillotomy, 137
Torticollis, 214
Trachea, 249
  foreign bodies in, 260
  rupture of, 219
  scabbard, 230
Tracheoscopy, 250
Tracheotomy, 251
Traumatic apoplexy, 25
  cephal-hydrocele, 56
  epilepsy, 30
  insanity, 32
  pleurisy, 269
  spondylitis, 83
Trephining, 14
Trifacial nerve, 62
Trigeminal nerve, 62
  neuralgia, 62
Tropa-cocain anæsthesia, 702
Tropical abscess of liver, 458
Trusses, 371, 378
Tubal abortion, 475
  gestation, 495
  mole, 495
Tuberculosis. *See* individual regions and organs
Tumours. *See* individual regions and organs
Tunica vaginalis, hydrocele of, 678. *See also* Hydrocele and Hæmatocele
  surgical anatomy of, 654
Tuning-fork test, 184
Tympanic membrane, normal, 185
  perforation of, 186
  traumatic rupture of, 192
Typhoid ulcer, perforation of, 445

Ulcers and ulceration. *See* individual regions and organs
Umbilical fistulæ, 317
  hernia. *See* Hernia
Umbilicus, affections of, 316
  inflammation of, 317
  tumours of, 318
Umbrella probang, 240
Urachal cysts, 317, 610
  fistula, 317
Urachus, cysts of, 317, 610
  persistent, 317
Uræmic coma, 23
Uranoplasty, 119
Ureter, 540
  abnormal origin of, 547
  avulsion of, 552
Ureter, calculus in, 565
  catheterisation of, 544
  congenital anomalies of, 547
  double, 547
  operations on, 544, 545, 546, 560, 561, 571
  rupture of, 555
  surgical anatomy of, 540
  tumours of, 579
Ureterectomy, 546
Uretero-pyelo-anastomosis, 561
Uretero-pyelo-neostomy, 560
Ureterotomy, 545, 571
Urethra, 626
  calculus in, 624, 632
  contusion of, 629
  dilatation of, retrograde, 645
  epispadias, 629
  examination of, 627
  "false passages," in, 643
  foreign bodies in, 633
  hypospadias, 627
  inflammation of, 633
  irrigation of, 636
  malformations of, 627
  occlusion of, 627
  rupture of, 629
  stricture of, 639. *See also* Stricture
  surgical anatomy of, 626
  wounds of, 629
Urethral calculus, 632
  fistulæ, 647
Urethritis, 633
  gonorrhœal, 633
  non-gonorrhœal, 633
Urethrometer, 642
Urethro-prostatitis, 616
Urethrotomy, Cock's operation, 646
  external, 631, 644
  internal, 644
  Syme's operation, 644
  Wheelhouse's operation, 631
Urinary bladder. *See* Bladder
  fever, 648
  fistulæ, 317, 647
  lithiasis, 565, 600
Urine, 541
  in cystitis, 594
  extravasation of, 630
  nocturnal incontinence of, 612
  three-glass test, 585
Urobacillus liquefaciens, 592
Uro-nephrosis, 555
Uterine fibroids, 498

Uterus, fibro-myoma of, 498
myoma of, 498
operations on, 500
Uvula, elongation of, 133

Vagus nerve, 65
Valsalva's inflation of ear, 187
Varicocele, 673
in sarcoma of kidney, 579
Varix, œsophageal, 242
Vas deferens, rupture of, 660
surgical anatomy of, 653
wounds of, 660
Vasectomy, 624
Ventral hernia, 332, 351, 381
Vermiform appendix. *See* Appendix and Appendicitis
Vertebræ. *See* Spine
Vertigo, 184
Vesiculitis, 661, 676
Vitelline duct, persistent, 316
Voice training, 120
Volvulus, 425
Vulvo-vaginitis, 638

Wax in ear, 189
Wharton's duct, 174
Wheelhouse's operation, 631
Whitehead's excision of tongue, 168
Witzel's gastrostomy, 392
Wounds. *See* individual regions and organs
Wry-neck, 214

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