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SURGICAL ANATOMY

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THE

STUDENT'S HAND-BOOK

OF

SURGICAL ANATOMY.

BY

JOHN M'LACHLAN.

EDINBURGH:

E. & S. LIVINGSTONE

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JOHNSON SYMINGTON, M.B., F.R.C.S.E.

LECTURER ON ANATOMY,

SCHOOL OF MEDICINE, EDINBURGH,

IN RECOGNITION OF HIS GREAT SKILL AS A TEACHER,

AND AS AN EXPRESSION OF SINCERE REGARD,

This Book is respectfully Dedicated

BY

AN OLD PUPIL.

PREFACE.

In the following pages I have endeavoured to point out the most important anatomical facts in relation to Practical Surgery. However imperfectly my object may have been realised, it is hoped that this little book will be found useful to the student of Surgical Anatomy, in recalling to his memory anatomical details and facts gathered in the dissecting-rooms, but which, from the press of other work, may have been partly forgotten by the time he begins to prepare for the Final Examination. The subject is looked at chiefly from an anatomical point of view; and in its preparation reference has been frequently made to the leading works on Surgery and Anatomy—such as Erichsen and Spence for Surgery; Turner, Quain, Ellis, Gray, and Heath for Anatomy; as well as anatomical details gleaned in the Dissecting-Room, together with various useful hints from my former teachers. I have endeavoured not only to point out the *normal* relation of parts, but, where *possible abnormalities* are of special importance, those have also been indicated.

It is hoped that the classification adopted in the Table of Contents, together with the fact that the headings of the leading paragraphs are printed in bolder type, will greatly facilitate reference to the various subjects here discussed.

J. M'L.

Edinburgh, *January* 1883.

TABLE OF CONTENTS.

	PAGE
SECTION I.—Head and Neck	1—37
Arteries, Ligature of—	
Brachio-Cephalic	10
Carotid, Common	7
,, Internal	15
,, External	16
Facial	13
Lingual	12
Mammary, Internal	6
Occipital	14
Subclavian	1
Thyroid, Inferior	6
,, Superior	17
Vertebral	17
Miscellaneous—	
Arteriotomy	30
Auditory Meatus, External	33
Eustachian Tube	34
Fifth Nerve, Division of, on Face	27
Jaw, Lower, Excision of	20
,, ,, Dislocation of	29
,, Upper, Excision of	18
Lachrymal Sac, The	26
Laryngotomy	24
Lingual Nerve, Division of	30
Meningeal Arteries	28
Nasal Duct	26
Neck, Deep Fascia of	36
Œsophagotomy	25
Parotid Duct	25
,, Gland	31
Puncta Lachrymalia	26
Scalp, Wounds of	27
Spinal Accessory Nerve, Stretching of	35
Sterno-Mastoid, Division of	36
Tongue, Excision of	32
Tonsils, Removal of	30
Tracheotomy	21

PAGE

Trephining 31
Venesection from External Jugular . . 29
Wry Neck 35

SECTION II.—Upper Extremity . . . 38–65

Amputations—
Elbow Joint, at 60
Forearm, Middle of 61
Methods of, Various 58
Shoulder Joint, at 59
Upper Arm, Middle of 60
Wrist, at 61

Arteries, Ligature of—
Axillary 38
Brachial 41
Radial 43
Ulnar 44

Axilla, The—
Abscess in 62
Brachial Plexus, Pressure on 62
Contents, Relation of, to Walls . . . 62
Glands of 61

Dislocations—
Clavicle 47
Elbow Joint 49
Scapula 47
Shoulder Joint 47
Wrist Joint 50

Excision of Joints—
Elbow Joint 55
Shoulder Joint 54
Wrist Joint 56

Fractures—
Clavicle 50
Forearm, Bones of 53
Humerus 51
Scapula 51

Miscellaneous—
Elbow Joint, Anastomoses round . . . 42
Flexor Tendons, Sheaths of 64
Palmar Arches 45
Synovial Membranes of Wrist . . . 64
Veins at bend of Elbow 62
Venesection 63

PAGE

SECTION III.—Lower Extremity. . . 66—102

Amputations—
- Ankle Joint, at 92
- Hip Joint, at 89
- Knee Joint, at 91
- Leg, Middle of 92
- Tarso-Metatarsal Articulation, at (*Hey, Lisfranc*) 94
- Thigh, Middle of 91
- Transverse Articulation of Foot, at (*Chopart*) 94

Arteries, Ligature of—
- Dorsalis Pedis 76
- Femoral 66
- Gluteal 77
- Plantar, External 76
- Popliteal 70
- Profunda 69
- Pudic 77
- Sciatic 77
- Tibial, Anterior 74
- ,, Posterior 71

Dislocations—
- Ankle Joint 83
- Hip Joint 77
- Knee Joint 81

Excision of Joints—
- Ankle Joint 89
- Hip Joint 87
- Knee Joint 87

Fractures—
- Femur 85
- Tibia and Fibula 86

Miscellaneous—
- Ankle Joint, Structures at 95
- Club Foot—Talipes Calcaneus 98
- ,, Equinus 97
- ,, Valgus 97
- ,, Varus 96
- Groin, Glands of 101
- Hip Joint, Disease of 101
- Knee Joint, Contracted Tendons of . . 102
- Sciatic Nerve, Great 100
- Synovial Membranes of Foot and Ankle Joint 96
- Thigh, Deep Fascia of 99

PAGE

SECTION IV.—The Trunk . . . . . 103—140

Arteries, Ligature of—
Aorta, Abdominal 104
Iliac, Common 105
,, External 109
,, Internal 107

Miscellaneous—
Bladder, Puncture of 138
Colotomy 111
Fascia, Pelvic 138
Gastrotomy 110
Hernia—
Femoral 120
Inguinal 114
Congenital 120
Direct 117
Infantile 120
Oblique 117
Litholapaxy 132
Lithotomy—
Bi-lateral Operation, The 130
High Operation, The 131
Lateral Operation, The 128
Median Operation, The 130
Lithotrity 131
Paracentesis Abdominis 140
,, Thoracis 103
Perinæum, Dissection of 123
Rectal Part 124
Urethral Part 125
,, ,, in Female 126
Prostate Gland, The 135
Rectum, The 139
Ribs, Fracture of 103
Testicle, The—Its Coverings 135
,, ,, Descent of 116
Urethra, The 132
Urine, Extravasation of 125

SURGICAL ANATOMY.

SURGICAL ANATOMY OF THE HEAD AND NECK.

SUBCLAVIAN ARTERY. **Origin.**—On the *right* side from the branching of the Innominate artery behind the sterno-clavicular articulation. On the *left* side directly from the arch of the aorta. **Extent** (in neck).—From the sterno-clavicular articulation to the lower border of the first rib. It is divided into three parts by the scalenus anticus muscle—a part internal to (1st part); a part behind, (2nd part); and a part external to that muscle, (3rd part). **Course.**—It crosses the lower part of the neck, taking an arched course over the apex of the pleura and first rib, passing between the anterior and middle scaleni muscles. It usually rises about one inch above the clavicle.

LIGATURE IN THE THIRD PART OF ITS COURSE—

Extent.—From the outer edge of the anterior scalenus muscle, to the lower border of the first rib. The patient should be recumbent, and the shoulder should be depressed so as to lessen the depth of the wound, the head being turned a little towards the opposite shoulder.

Superficial Guide.—The vessel lies beneath the most prominent part of the clavicle, and it is important to remember, that by pressing the thumb, or a padded key, firmly downwards and backwards behind that point of the clavicle, towards the first rib, the vessel may be compressed during life, and the circulation through the upper limb entirely commanded. **Incision**—With the inner side of the left hand draw down the skin over the clavicle for about one inch, and cut *along the bone* for 2½ or 3 inches, beginning over the clavicular origin of the sterno-cleido-mastoid and ending at the trapezius. This incision corresponds to the middle third of

the clavicle, or base of the Posterior triangle. But, further, to simplify matters it is advisable to make another incision one inch and a-half in length, along the outer edge of the sterno-mastoid joining the former incision nearly at a right angle.

Parts cut through.—While the skin is tense over the clavicle, there is divided *on* the bone, (1) Skin, (2) Superficial fascia, (3) Platysma, (4) Superficial nerves and vessels—nerves are the descending branches of the cervical plexus; the vessels are chiefly the tributaries of the external jugular vein, which at this point usually form a venous plexus in front of the subclavian artery. When the tension is taken off, and the wound thus moved a little above the clavicle, we then cut through, (5) the deep fascia in the middle of the wound, that part of the cervical fascia which binds down the posterior belly of the omo-hyoid to the clavicle. Next seek for the interval between the omo-hyoid (posterior belly) and the clavicle which will probably be about an inch in extent, but may be more or less. The knife must not be allowed to pass beneath the clavicle, lest the subclavian vein or the supra-scapular vessels be injured. Push the omo-hyoid upwards a little, and with the finger or the handle of the knife scratch away any intervening areolar tissue, or other structures lying over the artery, and define the outer edge of the scalenus anticus muscle, and follow it down to its insertion into the first rib. (6) The small nerve to the subclavius muscle also crosses in front of the artery near its middle.

Deep Guide to the Vessel.—Either the tubercle on the first rib at the insertion of the scalenus anticus and the outer edge of the same muscle, when the artery will be found immediately above, and a little behind it, but covered and bound down to first rib by a sheath of dense cervical fascia. When the tip of the finger touches the tubercle, the pulp of the finger will rest on the artery (Spence); or, the white cords of the brachial plexus seen at the outer end of the wound, and which are placed above, and a little behind the artery—the artery being between them and the first rib. (7) Open sheath and clear the vessel, and pass the aneurism needle from *above* so as to avoid the nerves going to form the brachial plexus,

which are far more liable to be included in the ligature than the vein, which is to the front, and considerably below the artery.

The other important relations of this artery are—*above*—the nervous cords going to form the brachial plexus. *Below*—the first rib, and partly, also, the nervous trunk formed by the union of the 8th cervical and 1st dorsal nerves. The same nervous cords also lie behind it. The artery is sometimes described as lying in the lower part of a little triangle formed thus—internally it is bounded by the outer margin of the scalenus anticus, externally by the scalenus posticus, the convergence of these two muscles forming the apex of the triangle, the base being formed by the first rib on which the vessel rests (SPENCE).

NOTE.—(1.) In thick-set, short-necked persons the artery is usually deeply seated; it may be below the level of the clavicle, or but slightly above it. (2.) In thin, long-necked persons its course is usually high, and, therefore, is much more easily reached and ligatured. (3.) The clavicle in some cases is very much curved. When this is the case, the depth of the vessel from the surface is increased, and is, therefore, more difficult to ligature. An aneurism in the axilla will produce the same effect (by raising the clavicle), and tends to complicate the operation considerably. (4.) The artery may pass in front of, or through the anterior scalenus; the clavicular head of the sterno-mastoid, instead of being confined in its origin to the inner third of the posterior surface of the clavicle, may pass beyond its usual limit outwards along the clavicle, and conceal the artery; and the trapezius may also pass further inwards than it usually does, and overlap the artery. In 5 per cent. of the cases, the omo-hyoid arises from the middle third of the clavicle, and, therefore, covers the artery. (5.) The posterior scapular artery frequently, and sometimes the supra-scapular, may spring from this part. (6.) The external jugular vein should lie on the outer edge of the sterno-mastoid; but, very frequently it is more external, and passes beneath the deep fascia just above the middle of the clavicle, crossing the third part of subclavian artery, and emptying itself into the sub-

clavian vein. While it lies over the artery it receives the supra-scapular and transversalis colli veins, and in this region also communicates with the anterior jugular vein. In this way a plexus of veins is formed over the artery. If any of the large venous trunks be cut in the operation, a double ligature must be applied to it. The subclavian vein may rise as high as the level of the clavicle, or may lie with the artery beneath the anterior scalenus. (7). A cord formed by the 8th cervical and 1st dorsal nerves lies immediately behind the subclavian artery—or may be between it and the first rib—and is, therefore, specially liable to be included in the ligature, or even to be tied instead of the artery—mistakes committed by several eminent surgeons.

Ligature of Second Part—

This part lies behind the anterior scalenus, and therefore the incision must be carried a little nearer the sternum. In connection with this it should be kept in mind that the outer edge of the sterno-mastoid corresponds very nearly to the outer edge of the scalenus anticus. In addition to the structures cut through in ligature of the third part, we must divide —(1) Clavicular origin of sterno-mastoid. (2) Scalenus anticus. (3) Usually external jugular vein, to which a double ligature must be applied.

Note.—(1.) In dividing the scalenus anticus special care must be taken to avoid cutting or bruising the phrenic nerve which lies on its anterior surface, inclining obliquely towards its inner border. Two cases are mentioned by Erichsen, one in which the phrenic nerve was divided, and the patient died on the eighth day of pneumonia; in the other case incessant hiccough followed the operation, and after death the phrenic nerve was found reddened and inflamed, having probably in some way been interfered with during the exposure of the vessel. (2.) The transversalis colli and supra-scapular arteries also lie superficial to the scalenus anticus, and must be carefully preserved from injury, as they play a very important part in the collateral circulation. (3.) The confluence of the internal jugular and subclavian veins is also commonly in front of scalenus anticus.

Reasons for applying the Ligature to the third part in preference to the other two.—(1.) It is the most superficial part. (2.) It is usually free from branches. (3.) The first rib is interposed between it and the pleura, and by passing the needle as the artery lies on the first rib, we avoid wounding the pleura, and will also usually avoid coming into contact with any abnormal arterial branches—as these usually arise close to the outer edge of the scalenus anticus.

But the **second** part *may* be ligatured, as it only gives origin, as a rule, to one branch, but greater care is necessary, because—(1) It is deeper; (2) Its close relations to the phrenic nerve, transversalis colli and supra-scapular arteries; (3) It rests on the pleura covering the apex of the lung.

Objections to first part.—(1.) Its great depth. (2.) Its shortness, and the number of branches given off. It is only about one inch and a-half in length, and gives off three large branches, so that ligature of this part is almost certain to be followed by secondary hæmorrhage. (3.) Its complicated relations—thus, in *front* (besides the superficial structures common to all the three parts) we have three muscles, three veins, and three nerves. The **Muscles** are—the sterno-mastoid, sterno-hyoid, and sterno-thyroid; the **Veins**—internal jugular, vertebral, and anterior jugular; the **Nerves**—vagus, several cardiac nerves, phrenic (on the left side, not so often on the right side). *Behind* the vessel we have—(1) the longus colli muscle separated from it by loose connective tissue in which there lie two nerves—the gangliated cord of the sympathetic, and the recurrent laryngeal. *Below*, is the pleura and the recurrent laryngeal nerve. *Above*, there is nothing worth noting. On the left side the connections of the first part are too complicated to admit of ligature, being invested by the pleura in all its extent, and hardly extending into the cervical region at all.

Branches of the Subclavian.

Of the first part.—**1. Vertebral.**—It arises from the upper surface of the artery, passes up beneath the internal jugular vein, between the longus colli on the inner side, and scalenus anticus on the outer side, to the foramen in the transverse

process of the sixth cervical vertebra. It is crossed by the inferior thyroid artery, and on the left side by the thoracic duct.

2. The Thyroid Axis.—This is a short trunk very soon dividing into three branches—(*a*) *Inferior thyroid*, which passes upwards and inwards in *front* of the vertebral artery, recurrent laryngeal nerve, and longus colli muscle, but *behind*, the carotid sheath and its contents, and the gangliated cord of the sympathetic. It takes a flexuous course to the inferior angle of the thyroid body. If this branch is ligatured as it passes behind the carotid sheath, the structures divided will be nearly the same as in ligature of the common carotid, the necessary modifications being evident. In excision of the thyroid body, this vessel requires to be ligatured as it enters the inferior angle of the gland. The branches of the inferior thyroid artery are—(1) Ascending cervical; (2) Inferior laryngeal branch; (3) Œsophageal; (4) Tracheal. (*b*) *Transversalis Colli*—Passes outwards in front of the scalenus anticus and phrenic nerve, and beneath the sterno-mastoid, into the posterior triangle of the neck, where it passes in front of the cords going to form the brachial plexus, and ends there by dividing into superficial cervical and posterior scapular arteries. (*c*) *Supra-Scapular, or, Transversalis humeri.*—This vessel is on a lower level than the last, and runs outwards in front of the scalenus anticus and phrenic nerve, but behind the clavicle and the omo-hyoid to the upper border of the scapula.

3. Internal Mammary.—This vessel passes downwards behind the inner end of the clavicle, and the beginning of the right innominate vein, and enters the chest between the first rib and the pleura; as it is about to enter the chest, it is crossed by the phrenic nerve. If this vessel were to be tied, it should be borne in mind that its anterior relations are precisely similar to those of the first part of the subclavian *(quod vide)*.

Branches of the Second Part.—The superior intercostal artery, and arising in common with it is the **profunda cervicis** branch, which ascends in the neck between the complexus and the semi-spinalis colli, supplying these muscles and anastomosing with the **princeps cervicis** of the occipital artery.

Collateral Circulation when the Subclavian is

tied in its second and third parts.—(1.) The supra-scapular from thyroid axis (first part of the subclavian) anastomosing with the dorsalis scapulæ branch of the subscapular (from third part of axillary). (2.) The posterior scapular branch of the transversalis colli, of thyroid axis, anastomosing with the subscapular branch of axillary. (3.) Internal mammary from 1st part of subclavian, and the aortic intercostals, anastomosing with the long and short thoracics of axillary artery, and the deep epigastric. Should the **first** part be tied, the collateral circulation is as follows:—(1.) The superior intercostal anastomosing with the aortic intercostals. (2.) The inferior thyroid anastomosing with the superior thyroid. (3.) By the inosculations of the vertebrals through the circle of Willis.

Common Carotid Artery.—Aneurism of this vessel gives rise to certain special symptoms; for instance, if the aneurism be situated near the bifurcation of the vessel (where it usually occurs), there is a constant hacking cough due to pressure on the superior laryngeal nerve; if it be placed lower down we may get spasm of the glottis from pressure on the recurrent laryngeal nerve. There may also be serious dyspnœa and difficulty in deglutition.

Origin.—On the *right* side in the bifurcation of the innominate artery opposite the sterno-clavicular articulation. On the *left* side it springs directly from the arch of the aorta.

Extent.—From behind the sterno-clavicular articulation to a point, a little higher than the upper margin of the thyroid cartilage, where it divides into internal and external carotids.

Course.—Its course is indicated by a line drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process.

The artery, together with the internal jugular vein and vagus nerve, are included in a common sheath of cervical fascia, although each structure lies in a separate compartment; the septa are comparatively strong, especially that between the vein and the artery. This is important, because the compartment containing the artery may be opened without interfering with those containing the vein and nerve, and in this way the vein is prevented from bulging over the artery

during the operation. In the sheath the artery is the most internal, the vein most external, and the nerve behind and between. Before describing the operation itself, we will state very briefly the chief relations of the sheath to the surrounding parts.

As high as the **Cricoid Cartilage** it is deeply placed, and is covered by—(1) The common investments (*i.e.*, skin and superficial fascia, platysma and deep fascia). (2) Sternal head of sterno-mastoid. (3) Sterno-hyoid. (4) Sterno-thyroid. (5) Crossed by omo-hyoid. Above this point it enters the carotid triangle, and is merely covered by the common investments of the parts. It is also crossed by (6) three veins—superior and middle thyroids, and anterior jugular. (7) The descendens noni lies on (sometimes in) the sheath. It may be slightly overlapped by the sterno-mastoid at its upper part. *Behind* the sheath is—(1) the gangliated cord of the sympathetic. (2) The recurrent laryngeal nerve crossing obliquely inwards behind the sheath. (3) Longus colli. (4) Rectus capitis anticus major; and behind these (5) the transverse processes of the cervical vertebræ, against which the vessel may be compressed during life. (6) The inferior thyroid artery also crosses obliquely inwards behind the sheath. (See "Branches of Subclavian.") To its *inner* side we have—(1) The larynx and trachea. (2) Pharynx and œsophagus. (3) Thyroid body. (4) Recurrent laryngeal nerve. To the *outer* side, a chain of lymphatic glands. To assist the memory, note the following points—(1) That there are four muscles in front of it, viz., sterno-mastoid, sterno-hyoid, sterno-thyroid, and omo-hyoid. (2) That there are four structures (or groups rather) on the inside. (3) That there are four veins in relation to the artery—two jugular and two thyroids, three of these cross it, and one (the internal jugular) lies to its outer side. (4) That there are four nerves in relation to it—*above*, the descendens noni; *behind*, the gangliated cord of the sympathetic: on the *inner* side, the recurrent laryngeal (at its lower part): on the *outer* side, the vagus.

To Ligature the Vessel.

I. Above the Omo-hyoid.—*Right side.*—The patient's

chest should be raised by means of pillows, the head depressed a little, and the face turned towards the opposite shoulder, in order to make the sterno-mastoid tense and prominent, and the angle of the jaw turned up somewhat. The neck should be compressed at the lower part, in order to make the superficial veins turgid, and their course noted, so that they may be avoided as much as possible in making the necessary incision.

Superficial Guide.—The line marking its course, or the anterior border of the sterno-mastoid. **Incision.**—With the line of the vessel in mind, make an incision three inches in length, commencing on a level with the upper part of the thyroid cartilage (or an inch and a-half above the cricoid cartilage). The upper part of this incision will be a few lines *nearer* the middle line of the neck than the anterior margin of the sterno-mastoid, this muscle diverging from the artery as it rises higher in the neck. By this incision we divide (1) the skin, (2) superficial fascia, (3) platysma, (4) then cut through the deep fascia and expose the fibres of the sterno-mastoid, and draw it aside, the head being turned a little towards the same shoulder, in order to relax its fibres. (5) Expose omo-hyoid by cutting through a dense fascia, covering it and the other muscles and carotid sheath. (6) Draw aside the lateral lobe of the thyroid body which is now exposed, and look for the **deep guide** to the vessel, viz., the angle formed by the anterior belly of the omo-hyoid with the anterior border of the sterno-mastoid—the artery bisecting this angle. Then expose the sheath fully, by carefully turning aside any intervening structures with the *handle* of the knife, using the blade as little as possible, in order that the descendens noni nerve, and sterno-mastoid branches of the superior thyroid artery be not injured. Open the *inner* compartment of the sheath, clear the artery, and pass the ligature (without using force) from the *outer* side to avoid the risk of wounding the internal jugular vein, holding the other edge of the opening in the sheath, with a pair of artery forceps to steady it during the passage of the ligature.

II. Ligature below the Omo-hyoid.—*Right side.*—If we wish to ligature the vessel below the omo-hyoid, it is necessary (1) That the incision be extended further down along the

anterior edge of the sterno-mastoid, which must be drawn well outwards, and, if necessary, its sternal head divided. (2) To divide the fascia binding the omo-hyoid to the muscles near it, and draw it upwards. (3) Draw the sterno-hyoid and sterno-thyroid muscles inwards, (or, if necessary, divide them), and the carotid sheath is now exposed. Proceed as in ligature above the omo-hyoid, bearing in mind the complicated relations of the parts (see before). On the *left* side the artery springs from the arch of the aorta, but beyond the sterno-clavicular articulation, its relations are almost the same as those of the vessel on the right side, with the following differences :—(1) It is more deeply placed. (2) The internal jugular vein and the pneumo-gastric nerve are placed over the artery in the lower third of the neck. (3) It is nearer the œsophagus. (4) Low down, the thoracic duct lies to its outer side. Otherwise the operation for ligature of the vessel on the left side is similar to the corresponding operation on the right side.

Collateral Circulation.—(1) Branches of the external carotid on the side tied anastomosing with the corresponding branches of the opposite side, viz., (*a*) Facial with Facial. (*b*) Temporal with Temporal. (*c*) Occipital with Occipital. (*d*) Superior Thyroid with Superior Thyroid. (2) Anastomoses between the internal carotids of opposite sides through the anterior segment of the "circle of Willis"—anterior cerebral of the one side, with the anterior cerebral of the other through the anterior communicating. (3) Anastomoses between the subclavian and external carotid of the side tied—(*a*) Deep cervical with princeps cervicis of occipital. (*b*) The vertebral with the occipital. (*c*) Inferior thyroid with superior thyroid. (4) Anastomoses between the subclavian and the internal carotid of the side tied, the vertebral (from subclavian) through the basilar and posterior cerebral, with posterior communicating from internal carotid, *i.e.*, through the lateral segment of the "Circle of Willis."

Innominate, or Brachio-Cephalic Artery.—Aneurisms of this vessel are extremely difficult to diagnose with certainty. Many cases diagnosed as aneurism of the innominate during life, have been found after death by the more perfect light of

the post-mortem room, to be aneurisms of the arch of the aorta. Aneurisms in this region give rise to certain symptoms, chiefly from pressure of the tumour on neighbouring structures. (1) The pulse on the affected side is small and feeble, and so is the pulsation in the right carotid. (2) The superficial veins of the neck are enlarged, and we have œdema of the eye and arm. (3) There are dull aching pains (or they may be sharp and shooting) from pressure on, and irritation of the cervical and brachial nervous plexuses. (4) Dyspnœa from pressure on the recurrent laryngeal nerve, or by direct compression of the trachea. (5) Difficulty in swallowing. (6) If the cervical sympathetic be *irritated* there will be dilatation of the pupil of the affected side; but, if it be completely *paralysed*, the pupil on that side will be contracted. The same remark applies to aneurisms of the common carotid.

Origin.—From the right side of the transverse part of the arch of the aorta. **Extent.**—From the above point to behind the right sterno-clavicular articulation and lower cervical region, where it bifurcates into the right subclavian and right common carotid. Its entire length is from $1\frac{1}{2}$ to 2 inches. **Course.**—Upwards and to the right, behind the first piece of the sternum. Its most important relations are—in *front* (1) The first piece of the sternum. (2) Lower part of the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles. (3) It is crossed by the left innominate vein, and there is also a network of thyroid veins in front of it, embedded in the loose cellular tissue. On its *right* side, (1) The right innominate vein; (2) Vagus; (3) Phrenic; (4) Trachea. On its *left* side, the left common carotid. *Behind*—(1), Trachea, at lower part; (2), Pleura.

In ligature of this vessel the patient should be in an easy recumbent posture, with the chest raised, and the head thrown back and turned towards the left shoulder.

Superficial Guide to the Vessel.—It lies just behind the right sterno-clavicular articulation. **Incision.**—The incision should be V-shaped. First make an incision about two inches long over the inner part of the clavicle and sterno-clavicular articulation to the sternum; another, two or three inches in length, along the inner border of the sterno-mastoid

muscle, meeting the other at the sternum. By these incisions we divide—(1), Skin ; (2), Fascia ; (3), Inner part of the origin of sterno-mastoid. These are thrown upwards and outwards, and then we cut through ; (4), Sterno-hyoid ; and (5), the sterno-thyroid. The head is now drawn well back in order to draw up the artery into the neck as much as possible. **Deep Guide to the Vessel.**—Trace down the common carotid with the finger till the bifurcation of the innominate artery can be *distinctly felt ;* then (6), clear from the surrounding cellular tissue and ligature, taking care not to wound the pleura ; the needle is passed *from* the vein.

The **Collateral Circulation** is practically the same as in ligature of the common carotid (*quod vide*).

As a rule, the innominate gives off no branch, but occasionally a small branch, the *thyroidea ima*, arises from it and runs up the front of the trachea to the thyroid body.

It is scarcely necessary to remind the reader that there is but *one* innominate artery, (though there are two innominate veins), and that it is on the right side. It does not look well when a student rises from the examination table where he has sat down for his "written," and asks the examiner on *which* side he wishes the artery tied ; it is apt to raise a *suspicion*, (however unjust and unfounded that suspicion may be) in that gentleman's mind that the student must have forgotten his anatomy considerably—if ever he knew it—of which fact he quietly makes a mental note for future reference. It is specially awkward to make *such* a mistake at *such* a time ; for if ever a student's words ought to be few and well chosen, it is at an examination.

The **Lingual Artery.**—It may be necessary to ligature this vessel to restrain profuse hæmorrhage from the tongue, *e.g.* in cancerous ulcers, or for the purpose of starving such growths.

Origin.—From the anterior border of the external carotid, either above or below the level of the hyoid bone. **Extent.**—From its origin to the anterior border of the hyo-glossus. **Course.**—At first inwards above the hyoid bone, and then upwards and inwards beneath the hyo-glossus.

In performing this operation, the patient's shoulders should

be slightly raised, the head thrown well back, and the face turned towards the opposite shoulder.

Incisions.—(1) A curved incision from a point a little below and behind the symphysis menti, down to the level of the hyoid bone, and then turning up to near the angle of the jaw. At this point the artery lies in a triangular space, the sides of which are formed by the anterior and posterior bellies of the digastric, the ninth nerve forming the base; or, (2) simply make an incision downwards and backwards over the great cornu of the hyoid bone. Either of these incisions may be chosen, according as you wish to tie it (1) while it lies under the hyo-glossus; or (2) between its origin and the posterior border of that muscle. **Deep Guide to the Vessel.**—The ninth nerve lying in the bottom of the wound, either crossing the vessel or lying parallel with it. Before it reaches the hyo-glossus it is simply covered by (1) skin and fascia; near the muscle it is crossed by (2) the ninth nerve; (3) digastric and stylo-hyoid muscles. It then passes beneath (4) the hyo-glossus, and rests on the middle constrictor, and then beneath (5) the mylo-hyoid, resting on the genio-hyo-glossus. In tying it beneath the hyo-glossus, the sub-maxillary gland and ninth nerve must be drawn upwards, and the digastric and stylo-hyoid muscles held aside, and the fibres of the hyo-glossus divided horizontally near the hyoid bone.

Branches.—(1) Hyoid, which runs along the upper border of the hyoid bone. (2) Dorsalis linguæ, which arises and ascends beneath the hyo-glossus to the dorsum of tongue. (3) Sublingual branches to sublingual gland. (4) Ranine, the direct continuation of the lingual, which runs forward to the tip of the tongue.

Facial Artery.—The first of the incisions for ligature of the lingual would also expose the origin of the facial. It arises from the external carotid artery, a little above the lingual, lying at first in the carotid triangle, where it is simply covered by the superficial investments of the parts (skin, platysma, and fasciæ.) It is then crossed by the posterior belly of the digastric and stylo-hyoid muscles and ninth nerve. After this it passes through the substance of the sub-maxillary gland, where it makes a sigmoid flexure, crosses the lower

jaw lying in a little hollow just about the point where the body joins the ramus, in front of the masseter muscle. Here its pulsations can be felt during life, and it may be readily compressed with the finger. After this, its general direction is towards the angle of the mouth, angle of the nose and inner angle of the eye, but in a very tortuous course. In its course through the face it is covered by the superficial structures and platysma, and that special part of the platysma known as the risorius muscle: it is also covered by the zygomatic muscles, and crossed by branches of the facial nerve. It rests on (1) the lower jaw, (2) buccinator, (3) levator anguli oris, (4) levator labii superioris.

Branches.—*In neck.*—(1) Inferior or ascending palatine which passes upwards between the stylo-glossus, and the stylo-pharyngeus to the soft palate. (2) Tonsillar to tonsils. (3) Glandular to sub-maxillary gland. (4) Sub-mental given off immediately below the lower jaw to the chin. This is the largest branch and must be kept in mind in operations about the lower jaw, such as excision, &c. *On the face.*—(1) Inferior labial: (2) the two coronary arteries which pass along the free margin of each lip. In operations about the lips, therefore, these must be kept in mind; (3) Lateral nasal to side of nose; (4) Angular, its terminal branch, anastomosing at the inner angle of the orbit with the nasal branch of the ophthalmic; and this is one reason why leeches at the inner angle of the eye relieve congestion of the eye or brain.

Occipital Artery.—This vessel arises from the posterior surface of the external carotid just as that vessel is about to pass beneath the posterior belly of the digastric. It may be divided into three parts—(1) A part that passes upwards and backwards almost parallel to and partially overlapped by the posterior belly of the digastric and stylo-hyoid, to between the transverse process of the atlas and mastoid process of the temporal bone. This part is quite superficial at first (as a rule) being simply covered by the integument; afterwards it is overlapped by the muscles already mentioned, and part of the parotid gland. It, however, *crosses* the following important structures—(*a*) Internal carotid artery; (*b*) Vagus; (*c*) Internal jugular vein; (*d*) Spinal accessory nerve; (*e*) Ninth nerve

(hypoglossal); (*f*) Gangliated cord of the sympathetic. (2) A part passing backwards and inwards along the superior curved line. At this part of its course it *lies* on (*a*) Rectus lateralis; (*b*) Superior oblique; and (*c*) Complexus; and is *covered* by—(*a*) Trapezius; (*b*) Sterno-cleido-mastoid; (*c*) Splenius capitis; (*d*) Digastric; (*e*) Trachelo-mastoid; and is overlapped by (*f*) the mastoid process. (3) The third part pierces the trapezius and turns upwards to scalp.

Branches.—(1) A sterno-mastoid branch; (2) Auricular to concha; (3) Meningeal, which enters skull through the jugular foramen; (4) Princeps cervicis; (5) Occipital to scalp.

Internal Carotid Artery.—Origin.—From the bifurcation of the common carotid opposite the upper border of the thyroid cartilage. **Course.**—Its course is indicated by the same line that marks the course of the common carotid. The part below the posterior belly of the digastric (*i.e.* the part in the carotid triangle) is the only accessible portion. *Relations of this part.*—In *front*—(1) Skin; (2) Superficial fascia; (3) Platysma; (4) Deep fascia; (5) Crossed by the ninth nerve sending down descendens noni; (6) also, crossed by the occipital artery giving off some sterno-mastoid branches. On the *outer* side—(1) Internal jugular vein; (2) Spinal accessory nerve. On the *inner* side—(1) Pharnyx; (2) Ascending pharyngeal artery. *Behind*—(1) Vagus; (2) Gangliated cord of sympathetic; (3) Superior laryngeal nerve (internal and external branches); (4) Rectus capitis anticus major; (5) Further back the cervical vertebræ.

Incision.—The incision should be made in the line of the vessel, beginning about two inches above the thyroid cartilage and carrying it down to its upper border, or from the lower border of the posterior belly of the digastric to the same point. The best position for applying the ligature is about midway between the hyoid bone and the digastric. By this incision we cut through, (1) Skin; (2) Superficial fascia; (3) Platysma; (4) Deep fascia. Draw aside the sterno-mastoid, when, (5) The occipital artery, with its mastoid branch, and, (6) The ninth nerve, with its descendens noni branch, are brought into view. Turn these aside, open the sheath, and apply the ligature.

NOTE.—The vessel lies at this part of its course, external to the external carotid. The internal jugular vein is to its outer side, and therefore the aneurism needle should be passed *from* this side; further, the gangliated cord of the sympathetic and the Vagus, with its superior laryngeal branch, is behind it. When one internal carotid trunk has been tied the circulation is very speedily re-established by the internal carotid, and vertebral of the opposite side, and vertebral of the same side, through the "Circle of Willis."

External Carotid Artery.—Origin.—At the same point as the internal. **Extent.**—From its point of origin upwards to a point opposite the neck of the lower jaw, where it divides into temporal and internal maxillary arteries. **Course.**—Runs upwards and slightly outwards, passing between the angle of the jaw and the mastoid process, lying a little to the front of the anterior border of the sterno-mastoid, very nearly corresponding to a line drawn from the front of the meatus of the ear to the cricoid cartilage, slightly arched forwards.

In the first part of its course the vessel lies in the carotid triangle, and is quite superficial, being merely covered by (1) Skin, (2) Superficial fascia, (3) Platysma, (4) Deep fascia, and may be slightly overlapped by the sterno-mastoid. In the second part of its course it is deeper, being covered by (5) the posterior belly of the digastric and stylo-hyoid muscles, and (6) crossed by the ninth nerve. In the third part it is still deeper, for it passes beneath the deep surface and enters the substance of (7) the parotid gland. *Behind* the vessel we have (1) the superior laryngeal nerve with its external branch and the structures which separate the external from the internal carotids, viz., (2) Stylo-pharyngeus and (3) Stylo-glossus muscles; (4) Styloid process, if long (if short we will have the stylo-hyoid ligament); (5) glosso-pharyngeal nerve, and (6) pharyngeal branch of vagus.

It may be ligatured as it lies in the carotid triangle, but its branches are so numerous that its ligature is apt to be followed by secondary hæmorrhage. At this part of its course it is also crossed by the lingual and facial veins. The incision used in ligature of the internal carotid will also do for ligature of this vessel, or the incision may be a little nearer the middle line

of the neck. We simply cut through the structures covering it in the first part of its course, and draw aside the sterno-mastoid, taking care to avoid the lingual and facial veins, and the branches of the vessel itself.

Branches.—*An Anterior Set.*—(1) Superior thyroid; (2) Lingual; (3) Facial. *A Posterior Set.*—(1) Occipital; (2) Posterior auricular; (3) Sterno-mastoid (sometimes). *An Ascending Set.*—(1) Temporal; (2) Internal maxillary; (3) Ascending pharyngeal.

Collateral Circulation.—For this see under Nos. 1 and 3 "Collateral circulation" of common carotid artery.

Thyroid Arteries.—Ligature of these arteries has been practised by some surgeons as a cure for bronchocele, with but doubtful success. We have already referred to ligature of the inferior thyroid (see p. 6).

The Superior Thyroid.—This vessel is a branch of the external carotid. It is the lowest of the three branches arising from the anterior surface of that vessel, and is usually given off not far from its origin, as it lies in the carotid triangle. The superior thyroid itself, therefore, is at first merely covered by the common investments of the parts, and at this point it may be ligatured. Make an **incision** in the line of the carotid vessels, three inches long, the centre of the incision being opposite the hyoid bone (the artery usually arises near the cornu of the hyoid bone). Here the vessel is quite superficial, being covered only by skin, superficial fascia, platysma, and deep fascia, and may be readily tied. After this it takes an arched course downwards, passing beneath the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles to the thyroid body.

Branches.—(1) Hyoid branch, runs inwards *below* the hyoid bone; (2) Sterno-mastoid, passes outwards across the carotid sheath to the sterno-mastoid muscle; (3) Superior laryngeal, pierces the thyro-hyoid membrane and supplies the mucous membrane of the larynx; (4) Crico-thyroid, runs across the crico-thyroid membrane; (5) Terminal branches to the thyroid body.

Vertebral Artery.—This vessel has been ligatured by Smyth, of New Orleans, who thus describes the operation—

"The head of the patient being thrown back and slightly turned to the left, an incision two inches in length was made along the posterior border of the sterno-mastoid muscle, commencing at the point where the external jugular vein crosses this muscle, and terminating a little below the clavicle, the edge of the muscle being exposed and drawn to the inner side, the prominent anterior tubercle of the transverse process of the sixth cervical vertebra was readily felt and taken for a guide. Immediately before this, and in a vertical line with it, lies the artery. A layer of fascia was now divided, some loose cellular tissue with lymphatics, and the *ascending cervical* artery were pulled to the inner side, and a separation was made between the scalenus anticus and longus colli muscles just below their insertion into the tubercle, when the artery and vein became visible, the latter was drawn to the outer side (this is important), and the needle passed around the former from without, inwards."

Note.—The prominent anterior tubercle of the transverse process of the sixth cervical vertebra is known as the "*carotid tubercle*," and by some surgeons is used as the "deep" guide in ligature of the common carotid artery.

Excision of the Upper Jaw and Malar Bone.—(1) Place the patient in a semi-recumbent position, compress the facial artery as it passes over the lower jaw; extract the central incisor tooth of the diseased side, and then make the **Incision,** (*A*) *Liston's.* Enter the knife opposite the external angular process of the frontal bone, (*i.e.*, a little above the zygoma), and carry it in a semi-circular manner downwards and forwards to the angle of the mouth; and from its upper end carry another incision about one inch along the zygoma, (if the malar bone is to be left this latter incision need not be made). Another incision is then made from the nasal process of the superior maxillary bone down the side of the nose, round the ala, and through the centre of the upper lip into the mouth, and the flap is then dissected upwards. This is the most convenient incision when the tumour is of large size. (*B*) *By External Flap.* Cut horizontally from the outer to the inner canthus of the eye, then straight down to the ala of the nose, round it and through the centre of the upper lip into the

mouth; this flap is then dissected downwards. The great advantage of this incision is that the arteries and nerves of the face are cut close to their terminations, and not through their larger branches, as they are more likely to be by Liston's method. (2.) Having dissected the flap off the jaw, separate the soft parts from the floor of the orbit, using a thin copper spatula to protect them and the globe of the eye. (3.) Divide the bony points by using a narrow saw and strong cutting bone pliers. (*a*) Zygoma: First notch it with the saw, and then divide it with the pliers. (*b*) External orbital angle; divided in the same way by placing one blade of the forceps in the orbit, the other on the malar bone. (*c*) Nasal process of superior maxilla; with the bone pliers—one blade in the orbit, the other in the nostril. Then divide the soft covering of the hard palate *longitudinally*, and separate the soft palate from the hard palate by an incision *transversely outwards*. The wound must be entirely *in front* of the soft palate, the whole of which must be left intact. This being done, divide (*d*) The hard palate by introducing a narrow saw into the nostril, and notching it deeply, especially in front, and complete the division with the bone pliers. (4) Draw the mass downwards and forwards, breaking down any adhesions with the fingers or bistoury—such as the origin of the temporal muscle in the zygomatic fossa. (5) Arrest hæmorrhage, and introduce some strips of lint to support the cheek flaps.

Chief parts cut through. (1) *Skin and fascia*, part of orbicularis palpebrarum, orbicularis oris, temporal fascia, part of masseter and temporal muscles, zygomatici, Buccinator, and other muscles of expression, nasal duct, etc. (2) *Nerves*, chiefly branches of facial and branches of 2nd division of the 5th that appear on the face, and in the end the trunk of the 2nd division of the fifth itself. (3) The various *bony points* already mentioned. (4) *Arteries*. (*a*) Branches of the temporal, i. Orbital; ii. Middle temporal; iii. Transverse facial. (*b*) Facial near the angle of the jaw and several of its branches, viz.:—i. Superior coronary; ii. Lateral nasal; iii. Angular. (*c*) Termination of internal maxillary artery, probably, and certainly many of its branches—i. Buccal; ii. Posterior dental;

iii. Infra orbital; iv. Descending Palatine; v. Spheno-palatine. (5) Corresponding veins.

The upper jaw may be removed without the malar bone; in that case the necessary modifications of the above description will readily suggest themselves.

Excision of the Lower Jaw—(one-half).—(1) Place the patient in a recumbent position, with the shoulders slightly raised, extract an incisor tooth, fix the point of the tongue, and make the **Incision.** Begin above and immediately behind the articulation of the lower jaw, but in front of the temporal artery, and carry it deeply down to the bone along the ascending ramus of the jaw, and forwards under the horizontal ramus till opposite the point where the bone is to be divided, and then carry it upwards towards, but do not divide, the lip. Secure the facial artery before dividing it, by acupressure below the jaw or otherwise. (2) Dissect this flap upwards and inwards to expose the bone and clear the inner side of the jaw from contiguous structures, using a narrow bistoury and keeping its edge close to the bone. (3) Saw through the jaw partially, close to the symphysis, and complete the division with the bone pliers. (4) Depress the divided ramus with the left hand till the insertion of the temporal muscle into the coronoid process is seen, and then divide it at its insertion. (5) Turn the jaw outwards a little, still depressing it, to make the external ligaments of the joint tense, and open the joint from the front, and keep the edge of the knife close to the bone to avoid wounding, if possible, the internal maxillary. (6) Divide the insertions of the internal, and the external pterygoids; evert the bone, and carefully separate all the soft parts from its inner surface, and remove it. Secure the bleeding points, and close the incision. *Note.*—In making the incision it is better not to carry it too far up behind the ascending ramus (if the jaw can be disarticulated without doing so) lest the trunk of the facial nerve be severed, and the various facial muscles be therefore paralysed (the portio dura (facial) being the *motor* nerve of the face), but only curve it slightly over the angle of the jaw, and dissect up beneath this flap close to the bone.

Chief Structures cut through.—(1) Superficial structures;

(2) *Muscles*, viz., Masseter, Platysma, part of Buccinator, insertion of Digastric, Genio-hyoid, Genio-hyo-glossus of the side excised (if the incision be through the symphysis), Mylo-hyoid, a few fibres of the superior constrictor of the Pharynx, Internal and External Pterygoids, Depressor Labii inferioris and Levator menti. (3) Probably a part of parotid gland. (4) Stylo-maxillary ligament. (5) *Nerves*, viz., Inferior dental, small twigs of the facial, part of auriculo-temporal, mylo-hyoid, and masseteric. Care must be taken to preserve the conjoined chorda tympani and lingual from injury. They lie on the internal pterygoid, and are covered by the external pterygoid ; the chorda being the nerve of taste to the anterior two-thirds of the tongue, while the lingual is the nerve of common sensation to the same part. (6) *Arteries*—Inferior dental, facial and its submental branch, and other small muscular branches. The internal maxillary may be cut, or even the external carotid near the point where it divides into temporal and internal maxillary.

The care necessary in disarticulating the jaw will be evident when one remembers the close relation of various important structures to it, such as : Internal maxillary artery, auriculo-temporal nerve with the middle meningeal artery between its two heads of origin and the chorda tympani close to the glasserian fissure.

Excision of the *central* part of the lower jaw is always a dangerous operation. There is the risk of suffocation from the retraction of the hyoid bone and tongue when the attachments of the mylo-hyoid, genio-hyoid, and genio-hyo-glossi muscles are divided from the bone. To prevent this as far as possible the tongue must be fixed by a strong ligature passed through its tip, and held well out by an assistant. For the same reason it is better in excision of one side of the lower jaw not to cut through the symphysis exactly, but a little external to it, so as to leave the insertions of the genio-hyoid and the genio-hyo-glossus muscles.

TRACHEOTOMY.

By this is meant the making of an opening in some part of the trachea. **Laryngotomy**—when the opening is made

in the crico-thyroid membrane—usually by a single thrust; **Tracheotomy**—when the opening is made through some part of the trachea itself, either above or below the isthmus of the thyroid body; and hence we have the *high* and the *low* operations. **Laryngo-tracheotomy.**—In this operation the opening is made through the crico-thyroid membrane, cricoid cartilage, and upper rings of the trachea. The opening may be temporary or permanent. A *temporary* opening may be required for (1) Obstructive œdema glottidis; (2) Acute laryngitis; (3) Spasms from pressure on or irritation of the recurrent laryngeal nerve; (4) Emphysema of the loose connective tissue of the neck, as from a pen-knife wound; (5) Scalds of rima, by boiling water or caustic fluid; (6) Foreign bodies in the air passages; (7) Masses of food in the gullet; (8) Croup; (9) Diphtheria. A *permanent* opening may be required for (1) Chronic diseases of the larynx, resulting in thickening of the mucous membrane, abscesses, necrosis of cartilages, &c.; (2) Polypi of the larynx. Some surgeons doubt whether it should be opened in croup and diphtheria. In croup, the dangers are: (*a*) Obstruction to the larynx; (*b*) Extension of the disease down to the lungs. So also in diphtheria we have similar dangers: (*a*) obstruction to larynx and pharynx; (*b*) Pulmonary inflammation, blood poisoning, and exhaustion. If the disease spreads downwards, opening the trachea may not save the patient's life; but it at least saves him from a very distressing kind of death, and there is a possibility (though it is not very great) that it may save his life. And we think, therefore, that even in croup and diphtheria opening the windpipe is a perfectly justifiable operation, so long as it gives temporary relief or affords the *least chance* of saving the patient's life.

In the **middle line of the neck** we find the following structures:—(1) Symphysis of the lower jaw; (2) Central tendon of mylo-hyoid muscles; (3) Body of the hyoid bone; (4) Thyro-hyoid membrane; (5) Thyroid cartilage; (6) Crico-thyroid membrane and arteries; (7) Cricoid cartilage; (8) Two or three rings of the trachea; (9) Isthmus of the thyroid body (usually crossing about the 3rd or 4th rings); (10) The trachea again.

Position of the Patient.—The shoulders are well raised by pillows; the head is thrown as far back as practicable, and kept perfectly straight and steady by an assistant. **Incision.**—In tracheotomy, begin the incision over the cricoid cartilage, and carry it downwards, *exactly in the middle line*, for 2 or 2½ inches. By this incision, (1) Skin, (2) Fascia, (3) Fatty tissue are divided. On either side of the median line are the two anterior jugular veins, which are very often connected by a transverse communicating branch: these must, if possible, be avoided. (4) Cut through the inter-muscular fascia connecting the edges of the sterno-hyoids and sterno-thyroids, and separate them with the handle of the scalpel; also turn aside the inferior thyroid veins and *thyroidea ima* artery (if present), and the isthmus of the thyroid body, and some loose cellular tissue will now be brought into view. Turn aside this loose tissue with the point of the finger or the handle of the scalpel, and the trachea is then exposed, and may be opened (either above or below the isthmus of the thyroid body, as circumstances may determine) thus:—Transfix and draw it forward by a sharp hook, and push in the point of the knife, with its *back* towards the sternum (this is done whether the operation be above or below the isthmus), and cut through three or four rings, and introduce the tube—taking care first that all bleeding has ceased, unless the urgency of the case be so great as to demand the immediate introduction of the tube. The opening in the trachea and the tissues covering it must correspond exactly, otherwise mucus and air will escape into the cellular tissue, producing emphysema.

Note.—The trachea extends from the lower border of the cricoid cartilage (or opposite the 6th cervical vertebra) to the body of the 4th dorsal vertebra. (1) If the incision is not exactly in the middle line, it will be difficult to keep the tube in its place; and besides, the carotid arteries might be injured. (2) Above the isthmus the trachea is quite superficial, and, as as a rule, has no veins of consequence in front, except a communication between the superior thyroids; where the isthmus crosses (about the 3rd or 4th rings), there is usually a plexus of veins, besides the isthmus itself; below the isthmus, the trachea is more deeply placed, being covered, in addition to

the superficial structures, by the sterno-hyoid and sterno-thyroid muscles, the large inferior thyroid veins, and sometimes by a special arterial branch to the thyroid body—the "thyroidea ima." (3) In stout, short-necked persons, the lower part of the trachea is more deeply placed. The chief difficulties of the *low* operation are: (1) The trachea is deeper; (2) The inferior thyroid veins are larger; (3) The danger to the isthmus is greater, because we must cut *towards* it, in order to avoid the important structures behind the upper part of the sternum; (4) The thymus body may be in front of this part; (5) The occasional presence of the "thyroidea ima."

Tracheotomy in Children.—Here the relations of the parts are somewhat altered. The neck is shorter; "but, relatively, the space is greater between the isthmus of the thyroid body and the top of the sternum, so that the cervical part of the trachea is longer than in the adult."—(SPENCE). But in the child the trachea is smaller, more deeply placed, and more moveable than in the adult; also, the danger from hæmorrhage is greater, on account of the large size of the venous plexus in connection with the thyroid body. There is more subcutaneous fat; and the carotids are in closer relation to the trachea, so that a *slight* deviation from the middle line may wound one or other of these important arteries. The presence and large size of the thymus body in the child will also complicate the operation. In other respects it is practically the same as in the adult.

Laryngotomy.—The crico-thyroid membrane is quite superficial, and may be felt as a slight depression about one inch below the "pomum Adami." If the case is urgent, open by plunging in the knife at once; if not, we may take the matter more coolly. Over the space make a vertical incision in the middle line through the skin, about an inch in length, and then make a *cross* cut through the membrane. The only danger likely to arise is hæmorrhage from the small arteries which cross and anastomose in front of the membrane (the crico-thyroid branches of superior laryngeals). They are seldom a source of trouble; and by making a *cross* incision they are not likely to be wounded. **Laryngotomy** is to be preferred in the adult because: (1) The opening is quite as

good as in the trachea; (2) It is far safer, from the simple anatomy of the parts; (3) It is more quickly performed; (4) Diseases which necessitate the operation in the adult have little tendency to spread downwards.

NOTE.—Œdematous infiltration about the larynx is chiefly confined to the sub-mucous areolar tissue around the epiglottis, margins of the glottis, and back of thyroid cartilage. In these situations the sub-mucous tissue is very loose and freely movable, and readily becomes infiltrated and distended with serous effusion—so much so, as almost to occlude the rima glottidis. But this effusion and distension never extends below the true vocal cords, being limited at this point by the direct adhesion of the mucous membrane to the fibrous tissue forming the cords, without the intervention of any sub-mucous coat.

Pharyngotomy or Œsophagotomy.—Make an incision about 4 inches in length along the anterior border of the *left* sterno-mastoid (as the œsophagus in the neck lies to the left of the middle line), beginning a little below the level of the upper border of the thyroid cartilage. The incision is almost the same as that necessary in ligature of the left common carotid, but a little nearer the middle line. Divide the skin, platysma, and fascia, and draw aside the sterno-mastoid. Carefully dissect down, with the handle of the knife, or fingers, between the carotid sheath, trachea, and larynx. Draw the sterno-hyoid and sterno-thyroid muscles towards the middle line, the thyroid body upwards, and if the omo-hyoid be in the way, divide it. Great care is now necessary to avoid wounding the thyroid arteries—especially the inferior—passing to the lower angle of the thyroid body behind the carotid sheath; also to avoid injuring the left recurrent laryngeal nerve, which lies between the œsophagus and trachea. The œsophagus being exposed, pass a metallic sound, or catheter, or probang through the mouth into it, and cause its walls to project: this is made to serve as a guide for the necessary incision; otherwise the air passages might be cut into.

Parotid Duct (STENSON'S).—Its course is indicated by a line drawn from the external auditory meatus to a little below the nostril. Above it is the transverse facial artery,

and below it are some branches of the facial nerve. It perforates the cheek obliquely, opposite the 2nd molar tooth of the upper jaw. It is necessary to remember its course, as it may be divided in wounds or operations about the face, and give rise to salivary fistula.

Lachrymal Sac.—If from any cause this sac requires to be opened (*e.g.*, when suppuration has occurred in it), it should be opened from the *outer* side, because the angular artery (the termination of the facial) and the large angular vein are on its inner or nasal side. The sac is placed in the inner angle of the orbit, and crossed by the tendo-oculi a little above its middle. If the finger be placed on the inner edge of the orbit, this tendon will be felt to tighten every time the eye is closed, and still more so if the eyelids are drawn outwards.

Nasal Duct.—This duct leads from the lachrymal sac to the inferior meatus of the nose. The edges of the canal through which it passes may be felt on one's own person, by pressing the finger on the inner edge of the orbit on its lower aspect. To pass a probe through it, it should be directed downwards, outwards, and a little backwards (the direction of the duct). Obstruction of this duct leads to distension, and consequently to irritation and disease of the lachrymal sac, and, unless properly treated, inflammation and suppuration follow, which may end in fistula lachrymalis. It is also a cause of "Epiphora" or "Stillicidium Lachrymarum," trickling of tears over the cheek. Each duct opens into the inferior meatus of the nose; they are about half-an-inch long, and they are narrowest about the middle.

Puncta Lachrymalia and Canaliculi.—The puncta are two small apertures situated, one on the free margin of each lid, about one quarter of an inch from the inner canthus; they are the openings of two small ducts—the canaliculi. Each canaliculus takes a curved course inwards—the upper first passing upwards and then curving downwards; the lower first passing downwards, and then curving upwards; and, therefore, in introducing a probe, the lid should be drawn outwards to straighten the canaliculus. The lower canaliculus is shorter, wider, and not so much arched as the upper,

and is the one usually opened. In doing this the edge of the knife is directed upwards and towards the nose, and passed first a little downwards and then straight inwards.

Division of the 5th Nerve on the Face.—The supra-orbital notch or foramen is situated about the junction of the inner with the middle third of the supra-orbital margin. From this point a perpendicular line drawn, with a slight inclination outwards, so as to cross the interval between the two bicuspid teeth, passes over the infra-orbital and mental foramina.—(HOLDEN.)

WOUNDS OF THE SCALP.

These, however slight, should be watched very carefully, because of the close anatomical relations that exist between the internal and the external structures of the cranium, and the possibility, therefore, of the effects of the injury implicating the brain and its membranes; and all the more so when we bear in mind that, from the nature of the textures wounded, they are far more likely to be followed by erysipelatous inflammation than wounds in other parts of the body. The chief anatomical peculiarities of the scalp are—(1) The great amount of dense fibrous tissue that enters into its formation. (2) Its great vascularity, and, consequently, (3) Its great vital activity. (4) Its vascular connections with the cranial bones and dura mater; this is especially the case with the cellular tissue on its deep surface, which is largely permeated by blood vessels which enter the bones and communicate in the diploë with branches from the dura mater. At several places also large vessels pass directly through from the scalp or face and communicate with the various sinuses and arteries within the cranium, *e.g.*, at the occiput the meningeal arteries of the occipital artery anastomose with those of the vertebral: behind the ear a large vein passes through the mastoid foramen to the lateral sinus; on the vertex another vein passes through the parietal foramen to the superior longitudinal sinus; on the face, at the inner angle of the orbit, the angular artery and vein anastomose, with the nasal branch of the ophthalmic artery and ophthalmic vein, and other branches of the ophthalmic artery anastomose with the middle meningeal, and so

on. Leeches may be applied at any of these parts to relieve congestion of the brain.

Attachment of the Pericranial Aponeurosis.—It is *firmly* attached to the fat and fascia superficial to it, but only *very loosely* connected with the parts beneath by means of a fine cellular tissue. *Posteriorly* it is attached to the superior curved lines of the occipital bone; at the *sides* to the mastoid process, attolens and attrahens aurem, and zygoma; in *front*, it is blended with the corrugator supercilii, orbicularis palpebrarum and pyramidalis nasi.

In bruises of the scalp, extravasation may take place either *into* or *under* the aponeurosis. In suppuration *beneath* it the pus gravitates to the most dependent parts until arrested by its attachments; and, according to its position, may form a a bag bulging over the orbits, the root of the nose, or above the zygoma, or passing down towards the neck behind. Sometimes it spreads over the whole extent of the head. Extravasation *into* the scalp texture may simulate a depressed fracture. Owing to the density of the scalp texture, the extravasation is limited, and forms a circumscribed flattened swelling; the edges feel extremely hard from the coagulation of the blood in the interstitial textures of the scalp, while the centre, where the blood is not yet coagulated, is soft, and gives rise to the supposition that there is a depressed fracture. By firm, downward pressure, however, the unbroken cranial bone may be detected beneath.

Meningeal Arteries.—(1) In the anterior fossa of the skull we have small branches from the anterior and posterior ethmoidal arteries. (2) In the middle fossa we have—(*a*) The middle meningeal entering through the foramen spinosum; (*b*) The small meningeal entering through the foramen ovale; (*c*) Meningeal branch from the ascending pharyngeal entering through the foramen lacerum medius. (3.) In the posterior fossa we have small branches from the occipital and vertebral arteries.

The largest and most important of these is the middle meningeal. It is liable to be ruptured by blows on the temple producing fracture of the parietal or temporal bones, or great wing of the sphenoid—more especially in the case of the

parietal and sphenoid, as it enters the skull through the foramen in the spinous process of the sphenoid, and frequently traverses for a short distance a bony canal *in* the anterior inferior angle of the parietal bone. But the various sinuses at the base of the cranium are also liable to be ruptured, *e.g.*, hæmorrhage into the orbit and eyelid points to rupture of the cavernous sinuses; bleeding from the ear, followed by the discharge of a clear fluid, may be due to fracture of the petrous part of the temporal bone, with laceration of some of the sinuses in that neighbourhood (inferior or superior petrosals and lateral).

Dislocation of the Lower Jaw.—Is usually caused by some sudden exertion on the part of the patient, or spasmodic action of the depressors of the jaw, as in gaping, fits of laughter, attempting to take too large a bite, &c. It may be—(1) Unilateral or incomplete; (2) Bilateral or complete, according as one or both of the condyles are displaced. When the mouth is opened the condyle with the inter-articular fibro-cartilage glide forward on to the emenentia articularis; but, if this be continued too far, and, if at the same time, the *external pterygoid* muscle contracts forcibly, the condyle slips forward into the zygomatic fossa. In this way a dislocation is produced. The capsular ligament is not ruptured, and reduction is, as a rule, easily accomplished.

Venesection from External Jugular.—This may be useful in cases of croup in young children, apoplexy in adults, or in venous congestion of the head or chest. The vein is crossed obliquely by the fibres of the platysma, their relative positions being represented very nearly by the letter **X**. To secure a good flow, the cut in the vein must be oblique, because if longitudinal the edges would not gape. But, the external jugular must not be opened by a single oblique thrust at once, because the cut would then be parallel to the fibres of the platysma, which by their contraction would prevent the free exit of the blood, and might give rise to extravasation and thrombus. It should be opened while it lies on the sterno-mastoid, because at this point it is most superficial and more firmly fixed. (1) Compress the vein at the lower part of the neck to make it "rise," and also to prevent the entrance

of air; (2) Make an incision in the skin obliquely to the course of the vein; (3) Divide the fibres of the platysma transversely; (4) Open the vein by an oblique incision (exactly the same direction as that made in the skin, but rather less). To stop bleeding, fix a pad of lint over the wound by strips of adhesive plaster.

Arteriotomy from Anterior Branch of Temporal.—This may be necessary in affections of the eye. Its pulsations can be felt about one inch and a quarter behind the external angular process of the frontal bone. Compress on the *distal* side of the intended opening (veins should be compressed on the *proximal* side). Expose it, by cutting through the superficial structures, and make an oblique opening into it. To stop the flow, cut the artery completely through, when its coats will, as a rule, contract and retract sufficiently to stop the bleeding, if not, secure by acupressure, or ligature the cut ends.

Division of the Lingual Nerve (*"Gustatory"*).—This being the nerve of common sensation to the anterior two-thirds of the tongue its division has been practised inside the mouth, with the view of relieving the pain of cancerous ulcers of that organ. *Guide.*—A line drawn from the middle of the crown of the last molar tooth to the angle of the jaw. This line will cross it in the exact place where it should be cut. It lies about half an inch from the tooth between it and the anterior pillar of the fauces, parallel to, but behind and below the prominent alveolar ridge on the inner side of the body, and ascending ramus of the lower jaw. Enter the knife about three quarters of an inch behind and below the last molar tooth, and cut down to the bone, and the nerve is certain to be divided.

Removal of the Tonsils.—The tonsils are situated between the anterior and posterior pillars of the fauces, and, in health, do not project beyond the level of these arches. If they are much enlarged they interfere with respiration, and must be removed; this may be done by a probe-pointed bistoury. Cut downwards and inwards, and on no account turn the edge of the knife outwards, lest the internal carotid artery, and the ascending pharyngeal branch of the external

carotid be injured, there being nothing covering these vessels at this point except the pharyngeal aponeurosis and the superior constrictor of the pharynx.

Tumours and Abscess of Parotid Gland.—These give rise to much pain because of the dense unyielding fibrous capsule of the gland, and, therefore, should be relieved early by incision (in the case of abscess), or excision (in the case of tumours). The relation of the gland to various important vessels and nerves must be kept in mind. (1) The external carotid enters the deep surface of the gland, and gives off in it the following branches:—(*a*) Occipital; (*b*) Posterior auricular; (*c*) Temporal; (*d*) Internal maxillary. (2) Passing from the gland is the external jugular vein, formed in the gland by the union of—(*a*) Temporal; (*b*) Internal maxillary; (*c*) Posterior auricular; (*d*) Transverse facial veins. (3) The auriculo-temporal nerve enters the gland at its lower and posterior part, and the facial nerve passes through the gland and leaves it by its upper, anterior, and lower borders. The order from the surface is—nerves, veins, arteries. But, further the deep surface of the gland is in relation with the internal carotid artery and internal jugular vein. In operations about the gland for the excision of tumours or the opening of abscess, the knife should not be entered behind a line drawn from the condyle to the angle of the jaw, lest the external carotid artery should be injured; and, to avoid wounding the trunk of the facial nerve or the chief branches of the "pes anserinus," the incisions should be made as far as possible parallel to the main trunk—*i.e.*, the knife must be held horizontally, and the gland at the same time be drawn well forwards. The facial is the motor nerve of the muscles of expression, and its division gives rise to paralysis of these muscles, hence the importance of preserving it from injury.

Trephining.—This operation should not be performed over the course of the sinuses, nor in situations likely to wound the middle meningeal artery. A line drawn over the head from the root of the nose to the occipital protuberance indicates the course of the *superior longitudinal sinus;* another line drawn from the same protuberance to the external auditory meatus indicates the course of the *lateral sinus*, and about

the middle of this line the pulsations of the occipital artery may be felt.—(HOLDEN.)

The middle meningeal artery traverses the foramen spinosum, and a groove or canal in the anterior inferior angle of the parietal bone, about one inch and a-half behind the external angular process of the frontal bone; neither, therefore, in this place, nor over the parts mentioned before, should the trephine be applied.

EXCISION OF THE TONGUE.—This operation may be performed in several ways—(1) From the inside of the mouth without any external incisions. (2) By incisions below the jaw (submental, or Regnoli's method). (3) By section of the lower lip and jaw (Sédillot's method).

1. From the inside of the Mouth.—The patient is gagged and the tongue seized with a strong hooked forceps and drawn well forwards and upwards. Then cut through—(*a*) Frænum linguæ; (*b*) Insertions of genio-hyoids; (*c*) Insertions of genio-hyo-glossi muscles, and cut well back so as to set free the base of the tongue; then cut (*d*) the reflexion of the mucous membrane of the floor of the mouth from the lower jaw. Draw the tongue well forwards, and apply the wire Ecraseur and gradually remove the organ. If the anterior pillar of the fauces be in the way it may be cut across.

2. By Incisions below the Jaw.—Regnoli's incisions were the following:—An incision of semi-lunar shape made along the line of the lower jaw, if possible confined within the space between the two facial arteries; another, a perpendicular incision carried from the centre of the semi-lunar one, under the chin down as far as the hyoid bone. Care must be taken not to injure the facial arteries. Then (*a*) the integuments are cut through, and after this the structures forming the floor of the mouth, viz., (*b*) Anterior bellies of the digastric muscles; (*c*) The mylo-hyoids; (*d*) Insertions of genio-hyoids and of the genio-hyo-glossi; (*e*) Mucous membrane of the floor of the mouth. A piece of strong whip cord is then passed through the tip of the tongue, or it is seized with a strong hook-forceps, and drawn through the opening between the lower jaw and the hyoid bone, and removed by dividing its attachments (1) to the epiglottis, viz., the three epiglottidean

folds of mucous membrane (a central and two lateral); and, (2) To the hyoid bone, viz., the hyoglossus and genio-hyo-glossus muscles and the hyo-glossal membrane. The lingual ends of the palato and stylo-glossus will also be divided. The lingual arteries may now be secured, or they may be exposed and tied before removing the tongue; they will be found to pass forwards to the outer side of the genio-hyo-glossi muscles between them and the hyo-glossi. The great objection to this operation is, that all the muscles that elevate the hyoid bone and larynx are divided, and it consequently interferes with the movements of deglutition and respiration to a certain extent.

3. By Section of the Lower Lip and Jaw.—(Sédillot's operation.)—By this operation the disadvantages of Rignoli's method are done away with, but there is an additional risk incurred from the section of the lower jaw, and that is the great disadvantage of this operation, as its severity is materially increased by division of that bone. A piece of strong whip cord is passed through the tip of the tongue so as to enable it to be drawn forwards when necessary, and the two central incisor teeth are extracted. Then an incision is made through the central line of the lower lip, across the chin, and down as far as the hyoid bone, and the lower jaw sawn through at the symphysis. The mucous membrane and genio-hyo-glossi muscles are then divided close to the jaw, and the two halves of the bone separated and the hyo-glossi muscles cut through. The tongue is next drawn forwards and the lingual arteries divided and secured, when it is then removed from the hyoid bone by a stroke of the knife.

External Auditory Meatus.—This meatus is about an inch and a-half in length; the lower wall is the longest on account of the oblique direction of the membrana tympani. It passes obliquely forwards and inwards, and is curved upon itself, the concavity pointing downwards, so that its floor is convex; it is also curved a little forwards. Its shape is oval, with the long axis vertical, and it is narrowest about the middle, and, therefore, the ear speculum should not be introduced beyond this point. About one-half its length is formed of cartilage, the rest of bone. In young children, however,

there is practically no bony part, and in them, therefore, the meatus is very short. In examining the membrana tympani, the pinna should be pulled upwards and backwards in order to straighten the meatus as much as possible. In health, the membrana tympani is smooth and shining, and has a slate blue colour, and it is concave from the outside. Besides, seeing the membrana (by means of the speculum) we also see the handle and short process of the malleus (which are situated between the outer and middle layers of the membrane) and that appearance known to aural surgeons as the "triangle of light."

Eustachian Tube.—The open trumpet-shaped mouth of this tube is situated on a level with the posterior extremity of the inferior turbinate bone. Obstruction of the tube gives rise, if not to deafness, at least to considerable impairment of hearing, and it may be advisable to pass the Eustachian catheter for its relief. This is done in the following way :—It is passed along the floor of the nostril as far as necessary, with the point directed upwards and outwards, while the handle is carried towards the septum of the nostrils. If these directions are attended to, and at the same time no force used, the point of the instrument will readily enter the tube. As this operation is very disagreeable and irritating to the patient, a full dose of Bromide of Potassium should be given about half an hour before attempting to pass the catheter, in order to deaden reflex excitibility.

Another method for forcing air up the Eustachian tube takes advantage of the physiological fact, that during deglutition the opening from the mouth into the upper part of the pharynx and posterior nares is closed, and also at the same time the Eustachian tube is opened by the circumflexus palati. Every time one swallows it is possible to hear a "click" in the ear due to the air being forced up the Eustachian tube and impinging on the membrana tympani, and this is rendered much more evident if the nostrils are closed by grasping the nose with the finger and thumb. By these means we have really an air-tight chamber, and if any of its walls are squeezed or forced inwards, or if more air be driven in, the air being practically incompressible is driven in the direction of the least

resistance, *e.g.*, up the Eustachian tube. The patient is directed to take a mouthful of fluid, and, at a given signal from the operator to swallow it. The operator introduces the end of a tube (the other end of which is in communication with a small reservoir of air) into one nostril, and closes the nostrils with the finger and thumb of one hand, while with the other hand he grasps the air-bag. He then directs the patient to swallow, and as he does so, the operator projects into the nostril a quantity of air, which increases the pressure, and some of it passes up the Eustachian tube into the tympanum.

Wry Neck.—*Causes:* (1) May be congenital, or it may follow measles or scarlatina; (2) Long-continued irritation, as from inflamed cervical glands; (3) Disease of the cervical vertebræ and their ligaments; (4) Traction from a cicatrix of a burn; (5) Spasmodic contraction of the sterno-mastoid and trapezius of the same side, from irritation of the spinal accessory; or it may even be due to contraction of the platysma; (6) Paralysis of the opposite sterno-mastoid. As a cure for some forms of wry neck, it has been proposed to stretch the spinal accessory nerve; but this operation is hardly ever followed by any permanent benefit, and if it is to be interfered with at all, it is better to cut it right through, or even to remove an inch or so out of the trunk of the nerve. Division of the sterno-mastoid is also practised for the relief of this deformity.

To Stretch Spinal Accessory Nerve.—This nerve leaves the cranium, in the same sheath of dura mater as the vagus, by the jugular foramen, and after having passed through, is found lying, with the other divisions of the 8th pair, between the internal jugular vein and the internal carotid artery. It then passes downwards and backwards across the internal jugular vein, and appears below the posterior belly of the digastric, and close to, but below, the transverse process of the atlas, and enters the deep surface of the sterno-mastoid. In this region it may be exposed, and stretched or cut, by an incision along the upper part of the anterior border of the sterno-mastoid, commencing at a point an inch and a-half above the angle of the jaw, and carried downwards for 2 or 3 inches. By dividing the superficial structures, and defining the anterior

edge of the sterno-mastoid, the nerve will be seen emerging from below the posterior belly of the digastric, and entering the deep surface of the former muscle. The incision must not be carried too far up, lest the external jugular vein (which lies midway between the angle of the jaw and the mastoid process) or the parotid gland be injured. The nerve is also crossed by the occipital artery.

Division of the Sterno-Mastoid.—The part which most frequently requires division is the sternal head; but both heads may be divided. In doing so it is well to bear in mind the proximity of important structures, *e.g.*, the internal jugular vein, and several veins passing to join it, lie behind the muscle, and if care be not taken the operation may be followed by a fatal result. The incision should be made from behind, forwards close to the sternum, and along the clavicle, and if this be done, there is little risk of doing any damage; the tension of the muscle tends to make it project forwards, and away from the carotid sheath. The following method is that recommended by Erichsen:—By passing a tenotome behind the tendon with its flat side towards it, just at the upper margin of the sternum, and then turning the edge towards the muscle and cutting forwards. In dividing the clavicular insertion make a puncture with a scalpel upon, and down to the clavicle in the space between the two heads of the muscle, and then push a blunt-pointed, narrow-bladed tenotome between that bone and the insertion of the muscle, and cut forwards.

The Deep Fascia of the Neck.—This is attached behind to the spinous processes of the cervical vertebræ. It splits to enclose the trapezius muscle, and then the two layers join to form the roof of the posterior triangle of the neck; and, it again splits to enclose the sterno-mastoid and the depressor muscles of the hyoid bone, and then unites across the middle line with the fascia of the opposite side. This layer is attached *above* to the base of the lower jaw, the zygoma, the superior curved line and the protuberance of the occipital bone; *below*, to the upper and posterior part of the manubrium sterni. If pus form beneath this layer, it will in all probability find its way into the anterior mediastinum.

From the deep surface of this layer, as it ensheaths the

sterno-mastoid, a strong process passes inwards across the neck, and forms the carotid sheath, and then passes in front of the prevertebral muscles, but behind the pharynx and œsophagus, to unite with the layer of the opposite side. This part is attached *above* to the angle of the lower jaw and the styloid process, and the part intervening between these two points is known as the *stylo-maxillary ligament*, which separates the parotid from the sub-maxillary gland. As this layer passes down, it divides into two parts—one is attached to the first rib, and binds down the central tendon of the omo-hyoid to that bone, the other layer passes into the thorax in front of the prevertebral muscles. If pus form in *front* of the former it will most likely find its way into the axilla; if behind it, it will gravitate towards the apex of the pleura and lung; if it form beneath the latter division, it will tend to pass into the posterior mediastinum.

SURGICAL ANATOMY OF THE UPPER EXTREMITY.

LIGATURE OF ARTERIES.

AXILLARY ARTERY.—**Origin.**—It is the direct continuation of the subclavian. **Extent.**—From the lower border of the first rib, to the lower border of the insertion of the teres major. **Course.**—With the arm well abducted, its course is indicated by a line drawn from a point somewhat to the sternal side of the middle of the clavicle, to the inner border of the coraco-brachialis muscle. It is divided into three parts—a part above, a part beneath, and a part below the pectoralis minor.

The First Part.—This part extends from the lower border of the first rib to the upper border of the pectoralis minor. With the arm at right angles to the trunk, the operator standing between the limb and the trunk, makes an **incision** in the line of the vessel limited by the depressions on either side of the *clavicular* head of the Pectoralis major. We cut through —(1) Skin; (2) Superficial fascia; (3) Platysma; (4) Deep fascia; (5) Clavicular head of the pectoralis major, taking care to avoid the *cephalic vein*, which lies to its outer side in the groove between it and the deltoid. After this we meet with a quantity of fatty tissue, in which ramify, or pass through, the structures that pierce the costo-coracoid membrane, viz.: —(*a*) Cephalic vein; (*b*) External anterior thoracic nerve; (*c*) Thoracic axis, or acromio-thoracic artery; (*d*) Superior thoracic artery; (*e*) Corresponding veins. Pass carefully through the fatty tissue, cutting as little as possible, lest the above structures be injured, till the axillary sheath (part of the costo-coracoid membrane) is exposed. (6) Open this sheath, taking care not to wound the axillary vein, which is superficial and internal to the artery. The cords formed by the union of the spinal nerves entering into the formation of the brachial plexus, lie to its outer side, or partially overlapping it. Clear the artery, and pass the needle *from* the vein.

Behind this part of the vessel is the first digitation of the serratus magnus, and the posterior thoracic nerve (Nerve of Bell.) Ligature of this part of the axillary artery is a dangerous operation, because of—(1) Its great depth; (2) Its relation to other blood vessels, *e.g.*, the axillary and cephalic veins, and branches of the thoracic axis; (3) Its relation to nerves, *e.g.*, the external anterior thoracic in front, and the posterior thoracic behind.

Collateral Circulation.—If tied *above* the thoracic axis it is the same as in ligature of the third part of the subclavian. If tied *below* the axis, in addition to the chief collateral branches mentioned under "collateral circulation" (see p. 6) in ligature of the subclavian, we have—(1) Branches from the thoracic axis anastomosing with branches from the posterior circumflex (third part of the axillary); (2) The long thoracic anastomosing with the aortic intercostals and internal mammary.

The Second Part of the Axillary.—The part beneath the pectoralis minor is not tied except when wounded—(1) Because it is short and gives off two or three branches; (2) It is too deeply placed; (3) It is so closely surrounded by nerve trunks. It is covered by the two pectoral muscles, and the three cords of the brachial plexus are arranged, one on each side, and one behind it.

The Third Part.—This is the longest of the three parts, and extends from the lower border of the pectoralis minor to the lower border of the teres major: it is twice as long as either of the others. In order to ligature it the arm is placed at right angles to the trunk, and the operator stands as before.

Superficial Guide.—The prominence caused by the coraco-brachialis. Make an **incision** along the inner side of this muscle for about 2 inches, beginning in the hollow of the arm-pit. Cut through—(1) Skin; (2) Fascia, and expose the edge of the coraco-brachialis. After dividing the fascia (superficial and deep) the median and the internal cutaneous nerves, with the artery behind and between them will be seen, or more correctly, the artery is really surrounded by nerve trunks; to the outer side are the median and the musculo-cutaneous nerves; on the inner side the ulnar and nerve of Wrisberg;

above, the internal cutaneous; behind, the musculo-spiral and circumflex. These branches form the **Deep Guide**, and in the midst of them the artery will usually be found. Carefully expose and open the sheath, clear the artery and pass the needle from the inner side. To give, shortly, the entire relations of the artery—In *front*, (1) Integument and fascia, and this only at the lower part of its course; (2) Pectoralis major (at the upper part), and internal cutaneous nerve; (3) Inner head of median. *Behind*—(1) Subscapularis; (2) Tendons of latissimus dorsi and teres major; (3) Musculo-spiral and circumflex nerves. On the *outer* side—(1) Coraco-brachialis; (2) Median nerve; (3) Musculo-cutaneous nerve. On the *inner* side—(1) Ulnar nerve; (2) Nerve of Wrisberg; (3) Axillary vein. The median nerve has a triple relation to this part of the artery—(1) Its two heads embrace it; (2) It usually lies above it; (3) It is placed to its outer side. This part of the axillary artery is better fitted for ligature than the parts we have previously considered; (1) It is twice as long as either of the others; (2) Its lower part (half or third) is simply covered by the common tegumentary structures, and has no muscle above it; (3) Its branches come off well up towards its beginning, and are therefore well out of the way when the artery is ligatured.

The following points should be noted:—(1) The artery may be covered by a muscular slip from the latissimus dorsi; (2) In one out of every ten cases there are two arteries instead of one, the second usually being one of the arteries of the forearm (usually the radial); (3) The position of the nerves vary: instead of encircling the axillary artery, they may encircle a large branch formed by the union of several of the usual branches, and in this case they would therefore be useless as the "deep guide."

Collateral Circulation.—If tied above the subscapular branch, it is the same as when the first part is ligatured. If tied below this branch, the collateral anastomoses are small, but usually sufficient—(1) Anastomoses between branches of the posterior circumflex and the superior profunda; (2) Anastomoses between branches of the subscapular and the superior profunda; (3) Anastomoses through the coraco-brachialis,

biceps, and long head of triceps—muscular branches; (4) Through the shaft of the humerus.

BRANCHES OF THE AXILLARY.

Of the First Part.—(1) Superior thoracic, (2) Acromio-thoracic, or thoracic axis situated at the *upper* border of the pectoralis minor. **From the Second Part.**—(1) The long thoracic or external mammary, which runs along in the *anterior fold* of the axilla at the *lower* border of the pectoralis minor to the mammary region; (2) Alar thoracic. **From the Third Part.**—(1) Subscapular artery which runs along in the *posterior fold* of the axilla at the lower border of the subscapularis muscle; (2) Posterior circumflex; (3) Anterior circumflex. These encircle the surgical neck of the humerus.

Brachial Artery.—Origin.—It is the direct continuation of the axillary. **Extent.**—From the lower border of the teres major to a point opposite the neck of the radius—about half-an-inch below the bend of the elbow—where it divides into radial and ulnar arteries. **Course.**—Its course corresponds to a depression along the inner border of the coraco-brachialis and biceps muscles, or a line drawn from the centre of the arm-pit to the middle of the bend of the elbow. It is at first to the inner side of the humerus, but gradually turns to the front of that bone; in applying digital compression this relation of the artery to the humerus must be kept in mind.

Relations of the Vessel.—In *front*—(1) Skin, superficial and deep fascia; (2) Bicipital fascia, with median basilic vein lying on it; (3) Median nerve crossing from the outer to the inner side. Note the triple relation of this nerve to the artery—at the *outer* side, above; in *front*, about the middle; and at its *inner* side, below. *Behind*—(1) Long and inner heads of triceps; (2) Insertion of coraco-brachialis; (3) Brachialis anticus; (4) Musculo-spiral nerve and superior profunda artery lying between it and long head of triceps. On the *inner* side—(1) Median, ulnar, and internal cutaneous nerves; (2) Basilic vein. On the *outer* side—(1) Median nerve; (2) Coraco-brachialis; and (3) Biceps. It is usually ligatured in the middle third of the arm.

Superficial Guide.—The prominence caused by the inner

edge of the biceps. **Incision.**—This should be about 3 inches long, and made on the biceps (and not exactly over the vessel) parallel with and close to its inner edge. We divide the skin, fatty tissue, and superficial fascia, and then define the inner edge of biceps, and draw it aside and cut through the deep fascia, and look for the **deep guide.**—The median nerve close to the edge of the biceps, or crossing the vessel in the bottom of the wound from without inwards. Open the sheath, clear the vessel, and pass the needle *from* the nerve, at the same time taking care not to injure the venæ comites.

NOTE.—(1) Unless the incision be made close to the inner edge of biceps, the operator may cut down upon the ulnar nerve with its companion, the inferior profunda artery, and mistake the latter for the brachial. (2) In one out of every five cases there are two arteries instead of one. (3) The biceps muscle has occasionally a third head of origin arising between the coraco-brachialis and the brachialis anticus, and when this is the case it crosses in *front* of the brachial artery near the spot where it is usually ligatured. (4) Several cases are recorded where the median nerve passed *under* the artery, instead of over it.

Branches.—(1) Muscular; (2) Superior profunda which joins and accompanies the musculo-spiral nerve; (3) Inferior profunda which accompanies ulnar nerve; (4) Nutrient to humerus; (5) Anastomotic branch, which is given off about 2 inches above the elbow joint, and divides into two branches —one passes to the front of the internal condyle, the other passes behind the joint.

Collateral Circulation.—Superior and inferior profundæ above, anastomosing with various branches in the general anastomoses round the elbow joint—*e.g.*, the superior profunda with the radial recurrent, posterior interosseous recurrent and anastomotic; the inferior profunda with the anterior and posterior ulnar recurrents and anastomotic. Besides these there is the circulation through the shaft of the humerus and muscles in the neighbourhood.

It will be well, at this point, to give a brief description of the **Anastomoses round the Elbow Joint.** There are seven vessels that take part in this anastomoses—three

branches coming down—superior and inferior profundæ and the anastomotic; four branches passing upwards—Radial recurrent, anterior and posterior ulnar recurrents, and the posterior interosseous recurrent. For convenience they may be divided into four groups—(1) In front of *external* condyle anastomoses between (*a*) Superior profunda, and (*b*) Radial recurrent. (2) In front of *internal* condyle anastomoses between, (*a*) Anastomotic branch; (*b*) Anterior ulnar recurrent; (*c*) Inferior profunda. (3) Behind *external* condyle anastomoses between, (*a*) Anastomotic branch; (*b*) Interosseous recurrent; (*c*) Superior profunda. (4) Behind *internal* condyle anastomoses between, (*a*) Anastomotic branch; (*b*) Posterior ulnar recurrent; (*c*) Inferior profunda.

Radial Artery.—This vessel, like the Brachial, of which it is the proper continuation, is quite superficial. **Origin.**—From the bifurcation of the brachial at the bend of the elbow. **Extent.**—From its point of origin till it ends in the deep palmar arch. **Course.**—A line drawn from the centre of the hollow in front of the elbow joint to the styloid process of the radius will roughly indicate its course. **Relations.**—In *front*—skin, superficial and deep fascia, cutaneous nerves and vessels, &c., and it may be slightly overlapped at the upper part by the supinator longus. On the *inner* side—(1) Pronator radii teres, above; (2) Flexor carpi radialis, below. On the *outer* side—(1) Supinator longus; (2) Radial nerve (but only about the middle third of the vessel). *Behind*—(1) Tendon of biceps; (2) Supinator brevis; (3) Pronator radii teres; (4) Flexor Sublimis (radial head); (5) Flexor longus pollicis; (6) Pronator quadratus; (7) End of the radius. Note that at the wrist it lies between the tendons of the supinator longus and the flexor carpi radialis, and that the nerve is only in relation to the *middle third* of its outer side. The vessel may be ligatured at its upper or lower part.

(*a*) **Above the Middle Third.**—*Guide.*—The guide is the inner edge of the supinator longus muscle; find the tendon of this muscle at the wrist, and trace up the muscle towards the bend of the arm. **Incision.**—This should be two or three inches in length, and parallel with the inner edge of the muscle. Divide the skin and superficial fascia, define the

edge of the supinator longus, and divide the deep fascia parallel with it, draw the muscle a little outwards, and the artery will be seen immediately below this. Open the sheath, clear the artery, and if the radial nerve is seen near the vessel, pass the needle *from* the nerve. (*b*) **Ligature of the Lower Third of the Vessel.**—Make an incision two inches in length in the middle of the space bounded by the supinator longus on the outer side, and the flexor carpi radialis on the inner side; at this point the artery may be felt pulsating. Divide the skin, fascia, cutaneous vessels, and nerves (usually one of the terminal branches of the musculo-cutaneous nerve lies over the artery). When the deep fascia is divided, the artery is seen with its venæ comites; avoid these in clearing the vessel and in passing the needle. Complete the operation in the usual manner.

Branches.—Its chief branches in the forearm are—(1) The radial recurrent, and (2) Superficialis volæ.

Collateral Circulation.—Chiefly by the ulnar artery and its branches through the palmar arches. The anastomoses here are so free, that if the radial is wounded a ligature must be applied on both sides of the wound.

Ulnar Artery.—Origin.—From the bifurcation of the brachial at the bend of the elbow. **Extent.**—From its point of origin till it ends in the superficial palmar arch. **Course.**—It first passes downwards and inwards, and then straight downwards. The course of the straight part may be indicated by a line drawn from the inner condyle of the humerus to the inner side of the pisiform bone. **Relations.**—This vessel, unlike the radial, is at first very deeply placed. In *front*—(1) The superficial structures; (2) Crossed by median nerve at its upper part; (3) The following four muscles—(*a*) Pronator radii teres, (*b*) Flexor carpi radialis, (*c*) Palmaris longus, (*d*) Flexor sublimis digitorum. *Behind.*—(1) Brachialis anticus; (2) Flexor profundus digitorum. To its *inner* side—(1) Flexor carpi ulnaris; (2) Ulnar nerve (for its lower two-thirds). To its *outer* side—the flexor sublimis digitorum. NOTE.—At the wrist it lies between the tendons of the flexor sublimis digitorum and the flexor carpi ulnaris, and that the nerve is on its inner side for the lower two thirds. Like the radial, it may be ligatured at its upper or lower part.

(*a*) **At its Upper Part.**—*Guide.*—The inter-muscular septum and groove between the fleshy bellies of the flexor carpi ulnaris, and the flexor sublimis digitorum; search for the tendon of the flexor carpi ulnaris and follow it up towards the bend of the elbow, and make an **incision** three or four inches in length, parallel with the edge of the flexor carpi ulnaris. Divide the skin and superficial fascia only by the first incision, and then search for the inter-muscular septum between that muscle and the flexor sublimis, and forcibly separate them. At the bottom of the wound, the ulnar nerve is exposed, and the artery with its venæ comites on each side will be found to the outer side of the nerve. Pass the needle from the nerve, and complete the operation in the usual manner.

(*b*) **At its Lower Part.**—Here the artery is quite superficial, and lies between the tendons of the flexor carpi ulnaris and flexor sublimis digitorum. *Superficial Guide.*—Tendon of the flexor carpi ulnaris; the pisiform bone, into which it is inserted, forms a sure guide to the tendon. **Incision.**—Make an incision two inches long parallel to the tendon, but a little external to it. By this incision the skin and superficial fascia are divided; then divide the inter-muscular layer of deep fascia, when the artery and nerve will be exposed to view. The *deep guide* is the ulnar nerve, which lies immediately internal to the artery. Insulate the vessel, taking care of its venæ comites and ligature in the usual manner.

Branches.—The more important branches are—(1) Anterior and (2) Posterior ulnar recurrents; (3) Common interosseous, and (4) Profunda branch, which is given off just beyond the pisiform bone, and dips down between the abductor minimi digiti and flexor brevis minimi digiti, and anastomoses, with the radial completing the deep palmar arch. For the termination of the recurrent branches see "Anastomoses round the elbow joint," (p. 42).

Collateral Circulation.—Chiefly from the radial and its branches through the palmar arches.

PALMAR ARCHES.

(*a*) **Superficial Arch.**—This is the direct continuation of

the ulnar artery. It forms an arch with the convexity downwards, and is completed on the radial side by the *superficialis volæ* branch of the radial artery. It lies beneath the integumentary structures and palmar fascia, and rests on the digital arteries and nerves, and tendons of the flexor sublimis digitorum. (*b*) **Deep Palmar Arch.**—This is the direct continuation of the radial artery, and is completed on the ulnar side by the *profunda* branch of the ulnar artery. It lies deeply, and, in addition to the structures covering the superficial arch, it lies beneath the digital nerves and arteries, and tendons of the superficial and deep flexors of the fingers, and some of the muscles of the little finger and thumb. It rests on the palmar interossei and metacarpal bones near their carpal ends. **Position of the Arches.**—*The Superficial.*—Extend the thumb till it lies at right angles to the hand, and then draw a line across the palm on a level with its lower margin. The *deep arch* lies fully a finger's breadth nearer the carpus.

If both the radial and ulnar arteries are ligatured, the blood reaches the palm from the anterior and posterior interosseous arteries through the anterior and posterior carpal arches which communicate with the deep palmar arch. There is usually a small artery accompanying the median nerve into the palm ("*comes nervi mediani*"), but this branch is sometimes of large size, and joins the superficial palmar arch. It arises from the anterior interosseous, and it is well to bear in mind the possible existence of this branch. Hence it is not advisable to tie the radial and ulnar arteries for wounds of the palmar arches, as the blood will still reach the wound. It is better to apply a graduated compress or plug, or ligature both ends of the bleeding vessel.

In the palm, the digital arteries and nerves lie on the interosseous muscles *between* the metacarpal bones, and, therefore, incisions in this region should be made over these bones. The arteries are superficial to the nerves, and they bifurcate near the clefts of the fingers (except the most internal branch), and run along their *sides;* hence incisions should not be made at the sides of the fingers. The relation between the nerves and the arteries differs in the palm and in the fingers; in the

palm the arteries are superficial to the nerves, but in the fingers they are deeper than the nerves.

DISLOCATIONS.

Of Clavicle.—Dislocation of this bone is rare—(1) Because of the very powerful ligaments of the joint and the thick expanded end of the bone, which gives them a very advantageous attachment. (2) The force is usually transmitted along the long axis of the bone, and it is bent, or broken rather than dislocated. (3) The mobility of the scapula. The strength of the joint is entirely due to ligaments, together with the inter-articular fibro-cartilage. The most important *ligaments* of the joint are—(1) What may be called a capsular; (2) The inter-clavicular; (3) Costo-clavicular, or Rhomboid. *Dislocations of inner end.*—(1) Forwards—this is the most frequent form, resulting usually from falls on point of shoulder; (2) Upwards; (3) Backwards. In this last form, the dislocated end may press on the trachea, œsophagus, or vessels at the root of the neck, producing difficulty in swallowing or breathing, congestion of the head, and probably coma. Dislocation of the clavicle is sometimes secondary to spinal curvature. *Of the acromial end.*—The bone may pass—(1) On to the upper surface of the acromion process; (2) Under it; (3) On to the anterior part of spine of scapula. The articular surface is very small and slanting, and, for this reason, is very difficult to keep in position if once dislocated.

Scapula.—The inferior angle sometimes slips from under the latissimus dorsi; this may also take place from paralysis of the serratus magnus muscle.

Shoulder Joint.—*Class*, Diarthrosis; *Sub-Class*, Enarthrosis (ball and socket). This is the most movable joint in the body, and is more frequently dislocated than any other articulation. Its strength is due to muscles, not ligaments, the bones being kept in apposition by the elasticity of the surrounding muscles and atmospheric pressure. **Ligaments.**—(1) Capsular, which is very loose; (2) Coraco-humeral; (3) Glenoid, deepening the cavity. **Movements.**—(1) *Adduction with Elevation*—(*a*) Supra-spinatus; (*b*) Middle fibres of deltoid. These only raise the arm to a right angle with the trunk, and

the trapezius continues the movement by elevating the scapula. (2) *Adduction*—(*a*) Gravity; (*b*) Long head of triceps; (*c*) Latissimus dorsi; and (*d*) Teres major. (3) *Flexion*—(*i.e.*, movement forwards) by (*a*) Anterior fibres of deltoid; (*b*) Biceps; (*c*) Coraco-brachialis. (4) *Extension* by (*a*) Posterior fibres of deltoid; (*b*) Teres major; (*c*) Latissimus dorsi. (5) *Rotation Inwards* by (*a*) Subscapularis; (*b*) Pectorals; (*c*) Lattissimus; and (*d*) Teres major. (6) *Rotation Outwards* by (*a*) Infra-spinatus; (*b*) Teres minor. (7) *Circumduction*—In addition to the above seven movements, other two are sometimes described—viz., *Adduction with Flexion* (as in crossing the arms in front of the chest) by means of (*a*) the pectoralis major; (*b*) the biceps; and (*c*) the coraco-brachialis. *Adduction with Extension* (as in crossing the hands behind the back) by (*a*) the latissimus dorsi; and (*b*) the teres major. The following peculiarities of this joint deserve special notice:—(1) The large head of humerus and the small glenoid cavity, hence the very free movement; (2) The very loose capsule, and hence the easy pendulum-like motion of the limb in walking; (3) Insertion of muscles into the capsule, they are elastic and prevent the capsule from being pinched between the articular surfaces in the various movements of the joint. *Above* is the supra-spinatus; *Posteriorly*, the infra-spinatus and teres minor; in *front*, the subscapularis; and, *below*, the long head of the triceps. All these muscles are intimately connected with the capsule of the joint. (4) The relation of the biceps tendon: this is to strengthen the joint, and it also gives steadiness and precision in the finer co-ordinated movements of the arm and forearm.

Dislocations.—(1) Sub-coracoid, (2) Sub-clavicular, (3) Subspinous, (4) Sub-glenoid. In all forms we have—(1) Flattening and squareness of shoulder; (2) A hollow under the acromion where the head of the bone should be; (3) Apparent projection of the acromion process; (4) Head of the bone is in an abnormal position; (5) Rigidity; (6) Pain; (7) Alteration in the axis of the humerus. (1) *Sub-coracoid*—(*a*) The head of the bone is felt in the upper and anterior part of the axilla; (*b*) There is shortening of arm; (*c*) The elbow is tilted outwards, and axis of humerus more oblique than natural; (*d*)

The head of the bone may press on the axillary nerves. This form of dislocation usually takes place in falls with the hand outstretched. The latissimus dorsi and teres major draw it towards the chest, while the deltoid and pectoralis major draw it up towards the clavicle. (2) *Sub-clavicular*—This is simply an increased degree of sub-coracoid. The head of the bone lies on the 2nd and 3rd ribs under the pectorals, and the symptoms resemble those of the former dislocation. There may also be œdema and coldness of the limb from the interrupted circulation in the axillary vessels. (3) *Sub-spinous.*—The head of the bone lies below the spine of the scapula, the axis of the limb is directed backwards, and the elbow is raised from the side. (4) *Sub-glenoid.*—This is the most common form—(*a*) the arm is lengthened about one inch, and tilted outwards; (*b*) There is severe pain and numbness in the hand and arm from pressure of the head of the bone on the axillary nerves and vessels. The circulation may be completely arrested, or the artery may be ruptured, and the head of the bone can be felt in the axilla below the glenoid cavity.

Elbow Joint.—*Class*, Diarthrosis; *Sub-Class*, Ginglymus. The **Ligaments** of this joint are four in number—anterior, posterior, internal, and external lateral. **Movements.**—(1) *Flexion*—By (*a*) Biceps; (*b*) Brachialis anticus; (*c*) Supinator longus (this muscle is chiefly a *flexor*, but does not act till flexion has been begun by other muscles); (*d*) Pronator radii teres (after pronation is complete, or when it is prevented by other muscles), and indirectly by the flexors of the wrist and fingers. (2) *Extension*—By (*a*) Triceps and anconeus; (*b*) Supinator brevis, and indirectly by the extensors of the wrist and fingers.

Dislocations.—The most common form is dislocation of both bones backwards, as when a person falls with his hand extended or the arm semi-flexed. The arm is semi-flexed and shortened, and there is a projection behind, and a swelling in front caused by the end of the humerus. The condyles can be felt in front, and the internal one lies *below* the olecranon process, and the arms cannot be flexed nor fully extended. The *ulna* alone may be dislocated backwards, the *radius* may be dislocated forwards, backwards, or outwards. The for-

ward variety is the most common; the forearm is slightly flexed and held midway between supination and pronation, and the elbow cannot be bent to more than an obtuse angle.

Wrist Joint.—*Class*, Diarthrosis; *Sub-Class*, An oblong form of hinge, with two axes of movement—a *long* (as in bending the hand backwards and forwards) and a *short*, (as in moving the hand towards the ulnar or radial sides). **Ligaments** are four—anterior, posterior, internal, and external lateral. **Movements.**—(1) *Flexors*—(*a*) Palmaris longus; (*b*) Flexor carpi radialis; (*c*) Flexor carpi ulnaris. (2) *Extensors*—(*a*) Extensor carpi radialis longior; (*b*) Extensor carpi radialis brevior; (*c*) Extensor carpi ulnaris. (3) *To bend to ulnar side*—(*a*) Flexor carpi ulnaris; (*b*) Extensor carpi ulnaris. (4) *To bend to radial side*—(*a*) Flexor carpi radialis; (*b*) Extensor carpi radialis longior; (*c*) Extensors of the thumb. Dislocation of this joint is very rare, as most of the so-called dislocations of the wrist joint have usually been found to be fractures. The guide is to be found in the relation of the base of the metacarpal bone of the thumb to the styloid process of the radius; just as in like injuries about the elbow the guide is found in the relation of the inner condyle of the humerus to the olecranon process. If the styloid process of the radius and the metacarpal bone of the thumb retain their normal relation, the case cannot be one of dislocation.

FRACTURES.

Clavicle.—Fracture of this bone is very common, because—(1) It is much exposed to *direct* violence; (2) It is the only osseous connection of the upper extremity with the trunk. Its shape enables it to withstand *indirect* violence, the force being partially broken at each curve. It is usually broken at the junction of the middle with the outer third—*i.e.*, where the two curves meet. (1) If broken between the conoid and trapezoid ligaments, there will be little, if any, displacement. (2) It may be broken to the outer side of these ligaments, when the small fragment is gradually drawn round, by the pectoralis minor and the rhomboid muscles depressing and rotating forwards the point of the shoulder, until it lies at a right angle with its shaft. By this means the shoulder is

narrowed, and drops a little from the weight of the arm dragging it down. (3) Fracture at the sternal end. This may resemble a dislocation. The outer fragment is drawn towards the sternum by the subclavius, and the pectoralis major and minor muscles. (4) By far the most common seat of fracture is at the junction of the two curves. The *outer* fragment is drawn downwards, forwards, and inwards—downwards by the weight of the arm and scapula and the action of the deltoid; forwards and inwards by the pectoralis major and minor, subclavius and serratus magnus; and at the same time the outer end is rotated forwards, whilst the inner end points backwards. The *inner* fragment seems raised, but this is because the outer one is depressed; it is practically kept in its natural position by the sterno-mastoid above, and the pectoralis major and rhomboid ligament below. *Comminuted* fracture of the clavicle is dangerous, because of its close relation to important vessels and nerves.

Scapula.—Fractures of this bone are rare. A fracture through the neck may simulate dislocation of the humerus; but by raising the arm the parts resume their natural appearance, but become displaced again when the arm is set free.

Humerus.—Fractures through the *anatomical* neck (intracapsular) occur chiefly in young children. Separation of the epiphysis from the shaft also occurs in young children, and requires great care in the diagnosis from other forms of injury. Fracture through *surgical* neck—that is, above the muscles inserted into the bicipital groove,—is a very common form of fracture, and is the result of direct violence. It is recognised by the shortening, distortion, and loss of power of the arm, while the shoulder is rounded and swollen. The *upper* fragment, together with the head of the bone, is rotated outwards, and abducted and raised by the muscles attached to the greater and lesser tuberosities—supra and infra-spinatus, and teres minor and subscapularis; still, the displacement of this fragment is not great, because the muscles of the two tuberosities almost counterbalance each other. The *lower* fragment is drawn, upwards, inwards, and forwards—upwards by the biceps, triceps, and deltoid; inwards and forwards by the pectoralis major, latissimus dorsi, and teres major. The axis

of this part also is altered, the elbow being tilted outwards by the action of the deltoid. At first sight this injury may seem to resemble sub-glenoid dislocation of the head of the humerus; but the head of the bone can be felt in its natural position, the limb is *shortened*, and there is increased mobility, and we may easily elicit crepitus. In *impacted* fractures there is no mobility, displacement, nor crepitus.

Fractures of the *shaft* of the humerus are usually oblique from above, downwards and outwards, and the brachialis anticus and biceps muscles in front, and the triceps behind, cause considerable displacement and shortening, by making the parts glide over each other. If the fracture be transverse there may be no displacement. If fractured at a point between the insertion of the deltoid below and the muscles in the bicipital groove above, the *lower* fragment will be drawn upwards by the deltoid, and glide over the *upper* fragment, which will be drawn towards the chest by the muscles in the bicipital groove—pectoralis major, latissimus dorsi, and teres major. Fracture just *above the condyles*. This may be confounded with separation of the epiphysis in children, or dislocation of both bones of the forearm backwards; but the presence of crepitus, the fact that the limb assumes its normal appearance on extension, the increased mobility, and the *guide* already mentioned—viz., the relation between the internal condyle of the humerus and the olecranon process will aid the diagnosis. In separation of the epiphysis there is no crepitation, but the age of the patient will guide us here. If the fracture be oblique, the displacing forces are the same as in oblique fracture through the shaft. The *olecranon* process may be fractured by the action of the triceps muscle, or by a fall on the elbow. The fragment is carried up by the triceps, and there is a hollow at the back of the joint, which is increased during flexion; and there is partial loss of extending power.

In fractures of the shaft of the humerus, the musculo-spiral nerve may be injured, either directly or by the "callus." Lower down, at the external condyle, the posterior interosseous branch may be injured. If the musculo-spiral be injured, supination is imperfect, extension of the hand and

fingers is entirely lost, and the hand therefore becomes pronated, and "wrist drop" ensues. But the *lumbricales* and the *interossei* are not paralysed, so that the upper two joints of the fingers, if forcibly bent, may be again extended a little. If the posterior interosseous nerve alone be injured, there is partial loss of supination and extension.

Bones of the Forearm.—(1) *Fracture of Radius alone, near its Middle.*—In this case the upper fragment is drawn upwards; or, rather, it is tilted forwards by the biceps and inwards by the pronator radii teres. The displacement inwards, however, may not be great, as the pronator radii teres is powerfully opposed by the supinator brevis, so that the bone retains a position midway between pronation and supination. The lower fragment is drawn towards the ulna, and pronated by the pronator quadratus, while the supinator longus tilts up the styloid process and depresses the upper end of the fragment. (2) *Fracture of the lower end of the Radius (Colles' Fracture).*—The fracture in this case is usually about three-quarters of an inch above its articular surface. The *lower* fragment is drawn upwards and backwards by the supinator longus and flexors, and extensors of the thumb and carpus; the *upper* fragment projects forward, and is drawn towards the ulna by the pronator quadratus, and is pronated by the pronator radii teres. Thus we have a prominence on the back of the wrist and a depression above it, caused by the lower fragment, and a projection in front with a hollow below it, caused by the upper fragment. It resembles dislocation of the carpus backwards, but may be distinguished from it by the fact that the deformity is removed on extension, and by the presence of crepitus. It also simulates separation of an epiphysis; but the age of the patient will aid the diagnosis.

Fracture of Ulna alone, near Middle.—In this case there is but little displacement of the upper fragment, except that it is drawn a little nearer the radius by the pronator radii teres; the lower fragment is drawn towards the ulna by the pronator quadratus, and the extensors and flexors tend to draw it upwards.

Fracture of both bones of the Forearm.—The *upper* ends.—The *radius* is tilted forwards by the biceps and inwards by

the pronator radii teres, and the ulna is tilted a little forwards by the brachialis anticus. The *lower* fragments.—The *radius* is pronated, and the two bones are approximated by the pronator quadratus, and are drawn upwards and forwards, or upwards and backwards, according to the obliquity of the fracture, by the flexors and extensors.

EXCISION OF JOINTS.

The objects aimed at in excision of joints are: (1) Complete removal of the diseased parts; (2) To leave a useful limb; and for this purpose it is necessary (1) To make the incisions parallel to the axis of the limb; (2) To avoid division of muscles and tendons as far as possible. In young children the epiphysis should never be entirely removed, as it is on this part that the development of the bone in length is mainly dependent.

Excision of the Shoulder Joint.—Various forms of incisions have been proposed: (*a*) A single longitudinal vertical incision; (*b*) A T-shaped incision; (*c*) A modification of this form, one half of the cross bar being omitted—somewhat like the letter L upside down; (*d*) The U-shaped flap operation.

By the Single Longitudinal Vertical Incision.—In connection with this incision, it should be noted that the posterior circumflex artery, which passes round the posterior aspect of the surgical neck of the humerus, though large at first, becomes very rapidly smaller; and therefore the incision should be towards the anterior part of the joint, in order to avoid wounding either the trunk of the vessel or its larger branches. Begin the incision a little to the outside of the coracoid process, and carry it downwards and a little outwards through the anterior part of the deltoid, for about four inches. By this incision (1) the integumentary structures and (2) the deltoid are divided. Draw aside the edges of the wound, and slit up the sheath of the biceps and draw aside its tendon, and secure the anterior circumflex artery and the other bleeding points. Project the head of the humerus forwards, and divide (3) the capsular ligament and (4) the muscles inserted into the great tuberosity—viz., (*a*) Supra-spinatus, (*b*) Infra-spinatus, and (*c*) Teres minor. Then

rotate the humerus outwards, and divide (5) the tendon of the subscapularis inserted into the lesser tuberosity. (6) Clear, saw through, and remove the head of the bone. In clearing the bone, the edge of the knife must be kept close to the bone, in order to avoid wounding the posterior circumflex artery and the circumflex nerve. In the *flap* operation the incision is commenced at the posterior part of the acromion process, and carried across the line of insertion of the deltoid, and up towards the inner side of the coracoid process. The structures divided are the same as in the other form of incision, but greater care is necessary, in order to avoid wounding the posterior circumflex artery and the circumflex nerve.

Excision of the Elbow Joint.—This may be performed by three different forms of incision: (1) The H-shaped incision; (2) Another, which is simply the H-shaped incision *minus* one of its upright bars; (3) A single longitudinal vertical incision, (in this case it is the H deprived of one of its vertical limbs and also the cross-bar).

By *the Single Longitudinal Vertical Incision.*—Begin the incision in the middle line, two-and-a-half inches above the elbow, and carry it downwards and a little outwards over the olecranon process and upper part of the ulna, ending two-and-a-half inches below the joint. Then separate the triceps on the outer side from its insertion, keeping the edge of the knife close to the bone; and in like manner the structures over outer condyle—the common tendon of the extensors and anconeus muscle. In the same way, separate the inner part of the triceps from the bone and the structures over internal condyle—the common tendon of origin of the flexors, and pronator radii teres. In separating the structures over the inner side of the joint, the edge of the knife must be kept close to the bone, and carefully follow all its sinuosities, so that the ulnar nerve, which lies between the internal condyle and the olecranon process, may escape injury. The structures thus separated are drawn over the condyles, the arm is bent, and the lateral ligaments divided; then project the bones backwards and divide the anterior ligament of the joint, clear the bones and saw off the requisite amount. In clearing the

bones, it may be necessary to partially separate the insertion of the brachialis anticus into the base of the coronoid process of the ulna, but the insertions of this muscle and the biceps should not, as a rule, be divided. The parts divided are—(1) The integumentary structures; (2) The separation of the muscles mentioned from the bones; (3) The ligaments of the joint; (4) Humerus, radius, and ulna; (5) The following vessels, which require to be ligatured:—(*a*) Branches of the superior profunda, (*b*) Branches of the inferior profunda, (*c*) Anastomotica magna, (*d*) the radial recurrent.

In the *second* form of incision, an incision is made three inches long parallel to the axis of the limb and a little way to the outer side of the ulnar nerve, then a transverse incision from the inner margin of the olecranon (joining the upright one at this point) to the articulation between the outer condyle of the humerus and the head of the radius; this is the ⊣-shaped form, and if we make another longitudinal incision at the outer end of the transverse one, we complete the first form of incision—the H-shaped form. The chief objections to these forms of incision are—(1) The unnecessary amount of division of textures; (2) If the transverse cut fail to heal by primary union, passive motion cannot be begun at the proper time without interfering with the healing process.

Excision of the Wrist Joint.

This joint may be excised by Lister's method, or by a single longitudinal incision in the central line of the forearm behind, four inches long, commencing one inch and a-half above the styloid process of the radius, and ending one inch below the carpo-metacarpal joint.

Lister's Method.—*Incisions.*—(*a*) An incision is made from the middle of the dorsal aspect of the radius, on a level with the styloid process downwards and outwards towards the inner side of the metacarpo-phalangeal articulation of the thumb; but, on reaching the line of the radial border of the metacarpal bone of the index finger, it is carried downwards longitudinally for half the length of that bone. The first part of this incision should be parallel to the tendon of the extensor secundi internodii pollicis, but without injuring it;

neither should it be carried too far down lest the radial artery be injured. (*b*) Another incision is made on the ulnar side, commencing two inches above the end of the ulna, and immediately anterior to it, and carried downwards between the flexor carpi ulnaris and the ulna, as far as the middle of the palmar aspect of the fifth metacarpal bone. By the first incision there is divided—(1) The tendon of the extensor carpi radialis brevior, then push aside the tendon of the extensor secundi internodii pollicis together with the radial artery and soft parts, and divide (2) the tendon of the extensor carpi radialis longior. Dissect the other tendons from their grooves, and raise the soft parts on the back of the carpus completely, and separate the trapezium from the other bones of the carpus. By the second incision (3) the tendon of the extensor carpi ulnaris is to be divided close to its insertion, and after this, (4) the dorsal and internal lateral ligaments, and then the soft parts are to be raised from the anterior aspect of the joint, the edge of the knife being kept close to the bone lest the ulnar artery or nerve be injured. Separate the pisiform bone to which is attached the tendon of the flexor carpi ulnaris, which is not to be cut; (5) Clip off the "hook" of the unciform bone, and raise the tendons from the ends of the metacarpal bones; and (6) cut off the ends of these bones, keeping close to their bases lest the deep palmar arch be wounded; then divide (7) the anterior and internal lateral ligaments, and remove the carpal bones (except trapezium and pisiform); (8) Then protrude and saw off the requisite amount from the ends of the radius and ulna, afterwards dissect out the trapezium, taking care of the radial artery, and the tendon of the flexor carpi radialis which lies in the groove on that bone. The tendons, therefore, divided in this operation are the three extensors of the wrist. If the bases of the metacarpal bones be divided too low down, the tendon of the flexor carpi radialis may be injured, but it usually escapes, while the flexor carpi ulnaris is left attached to the pisiform bone, which, unless diseased, is not removed.

AMPUTATIONS.

There are certain general methods of amputation which it will be well to describe very briefly.

(1.) Liston's Method.—The flaps are made by transfixion, and consist of a short anterior and a long posterior flap. The bone is cut a *little* higher up than the bases of the flaps; but during the healing process the flaps retract too much, so that the cicatrix comes to lie at the end of the stump.

(2.) Spence's Modification of Liston's Method.—The limb is transfixed *two inches* lower down than the point where the bones are to be sawn, and the anterior flap is made longer than the posterior. In this case, although the parts retract during healing, there is still a good covering left for the bone, and the cicatrix remains behind.

(3.) The Circular Method.—(Bell's Method.)—The skin and fat are first divided by a single circular sweep of the knife, and dissected up for a distance equal to half the diameter of the limb; the muscles are then divided by another circular sweep of the knife, and retracted for a distance varying from one to two inches, according to the thickness of the limb, and the bone sawn as high up as possible.

(4.) Syme's Method.—(Modified circular method).—Two semi-lunar incisions are made through the integuments, which are then dissected and drawn up for two inches, and the muscles cut obliquely towards the bone, on a level with the retracted skin, the muscles on the posterior aspect being divided somewhat lower down than those on the anterior aspect. The soft parts are then forcibly retracted, and the bone cleared and sawn higher up.

(5.) Teal's Method.—By long anterior and short posterior rectangular flaps. The long anterior flap is folded over the end of the bone, and should not contain the large blood vessels and nerves of the limb; and its length and its breadth should be equal to one-half the circumference of the limb. The short posterior flap should only be one-fourth the length of the long one, and should contain the large blood vessels and nerves. The *advantages* claimed for this method are—(1) The bone is completely covered by sound tissue; (2) The cicatrix is situated high up on the posterior aspect. Its *disadvantages* are—(1) The great length of the flaps; (2) Their *square* form (nature disliking *corners*); (3) The anterior flap is doubled upon itself, and there is, therefore, great risk of impairing its vitality.

(6.) Spence's Method.—By a long anterior flap; but the flap is *not doubled upon itself*, nor does it require to be so *long* as in Teal's method; it simply folds loosely over the posterior segment of the stump, and, when healed, the cicatrix is on the posterior aspect. Its breadth should be fully one-half the circumference of the limb, and its free end gently *rounded*. A flap four inches in length will be sufficient for a limb twelve inches in circumference. On the posterior aspect the soft parts are divided obliquely towards the bone, beginning two inches lower than the level of the base of the anterior flap. The whole of the soft parts are then retracted, and the bone is sawn two inches higher up than the base of the flaps. This method, then, possesses all the advantages of Teal's method, with none of its disadvantages.

(7.) Carden's Method.—A single anterior flap composed entirely of skin. Its form and position resemble the anterior flap of Spence's method.

Amputation at Shoulder Joint.—This may be accomplished by (1) a large deltoid flap formed by transfixion; (2) Double flap—the two flaps almost equal in size; (3) Spence's single linear incision, like that used in excision; one of the advantages of this form of incision is that the terminal branches only of the posterior circumflex artery are divided, whereas in the other two forms, the trunk of the vessel, or its larger branches, are divided at an early stage of the operation, so that there is frequently a great loss of blood.

Chief Structures Divided.—(1) The integumentary structures. (2) *Muscles*—(*a*) Deltoid, and the muscles in connection with the capsule of the joint—viz., (*b*) Supra-spinatus; (*c*) Infra-spinatus; (*d*) Teres minor; (*e*) Sub-scapularis; (*f*) Long head of triceps; muscles not attached to the capsule—(*g*) Pectoralis major; (*h*) Latissimus dorsi; (*i*) Teres major; (*j*) Coraco-brachialis; (*k*) Biceps (both heads). The large vessels and nerves will be found on the inner flap, and consist of the axillary vessels and the cords of the brachial plexus; in addition to these the cephalic vein and the posterior circumflex artery are divided at some stage of the operation. The capsular, and coraco-humeral ligaments, and the costo-coracoid membrane are also cut through.

Amputation through the Middle of the Upper Arm.—This may be accomplished by—(1) The circular method; (2) By antero-posterior flaps; (3) by lateral flaps; (4) By Teal's method. Chief structures divided—(1) Integumentary coverings; (2) *Muscles*—(*a*) Biceps, (*b*) Brachialis anticus, (*c*) Triceps; (3) *Vessels*—(*a*) Brachial vessels, (*b*) Superior profunda vessels, (*c*) Basilic vein, (*d*) Cephalic vein, (*e*) Inferior profunda vessels; (4) *Nerves*—(*a*) Musculo-cutaneous (between the biceps and the brachialis anticus), (*b*) Median (in close relation to and towards the inner side of the brachial vessels), (*c*) Ulnar (accompanying the inferior profunda vessels) (*d*) Musculo-spiral (accompanying the superior profunda vessels) (*e*) Internal cutaneous close to the basilic vein. At this point the brachial vessels are found on the *inner* side of the humerus; the inferior profunda vessels are found close to the brachial vessels, but a little further back; while the superior profunda vessels are found towards the posterior and outer aspect of the humerus.

Amputation at Elbow Joint.—This may be done by cutting a large flap from the anterior aspect of the joint and a smaller one posteriorly. It is seldom performed, because it is rarely possible to get sufficient sound texture to cover the large condyloid end of the humerus. *Chief Structures Divided*—(1) Integumentary structures; (2) *Muscles*—(*a*) Biceps, (*b*) Brachialis anticus, (*c*) Pronator radii teres and flexors of the wrist and fingers, including the following muscles—flexor carpi radialis, palmaris longus, flexor sublimis digitorum, flexor carpi ulnaris, flexor profundus digitorum, and flexor longus pollicis, (*d*) Triceps and anconeus, (*e*) Supinator longus, (*f*) Supinator brevis, and (*g*) the following extensors of the wrist and fingers—Extensores carpi radialis longior and brevior, extensor communis digitorum, extensor minimi digiti, and extensor carpi ulnaris; (3) *Vessels*—(*a*) Radial artery, (*b*) Ulnar artery, (*c*) The common interosseous, or its branches, (*d*) Posterior ulnar recurrent, (*e*) The corresponding veins, and also the superficial veins of the forearm. (4) *Nerves*—(*a*) Median, (*b*) Ulnar, (*c*) Radial, (*d*) Anterior and posterior interosseous nerves; (5) *Ligaments* of the joint.

Amputation through the Middle of the Forearm.—This may be performed by—(1) Antero-posterior flaps by transfixion; (2) Teal's method. *Chief Structures divided*—(1) Integumentary structures; (2) *Muscles*—(*a*) Pronator teres and flexor carpi radialis, (*b*) Palmaris longus, (*c*) Flexor sublimis digitorum, (*d*) Flexor carpi ulnaris, (*e*) Flexor profundus digitorum, (*f*) Flexor longus pollicis, (*g*) Supinator radii longus, (*h*) Supinator brevis, (*i*) Extensores carpi radialis longior et brevior, (*j*) Extensor communis digitorum, (*k*) Extensor minimi digiti, (*l*) Extensor carpi ulnaris (*m*) Extensor ossis metacarpi pollicis, (*n*) Extensor secundi internodii pollicis; (3) *Vessels*—(*a*) Radial (in the outer side of the anterior flap, and quite superficial), (*b*) Ulnar (in the inner side of the anterior flap, and much deeper, (*c*) Anterior interosseous, (*d*) Posterior interosseous; (4) *Nerves*—correspond to and accompany the arteries—(*a*) Radial, (*b*) Ulnar, (*c*) Anterior interosseous, (*d*) Posterior interosseous; (5) Radius and ulna and interosseous membrane.

Amputation at the Wrist.—This may be performed by the modified circular method (*i.e.*, Syme's method). *Chief Structures Divided.*—(1) Integumentary structures; (2) *Muscles*—(*a*) Those towards the anterior aspect—tendons of the flexor carpi radialis, palmaris longus, flexor sublimis and profundus digitorum, flexor longus pollicis, flexor carpi ulnaris, (*b*) Those on the posterior or lateral aspect—Supinator longus, extensor ossis metacarpi pollicis, extensor primi internodii pollicis, extensores carpi radialis longior and brevior, extensor secundi internodii pollicis, extensor communis digitorum, extensor minimi digiti, extensor indicis, extensor carpi ulnaris; (3) *Vessels*—(*a*) Radial vessels, (*b*) Ulnar vessels; (4) *Nerves*—(*a*) Ulnar, (*b*) Radial, (*c*) Median; (5) *Ligaments* of the wrist joint.

THE AXILLA.

(1.) Glands of the Axilla.—The lymphatic glands of the axilla are arranged in three sets—(1) One group lies along the subscapular artery in the posterior fold of the axilla; (2) Another group accompanies the long thoracic artery in the anterior fold of the axilla; (3) While the third is placed along

the axillary artery. The posterior group receives lymphatics from the side of the chest and back, the anterior group from the front of the chest and mamma, while those placed along the axillary vessels receive the lymphatics from the forearm and hand, and upper limb generally. A knowledge of these facts is of practical value, because disease in the parts from which the lymphatic vessels come will point to the group of glands likely to be affected; thus, in disease of the mamma (*e.g.*, cancer) the anterior group will be enlarged, and in a poisoned wound of the hand, the group along the axillary artery will be affected, and so on.

(2.) **Abscess in the Axilla.**—If pus form in the axilla, it will be unable to make its way to the surface through the base of the space on account of the strong axillary fascia which is found in this region, but will rather burrow up towards its apex, and point in the neck. The necessity, therefore, of making an early and full incision for its evacuation is evident.

(3.) **The Relation of the Contents of the Axilla to its Walls.**—In the *outer* wall are the large axillary vessels and nerves; in the *anterior* wall there is a large vessel—the long thoracic artery; in the *posterior* wall there is also a large vessel—the subscapular artery; in the *inner* wall we find the Nerve of Bell and the superior thoracic artery, but the artery is small and placed high up. In making incisions, therefore, into the axilla, as for the evacuation of pus, the operator must cut *towards the inner wall* in order to avoid the important structures in relation to the other walls of the space.

(4). **Pressure on the Brachial Plexus.**—Pressure on this plexus, as from a tumour in the axilla, or sub-glenoid dislocation of the humerus, will cause a severe numb pain to be experienced in the hand and arm.

Veins at the Bend of the Elbow.—Passing up the centre of the forearm is the median vein, which, when it reaches the hollow in front of the elbow joint, divides into the median basilic and the median cephalic veins. The median cephalic is joined by the radial vein, then passes up the arm as the cephalic vein, and empties itself into the axillary vein. The median basilic is joined by the anterior and posterior ulnar veins, then passes upwards as the basilic vein, and about the

middle of the arm pierces the deep fascia, and is joined by the venæ comites of the brachial artery, and is then known as the axillary vein. At the bend of the elbow the median basilic vein overlies the brachial artery, but is separated from it by the semi-lunar or bicipital fascia, and the internal cutaneous nerve passes over or under it, while the external cutaneous passes under the median cephalic.

Venesection at the Bend of the Elbow.—Either of these (median cephalic or median basilic) may be opened. The median basilic is the larger, and more easily compressed and fixed, because it has the firm bicipital fascia behind it; its great disadvantage is that it lies just over the brachial artery, so that if the operation be performed carelessly, or if the patient start during the entering of the lancet, it may pass through the vein and fascia into the artery beyond. The median cephalic is not quite so large, although it is large enough to afford a good stream of blood, but it is separated by a considerable interval from the brachial artery. *Operation.*—Whichever vein be chosen, the steps of the operation are practically the same—(1) A bandage is tied round the arm above the point where the vein is to be opened, to make it "rise," but must not be drawn too tightly lest the flow through the brachial artery also be checked. (2) The thumb is then pressed on the vein, just below the point where it is to be opened, in order to steady it. (3) The point of the lancet is then pushed into the vein and made to cut an *oblique* opening, taking care that the opening in the skin is larger than that in the vein, lest blood escape into the cellular tissue and give rise to "thrombus." If the flow be sluggish, the patient should move his fingers while he grasps something firm in his hand, so as to compress the deep veins and cause the blood to flow into the superficial set. When enough blood has been extracted, place the thumb over the wound, and remove the bandage or "fillet," bend the arm and apply a compress of lint, and fix it by a figure-of-eight bandage.

If the artery be punctured during the operation, this injury will be manifested by (1) the blood being redder than it should be; (2) That it escapes in jerks, and (3) Pressure on the vein below the opening does not stop the bleeding. The results of

such an accident are various; it may lead to (1) a *false aneurism*, that is, the blood poured from the artery may be enclosed in a sac, not formed by the coats of the vessel as in true aneurisms, but by the surrounding tissues; (2) It may lead to an *aneurismal varix*, that is, when the wounded artery and vein adhere at the wounded point, and jets of blood are driven into the vein from the artery, dilating it, and causing incompetency of its valves, and leading to a varicose state of the veins in the neighbourhood; (3) It may lead to a *varicose aneurism*, that is, an aneurism the sac of which communicates with both artery and vein, and blood from the artery is projected into the vein *through* the sac of the aneurism.

Synovial Membranes of the Wrist.—These are *five* in number. (1) The membrana sacciformis, which lines the lower end of the ulna, the sigmoid cavity of the radius, and the upper surface of the triangular fibro-cartilage. (2) The second lines the wrist joint proper—*i.e.*, the end of the radius and the triangular fibro-cartilage above, and the scaphoid, semi-lunar and cuneiform bones below. (3) The third is the most extensive; it covers the contiguous surfaces of the two rows of carpal bones, and, passing between the bones of the second row, lines the carpal ends of the four inner metacarpal bones. (4) The fourth lies between the trapezium and meta-carpal bone of the thumb. (5) The fifth is between the pisiform and the cuneiform bones. We see, therefore, that one synovial membrane (the third) does for all the carpal bones except the pisiform, and also for all the meta-carpal bones except the first (that of the thumb).

The Sheaths of the Flexor Tendons.—When erysipelatous inflammation attacks the sheaths of the flexor tendons in the fingers (whitlow), it is excessively painful owing to the resistant nature of the structures attacked, and consequent tension, and it is at the same time fraught with danger to the utility of the finger or hand. Pus forms very rapidly, and finds its way up the synovial sheaths of the flexor tendons to the hand and common synovial sheath under the anterior annular ligament; and, if the disease be not checked by timely interference, the sheaths and tendons are rapidly destroyed, the joints of the fingers injured, and the phalanges

may even necrose or the finger become gangrenous, and the erysipelatous inflammation extend up the forearm. Suppuration occurring in the sheaths of the tendons of the little finger and thumb, is far more likely to involve the common sheath under the anterior annular ligament than when it occurs in any of the other fingers; because the synovial sheaths of the flexor tendons of the thumb and the little finger communicate directly with the common sheath, while those of the three other fingers do not; but, in no case, however, is the distance between the common sheath and the synovial sheaths of the flexor tendons great. To check the spread of the inflammation and relieve the tension, it is advisable either to foment the finger with warm water, or make an early and free longitudinal incision into the finger, and if the pus has formed *within* the sheaths, make an incision down to the bone at once. If pus form or accumulate in the common synovial membrane under the anterior annular ligament, the appearance presented is peculiar—there is a swelling in the palm and another in the lower part of the forearm, with a constriction between caused by the annular ligament. Passing beneath the anterior annular ligament, and enveloped by a common synovial sheath, we find—(1) The tendons of the flexor sublimis; (2) The tendons of the flexor profundus; (3) The tendon of the flexor longus pollicis; (4) The median nerve.

SURGICAL ANATOMY OF THE LOWER EXTREMITY.

LIGATURE OF ARTERIES.

THE FEMORAL ARTERY.—**Origin.**—It is the direct continuation of the external iliac artery. **Extent.**—It extends from Poupart's ligament to the opening in the adductor magnus; this corresponds to the upper two-thirds of the thigh. **Course.**—Flex the thigh upon the abdomen, and rotate it a little outwards, and the course is then indicated by a line drawn from a point midway between the anterior superior iliac spine and the symphysis pubis, to the inner side of the internal condyle of the femur. The artery at first lies immediately over the hip joint, but as it passes downwards it takes an oblique course along the inner side of the femur, and finally passes behind it as it enters the popliteal space through the opening in the adductor magnus. In applying pressure, therefore, to the femoral artery in the upper part of its course, we ought to press directly backwards; but, if applied to the middle third of the thigh, as the artery lies in Hunter's canal, the pressure must be directed outwards towards the femur. It is well to know that the names applied by surgeons to different parts of this artery, and the names applied by anatomists are not quite the same. The "*common femoral*" of surgeons is the femoral artery before it has given off its profunda branch, and is usually about one inch and a-half in length; below this point it is known as the "*superficial femoral.*" But the *common femoral* and the *superficial femoral* of Surgeons form simply the femoral of Anatomists; while the "*deep femoral*" of Surgeons is the *profunda* branch of Anatomists.

Relations.—The artery is divided into a superficial and a deep part. The *superficial* part is contained in Scarpa's triangle, and corresponds to about the upper third of the thigh; the *deep* part is contained in Hunter's canal, and corresponds to the middle third of the thigh. In *front* of the artery, as it lies in Scarpa's triangle, we have—(1) Skin, (2)

Superficial fascia, (3) Deep fascia, (4) Cribriform fascia, (5) Some large tributaries of the long saphenous vein, (6) Anterior part of femoral sheath, (7) The internal cutaneous nerve just at the apex of the space. As it lies in Hunter's canal, in addition to the superficial structures, we find covering it (8) the sartorius muscle, (9) Roof of Hunter's canal, (10) The long saphenous nerve. *Behind* it there is—(1) The psoas muscle which separates it from the margin of the pelvis and the capsule of the hip joint, (2) The nerve to the pectineus, (3) The femoral vein, (4) The pectineus, (5) The adductor longus, and (6) Part of the adductor magnus. On the *inner* side—(1) The femoral vein (at the upper part); (2) The adductor longus; (3) The sartorius. On the *outer* side—(1) The anterior crural nerve (about a quarter of an inch from it); (2) The vastus internus; (3) The femoral vein (at the lower part); (4) The internal cutaneous nerve; (5) The long saphenous nerve; (6) The nerve to the vastus internus. The femoral vein is at first on the same plane, and on the inner side of, and close to the artery; but in its course downwards it gradually passes behind the artery, until, when it reaches the apex of Scarpa's triangle, it lies directly behind the artery; it then gradually passes to its outer side. The following is the arrangement of vessels at the apex of Scarpa's triangle—(1) Femoral artery; (2) Femoral vein; (3) Profunda vein; (4) Profunda artery; hence, if a person receives a stab or bullet wound at this point, these vessels are liable to be injured.

Ligature at the Lower Part of Scarpa's Triangle.—Incision.—Ascertain the position of the large superficial veins, and then make an incision three inches long in the course of the vessel along the *inner* border of the sartorius, beginning two inches below Poupart's ligament, and carrying it down for three inches—*i.e.*, if the operation be performed on the right leg; if it be performed on the left leg it is more convenient to begin the incision below the apex of Scarpa's triangle, and carry it upwards. We cut through—(1) The skin; (2) Superficial fascia and fatty tissue; (3) The deep fascia forming the sheath of the sartorius, which at this point lies above the artery. The muscle is gently drawn towards the outer side; and, (4) The femoral sheath is

divided; and then (5) the proper sheath of the vessel, which is then cleared and ligatured in the usual way. At the point where the artery is ligatured the vein lies behind it, so that it matters little from which side the needle is passed; but on account of this relation, great care is necessary in clearing the artery and passing the needle; and not only does the vein lie immediately behind the artery, but it is very firmly connected to it, so that the artery must be completely cleared before we attempt to pass the ligature, which must then be passed without using force. But, while the artery should be cleared completely, due care must be taken at the same time to avoid undue disturbance of the parts, lest the "*vasa vasorum*" supplying the coats of the vessel be unnecessarily injured, and lead to death of that part of the vessel (the same remark applies to all arteries).

Ligature in Hunter's Canal.—"Hunter's canal" is formed by an aponeurotic expansion thrown across from the adductors longus and magnus on the inner side to the vastus internus on the outer side. It is triangular in shape, the base being formed by the expansion already alluded to, and extends from the apex of Scarpa's triangle to the opening in the adductor magnus, and corresponds, therefore, to the middle third of the thigh. It encloses the femoral artery and vein, and the long saphenous nerve—the vein being at first behind, and then to the outer side of the artery, while the nerve is above it, and crosses from its outer to its inner side. **Incision.**—Make an incision three inches long in the line of the vessel, along the *outer* border of the sartorius muscle, and cut through—(1) Skin, (2) Superficial fascia and fatty tissue, (3) Through the fascia forming the sheath of the sartorius, and expose the edge of that muscle, and draw it well to the inner side. Next divide (4) the roof of Hunter's canal with the point of the knife and then enlarge the opening with a probe-pointed bistoury; the saphenous nerve is then to be drawn aside, and the proper sheath of the vessel opened, and the artery cleared to the requisite extent, and the ligature passed from the outer to the inner side.

Branches of the Femoral.—(1) The superficial epigastric; (2) The superficial circumflex iliac; (3) The superficial external

pudic; (4) The deep external pudic; (5) The profunda branch; (6) The anastomotica magna, which is given off in the lower part of Hunter's canal. The only branch which requires special notice is the profunda branch.

The Profunda Artery.—(Deep femoral).—This branch arises from the outer and posterior part of the femoral artery about an inch and a-half from its commencement. At first it passes downwards and outwards, then curves inwards behind the femoral artery and the adductor longus muscle (this muscle separating the two vessels), and then passes downwards, at first lying between the adductors longus and brevis, and afterwards between the adductors longus and magnus, and terminates by piercing this latter muscle. **Relations.**—It *lies on*—(1) The iliacus, (2) The pectineus, (3) The adductor brevis, (4) The adductor magnus. In *front* of it (besides the structures covering the femoral artery) we have—(1) The femoral and profunda veins, (2) The adductor longus. To its *outer* side is the vastus internus. It may be ligatured near its origin by the same incision as that used for ligature of the femoral in the lower part of Scarpa's triangle; or, lower down by following it inwards behind the adductor longus muscle, but great care would be necessary on account of its relations to its own vein, and also to the femoral vessels.

Branches of the Profunda.—(1) The external circumflex—this branch passes outwards beneath the sartorius and rectus, and divides into—(*a*) Ascending branches which pass upwards and anastomose with the gluteal and the circumflex iliac arteries; (*b*) Transverse branches which pass outwards over the crureus, and anastomose on the back of the thigh with the internal circumflex, gluteal, sciatic, and superior perforating arteries; (*c*) Descending branches which pass downwards towards the knee, and anastomose with the superior articular branches of the popliteal artery. (2) The internal circumflex—this vessel passes directly backwards towards the gluteal region, and there anastomoses with the gluteal, sciatic, and superior perforating arteries. It gives a small branch to the hip joint. It arises from the posterior surface of the profunda, and disappears by passing between the pectineus and psoas muscles, and continuing its course

backwards between the obturator externus, and the adductor brevis, and finally appearing behind, between the adductor magnus and the quadratus femoris muscles. (3) The three perforating arteries which pass backwards *close* to the femur, and appear on the posterior surface of the adductor magnus. These arteries form a regular chain of anastomoses in the back of the thigh, connected above with the gluteal and sciatic arteries, and below with the anastomotica magna and the superior articular branches of the popliteal.

Collateral Circulation.—(1) *In Ligature of the common Femoral.*—(*a*) The obturator artery above, anastomosing with the internal circumflex below; (*b*) The sciatic artery above, anastomosing with the perforating branches of the profunda and the articular branches of the popliteal below; (*c*) The gluteal artery above, anastomosing with the ascending branches of the external circumflex below. (2) *In Ligature of the Superficial Femoral*—(*a*) The descending branches of the external circumflex above, anastomosing with the superior articular branches of the popliteal and anastomotica magna below; (*b*) The obturator artery above, anastomosing with the internal circumflex artery, muscular branches, and anastomotica magna below; (*c*) The chain of anastomoses already mentioned, formed by the perforating arteries, inosculating above with the gluteal, sciatic, and ascending and transverse branches of the external circumflex, and below with the anastomotica magna and articular arteries; (*d*) Terminal branches of the profunda above, anastomosing with the anastomotica magna below. (3) *In Ligature of the Deep Femoral.*—(*a*) The descending branches of the external circumflex above anastomosing with the anastomotica magna and superiör articular arteries below; (*b*) Branches of the internal circumflex above, anastomosing with the perforating arteries below.

Popliteal Artery.—Origin.—It is the direct continuation of the femoral. **Extent.**—It extends from the opening in the adductor magnus to the lower border of the popliteus muscle, where it divides into the anterior and posterior tibials. **Course.**—It passes from the inner side of the femur to the middle of the popliteal space, exactly behind the knee joint, and then passes straight downwards. The artery lies deeply

in the space, and is covered and crossed by the internal popliteal nerve and the popliteal vein; both vein and nerve crossing the artery from without inwards. Behind the knee joint, the artery lies in the middle of the space, and is covered (as looked at from behind) by the nerve and vein, so that if a person receive a stab in this region all the three structures may be injured, or perhaps divided, in the order of nerve, vein, artery.

Ligature of this artery is seldom performed, but it may be cut down upon and exposed as it lies in the middle of the space by making an incision three or four inches long in the middle line, and dividing the skin, superficial fascia, and popliteal fascia, and carefully turning aside the internal popliteal nerve, and the popliteal vein and their branches (towards the inner side), and dissecting carefully down among the fatty tissue with the handle of the knife till the artery is exposed, and then ligature in the usual manner, passing the needle from the inner to the outer side. The circulation will be re-established by the superior articular anastomosing with the inferior articular and other branches around the knee joint.

Posterior Tibial Artery.—Origin—From the bifurcation of the popliteal artery at the lower border of the popliteus muscle. **Extent.**—From its point of origin to the inner side of the os calcis, where it ends by dividing into the internal and the external plantar arteries beneath the internal annular ligament. It lies between the superficial and the deep layers of muscles on the back of the leg. **Course.**—Its course is indicated by a line drawn from a point one inch below the middle of the popliteal space, and in the middle line of the limb to a point a finger's breadth behind the internal malleolus. **Relations.**—It is covered by—(1) Skin and fascia; (2) Gastrocnemius; (3) Soleus; (4) Plantaris; (5) A tendinous arch covering it which stretches between the flexor longus digitorum and the flexor longus hallucis; (6) Posterior tibial nerve which crosses it at its upper part from within outwards. It *lies upon*—(1) The tibialis posticus; (2) The flexor longus digitorum; (3) The lower end of the tibia (this is of importance in compression). On its *inner* side—The posterior tibial nerve (in its upper third). On its *outer* side—The posterior tibial nerve (in its lower two-thirds).

Ligature of the Vessel at its Upper Part.—The vessel may be reached by two **incisions**—(1) By a long incision along the internal edge of the tibia, cutting through the skin and superficial fascia; then divide the deep fascia and expose the inner margin of the gastrocnemius, which is then lifted up and held aside. The tibial origin of the soleus is next exposed, which we either detach from the bone, or cut through it from the surface towards the artery; it is then raised and held aside, and the fascial sheath covering the vessels is exposed and divided, and pressed backwards, and the artery is cleared and ligatured in the usual way. (2) The second form of incision is that recommended by the late Mr Guthrie, and is known as the mesial or direct plan. An incision six inches long is made in the mesial line of the leg, in the course of the vessel, beginning about two inches below the middle of the popliteal space, and dividing the skin and fascia. The external or short saphenous vein is then cleared and held aside, and the *septum* between the two heads of the gastrocnemius is divided to the same extent as the superficial incision, and the two heads separated. The soleus is next cut through, and then the aponeurotic arch covering the vessels, when the posterior tibial nerve will come into view, with the posterior tibial artery and its venæ comites to its *inner* side. The artery is then cleared and the ligature passed *from* the nerve.

Ligature of the Vessel at the Inner Ankle.—Here the artery is quite superficial, and its pulsations may be detected during life. It lies between the tendons of the flexor longus digitorum and the flexor longus hallucis, with a vein on either side, and the posterior tibial nerve immediately behind it (that is, nearer the heel). Make a semilunar incision two inches long, a finger's breadth behind the internal malleolus, towards which the concavity of the incision is to be directed. Cut through the skin and superficial fascia, when the deep fascia covering the vessels is brought into view and divided, and the posterior tibial nerve is then seen, and the artery will be found a little nearer the tibia; separate the artery from its venæ comites and ligature in the usual manner. The artery may also be exposed in the lower third of the leg by a vertical

incision a little to the inner side of the tendo achillis; in this situation it will be found lying on the flexor longus digitorum.

Branches.—(1) Nutrient to tibia; this is the largest nutrient branch in the body; (2) Peroneal; (3) Muscular; (4) Communicating to peroneal; (5) Calcanean; (6) the plantar arteries.

The Peroneal Branch requires special notice. It is often as large as or even larger than the posterior tibial artery, and arises from that vessel about an inch and a-half from its origin. At first it passes obliquely outwards towards the fibula, and then passes downwards behind, and lying close to that bone until about two inches above the ankle, where it divides into its terminal branches. It first lies on the tibialis posticus, and then passes into the substance of the flexor longus hallucis, in which it lies for the rest of its extent. The artery may be ligatured by the same incision as that recommended by Guthrie for ligature of the posterior tibial artery. The posterior tibal nerve forms a safe guide to either of these vessels; it lies almost exactly between, and in close relation to them both—the posterior tibial artery lying immediately to its inner side, while the peroneal branch occupies the same position on its outer side. The structures divided, therefore, are the same in both cases.

Branches of the Peroneal Artery.—(1) Muscular; (2) Nutrient to fibula; (3) Communicating to posterior tibial; (4) Anterior peroneal, which is given off about two inches above the ankle, pierces the interosseous membrane, and passes down in front of the fibula to the outer ankle, and there anastomoses with the external malleolar and tarsal branches of the anterior tibial; (5) Terminal branches, which pass down to the external malleolus, and anastomose with the malleolar and plantar arteries of the posterior tibial.

Collateral Circulation.—When the *posterior tibial* artery is tied at its *upper* part—(1) By the communicating branch between the posterior tibal and peroneal; (2) Muscular branches of the posterior tibial anastomosing with muscular branches of the peroneal; (3) Malleolar branches of the anterior tibial anastomosing with the anterior peroneal, and terminal branches of the peroneal, and calcanean branches

of the posterior tibial; (4) The communicating branch of the dorsal artery of the foot, anastomosing directly with the external plantar from the posterior tibial; (5) The tarsal and the metatarsal branches of the dorsal artery of the foot, anastomosing at the sides of the foot with the external and internal plantar arteries; (6) The perforating branches of the plantar arch anastomosing with branches of the metatarsal branch of dorsal artery. When the artery is ligatured at the *lower* part, the collateral circulation is carried on by anastomoses 2 to 6 (inclusive) of above. When the *peroneal* artery is tied, the collateral circulation will be carried on chiefly by the first three anastomoses enumerated above.

Anterior Tibial Artery.—Origin.—From the bifurcation of the popliteal artery at the lower border of the popliteus muscle. **Extent.**—From its point of origin to the middle of the ankle joint, where it becomes the dorsal artery of the foot. **Course.**—It passes forwards through an opening above the upper part of the interosseous membrane, and then passes downwards obliquely towards the ankle joint. Its course may be indicated by a line drawn from the inner side of the head of the fibula to a point midway between the internal and external malleoli. In its upper third the vessel lies deeply, in its lower two-thirds it is more superficial. **Relations.**—It is covered by—(1) The skin; (2) Superficial fascia; (3) Deep fascia; (4) The anterior tibial nerve crosses it once or twice; (5) Near the ankle it is crossed by the tendon of the extensor proprius hallucis. It is also overlapped by the fleshy bellies of the contiguous muscles. On its *inner* side—(1) The tibialis anticus; (2) Near the ankle the extensor proprius hallucis. On its *outer* side—(1) The anterior tibial nerve, at the upper part of the vessel; (2) Extensor longus digitorum for about two inches; (3) The extensor proprius hallucis; (4) Anterior tibial nerve, at the lower end. It *rests* on—(1) the interosseous membrane in its upper two thirds; (2) The tibia, in its lower third; (3) The anterior ligament of the ankle joint.

To tie the vessel in its *upper third* an **incision** four or five inches long should be made in the line of the vessel along the outer margin of the tibialis anticus muscle, beginning one

inch below the head of the fibula. Divide the skin and fascia, and expose the muscular aponeurosis. The inter-muscular septum between the tibialis anticus and the extensor communis digitorum (the long extensor of the great toe, not arising so high up on the fibula as this muscle) is next to be found and divided to the same extent as the superficial incision; great care is necessary lest the septum between the common extensor and the peroneus longus be opened instead of this one, and so the operator be led away from the artery. To prevent such a mistake, it will be well to bear in mind that the septum between the tibialis anticus and the common extensor is very *weak*, so that the two muscles are very readily separated; while the septum between the common extensor and the peroneus longus is very *strong* so that these muscles are separated with difficulty. This is all the more important to remember, because the common extensor is very narrow above, and the operator is very apt, therefore, to open the septum between it and the peroneus longus. The two muscles—tibialis anticus and the extensor communis digitorum—are then separated, and the artery is found lying on the interosseous membrane, with the anterior tibial nerve to its outer side. It is then separated from its venæ comites, and its sheath opened and the vessel cleared, and the ligature passed from the outer side.

Above the ankle the vessel is more easily reached, as the bulk and depth of the muscles are much diminished. An **incision** should be made in the line of the vessel three inches long upon the outer side of the tendon of the tibialis anticus, and parallel to it; at this point the tibialis anticus is much narrower than it is at the upper part of the leg, and the extensor proprius hallucis lies to the outer side of the artery. At this point, therefore, the artery lies between the tendons of the tibialis anticus and the extensor proprius hallucis, with the nerve to its outer side, and rests on the lower end of the tibia. The steps of the operation are similar to those described above.

Branches.—(1) The anterior tibial recurrent; (2) Muscular; (3) Internal malleolar; (4) External malleolar, which is the largest, and anastomoses with the anterior peroneal artery.

Collateral Circulation.—For this, see anastomoses, from three to six inclusive, in "collateral circulation" under the posterior tibial artery.

Dorsalis Pedis Artery.—Origin.—It is the direct continuation of the anterior tibial artery. **Extent.**—From the centre of the instep, beneath the anterior annular ligament, to the base of the metatarsal bone of the great toe, where it divides into the communicating branch to the sole of the foot and the dorsal artery of the great toe. **Course.**—Its course is from the centre of the instep to the cleft between the first two toes. **Relations.**—It is simply covered by the integumentary structures, and crossed near its point of bifurcation by the innermost tendon of the extensor brevis digitorum. It lies between the tendons of the extensor proprius hallucis and the extensor communis digitorum, and has the anterior tibial nerve to its outer side. It rests on the bones of the tarsus and their dorsal ligaments. It may be tied in the upper part of its course by an **incision** an inch and a-half long, in the line of the vessel, on the outer side of, and parallel to the tendon of the extensor proprius hallucis. To reach the vessel it is only necessary to cut through the skin, superficial, and deep fascia.

Branches.—(1) Tarsal, (2) Metatarsal, (3) Communicating, (4) Dorsalis hallucis.

Collateral Circulation.—See anastomoses, four to six inclusive, under posterior tibial artery.

The External Plantar Artery and Plantar Arch.—The course of this vessel may be mapped out on the sole of the foot as follows :—It begins at the lower part of the internal lateral ligament, behind the internal malleolus, and runs forwards and outwards, taking a slightly arched course, with the convexity outwards, to the base of the fourth intermetatarsal space; this forms its superficial part, and it is covered by the superficial structures and the first layer of muscles of the foot. From this point its course is deeper; it turns round the outer border of the accessorius, and runs forwards and inwards to the posterior part of the first interosseous space forming the plantar arch, lying upon the interossei and the bases of the metatarsal bones. The arch is completed by the

communicating branch from the dorsalis pedis, and is covered by the first three layers of muscles of the sole of the foot.

The Gluteal, Sciatic, and Pudic Arteries.—These three vessels are branches of the internal iliac artery, and are found in the gluteal region beneath the gluteus maximus muscle. They all emerge from the pelvis through the great sacro-sciatic foramen. The trunk of the **gluteal** will be found between the pyriformis and the gluteus minimus muscles where it divides into a superficial and a deep division. The *superficial* part is distributed to the under surface of the gluteus maximus; the *deep* divides into superior and inferior branches—the *superior* runs along the middle curved line between the gluteus medius and minimus, and anastomoses with the ascending branch of the external circumflex artery; the *inferior* crosses the gluteus minimus to the great trochanter. The **Sciatic** artery appears below the pyriformis. It anastomoses with the external and the internal circumflex branches of the profunda femoris. Its branches are—(1) Muscular, (2) Coccygeal, (3) Comes nervi ischiadici, (4) Anastomotic. The **Pudic** artery is seen close beside the sciatic. It winds out of the great sacro-sciatic foramen, crosses over the spine of the ischium, and re-enters the pelvis by the lesser sacro-sciatic foramen above the tendon of the obturator internus. As it lies on the spine of the ischium it has a vein on either side, the nerve to the obturator internus on its outer side, and the pudic nerve internal to it. The position of these three vessels may be indicated on the surface thus: "If a line is drawn from the posterior superior spinous process of the ilium to the tuberosity of the ischium the gluteal artery issues from the pelvis at a point about an inch external to the junction of the upper and middle thirds of this line; the ischiatic and pudic arteries a couple of inches lower down."—(CHIENE).

DISLOCATIONS.

The Hip Joint.—*Class*, Diarthrosis; *Sub-Class*, Enarthrosis. *Ligaments.*—(1) Cotyloid, (2) Transverse, (3) The ligamentum teres, (4) The capsular. The capsular ligament is attached above to the margin of the cotyloid cavity and transverse ligament; and below—in *front* to the anterior

inter-trochanteric line; *above*, to the root of the great trochanter; *behind* and *below* to the junction of the middle and outer thirds of the neck of the bone. It consists of circular and longitudinal fibres, and on the posterior and inferior aspects of the capsule, the fibres are almost all circular, so as not to interfere with the swinging movements of the limb as in walking, and in these situations also the capsule is very thin and very loosely attached. On the anterior aspect of the capsular ligament there is a specially thickened part known as the *ilio-femoral band* or Y-shaped ligament of Bigelow. It is attached above to the anterior inferior iliac spine, and below the two limbs diverge, one to be attached to the upper end of the inter-trochanteric line, the other to the root of the lesser trochanter. The inner slip specially limits extension, and the outer slip, eversion of the femur. There is another specially thickened part of the capsule on the superior aspect known as the *ilio-trochanteric* band, which specially limits adduction. By flexing the thigh upon the trunk and rotating the femur inwards, the Y-ligament is rendered lax; this is of importance in the reduction of dislocations. The centre of gravity falls *behind* the centres of rotation of the hip joint, and the trunk, therefore, naturally tends to fall backwards, but this is prevented by the *ilio-femoral* band. By this wise provision of nature, muscular effort is not required to maintain the erect attitude, so that energy is economised. There is another part of the capsular ligament that requires special notice—viz., the *cervical reflexion.* This consists of bands of fibres which come off from the inner surface of the capsule, and are reflected upwards on to the neck of the femur. This reflexion is not necessarily ruptured in intra-capsular fracture, and conveys blood across the fractured point, and by this means will tend to a certain extent to aid the union of the broken parts. *Movements at the Hip Joint.*—**Flexors.**—These muscles flex the thigh on the trunk, or the trunk on the femur. *Direct* flexors (*i.e.*, those that pass from the trunk over one joint only)—(1) Psoas, (2) Iliacus, (3) Pectineus. *Indirect* flexors (*i.e.*, muscles passing over two joints, and only acting secondarily on the hip joint)—(1) Rectus, (2) Sartorius. **Extensors.**—*Direct.*—

The three glutei muscles. *Indirect.*—The three hamstrings (biceps, semi-tendinosus and semi-membranosus). **Abductors.**—(1) Gluteus medius; (2) Gluteus minimus; (3) Tensor fasciæ femoris; (4) Sartorius. **Adductors.**—(1) The three adductors; (2) Gracilis; (3) Pectineus; (4) Quadratus femoris; (5) Obturator externus. **External Rotators.**—(1) Gluteus maximus; (2) Gluteus medius (posterior part); (3) Pyriformis; (4) Obturator internus and the two gemelli; (5) Quadratus femoris; (6) Obturator externus; (7) Psoas and iliacus. **Internal Rotators.**—(1) Gluteus minimus; (2) Gluteus medius (anterior part); (3) Tensor fasciæ femoris. It will be noticed that the external rotators are much more numerous and powerful than the internal, so that the foot naturally tends to fall outwards when one assumes the supine position. *Muscles in direct contact with the capsule of the Hip Joint.*—In *front*—Psoas and iliacus. *Above*—(1) Rectus (reflected tendon), (2) Gluteus minimus. On its *inner* side—(1) Pectineus; (2) Obturator externus. *Behind* it—(1) Pyriformis, (2) Obturator internus and the two gemelli, (3) Part of gluteus minimus, (4) Obturator externus, (5) Quadratus femoris.

Dislocations of the Hip Joint.—The dislocations of this joint are various, but whatever position the head of the bone ultimately assumes, the primary dislocation is *always* in a downward direction. The forms of regular dislocation are—(1) Upwards on to the dorsum ilii; (2) Backwards into the great sacro-sciatic notch; (3) Downwards into the foramen ovale; (4) Forwards on to the pubes. The first two forms are the most common.

We have to notice the influence exerted (1) by the Y-ligament; (2) By the tendon of the obturator internus, as it is found in the gluteal region, on the various forms of regular dislocation of this joint—(1) *The Y-ligament.*—If this ligament escape rupture, we may get any of the four *regular* forms of dislocation enumerated above; if it be wholly ruptured the dislocation will be of an *irregular* form. In no case do muscles (except perhaps the obturator internus) exercise any direct influence on the displacement. In dislocation on to the dorsum ilii, and into the great sacro-sciatic notch there is marked *inversion* of the limb; this is because the ilio-femoral

band is not ruptured, and the external rotators are powerless to rupture it, and are therefore unable, so long as the ligament remains intact, to evert the limb. For the same reason, in dislocation into the foramen ovale the limb is *flexed*. In dislocation on to the pubis the ligament is lax, and hence the external rotators are at liberty to act, and, having nothing to oppose them, produce marked *eversion*. (2) *The Tendon of the Obturator Internus.*—Bigelow has pointed out that the muscular body of this muscle is usually mixed with tendinous structure; by this means it acquires great strength, and when contracted acts as a powerful accessory ligament on the posterior aspect of the hip joint. It has also been pointed out by the same surgeon that in dislocations on to the dorsum ilii, and into the great sacro-sciatic notch, the bone passes in exactly the same direction in the first instance; but, in dislocation on to the dorsum ilii the head, in passing upwards and backwards, passes *between* the tendon of the obturator internus and the pelvis, whereas in dislocation into the great sacro-sciatic notch, the head of the bone as it passes backwards, passes *behind* the tendon of the obturator internus, the tendon lying between the neck of the bone and the pelvis.

In dislocation on to the *dorsum ilii* (upwards), which is the most common form, the limb is shortened one or two inches, the knee is inverted and rests against the opposite *thigh*, and the great toe rests on the instep of the opposite foot; the thigh is flexed, and there is great bulging at the hip from the projection of the great trochanter. In dislocation into the *sciatic notch* (backwards) the limb is shortened about half an inch, the knee is inverted and touches the opposite knee, but does not tend to cross over it, and the great toe rests on the metatarsal bone of the great toe of the opposite foot. There is less flexion and less bulging at the hip than in dislocation on to the dorsum ilii. In dislocation into the *foramen ovale* (downwards) the limb is *lengthened*, the toes point downwards and are a little everted, and seem to lie away from the other foot—the thigh being flexed and abducted, and in front of the opposite one. In dislocation *on to the pubis* (forwards) the limb is shortened, and there is marked eversion of the foot and knee, and the heel inclines towards the opposite one.

This form of dislocation is said to resemble fracture of the neck of the femur.

The Knee Joint.—*Class*, Diarthrosis; *Sub-Class*, Ginglymus. There are three circumstances which tend to make this joint insecure; (1) The configuration of the articular surfaces of the bones; (2) The fact that it is between the two longest bones in the body, and, therefore, powerful leverage is brought to bear upon it; (3) Its great mobility. Nevertheless, dislocation of this joint is rare, its great strength being due to very powerful ligaments. *Ligaments*—The ligaments of this joint are very numerous, and are divided into exterior and interior sets. *Exterior*—(1) The internal lateral; (2) The external lateral (long and short); (3) Posterior ligament, or ligament of Winslow; (4) Ligamentum Patellæ; (5) The capsular, which is a strong fibrous membrane filling up the gaps left by the other ligaments, and is strengthened by fibres from the various muscles surrounding the joint. *Interior ligaments*—(1) Crucial, anterior, and posterior. (*a*) The *antero-external* is attached below to the inner part of the pit in front of the spine of the tibia; above, to the inner and hinder part of the external condyle of the femur. Its direction is upwards, backwards, and outwards. (*b*) The *postero-internal* is attached below to the back of the pit behind the tibial spine; above, to the fore part of the inter-condyloid hollow and side of the inner condyle. Its direction is upwards and a little forwards. (2) The semi-lunar cartilages. (*a*) The *internal* forms almost a semi-circle, and embraces the ends of the external. Its anterior end is attached to an impression towards the front part of the internal articular surface; its posterior end is attached to the inner edge of the hollow behind the spine of the tibia, along with the posterior crucial ligament. (*b*) The *external* forms about three-fourths of a circle, and its anterior and posterior ends are interposed between the attachments of the internal cartilage in front of and behind the spine of the tibia. (3) The transverse ligament, which passes between the two cartilages. (4) The coronary ligament, which connects the convex borders of the cartilages with the head of the tibia. (5) Ligamentum

mucosum, which is simply a process of synovial membrane. (6) Ligamenta alaria, its fringed borders.

The **movements** of this joint are in some respects peculiar. (1) It is not a pure hinge-joint, but has in addition a gliding and rolling movement. In these movements the semi-lunar cartilages (which may be regarded as inter-articular fibro-cartilages) form movable and accurately fitting wedges. (2) The movement is through an oblique plane, the axis of the femur is downwards and inwards, but when the leg is flexed, it is parallel to the thigh. (3) There is a movement of rotation at the completion of extension which is called the "locking," or "screwing home" of the joint. (4) When the knee is partly flexed, the joint admits of internal and external rotation. Another point worthy of notice is the movements of the patella on the articular surface of the femur. This is a movement partly of gliding and partly of co-aptation. The patella has seven facets on its articular surface—three pairs, and one internal perpendicular facet. When the knee is extended, as in the erect position the two inferior facets are in contact with the upper part of the trochlear surface of the femur; in semi-flexion the middle facets come into contact with the femur; in still greater flexion, the superior pair are brought into contact, while in extreme flexion, the patella leaves the trochlear surface of the femur altogether, and the internal perpendicular facet lies in contact with the outer margin of the inner condyle. Further, at the completion of extension, there is a slight rotation outwards to "lock" the joint; and, at the beginning of flexion, there is a slight rotation inwards of the leg and foot to "unlock" it. The centre of gravity of the body, in the erect attitude, falls in *front* of the axis of motion of the knee joint, and there is a tendency, therefore, to over-extension; but this is impossible, because of the tension of the lateral, posterior, and *anterior* crucial ligaments (the *posterior* crucial being tightened in flexion.) In this way the erect attitude is maintained without the expenditure of muscular energy.

Flexors.—*Direct*—(1) Biceps, (2) Semi-tendinosus, (3) Semi-membranosus, (4) Popliteus. *Indirect*—(1) Gastrocnemius, (2) Plantaris, (3) Sartorius, (4) Gracilis. **Extensors.**—Quad-

riceps extensor cruris (formed by the two vasti, the rectus femoris and the crureus). **External Rotator.**—(When the limb is partly flexed)—The biceps muscle as a whole. **Internal Rotators.**—(1) Popliteus—(this is the chief one, but only acts when the knee joint is flexed, and the tendon of the popliteus lying in its groove), (2) Semi-tendinosus, (3) Semi-membranosus, (4) Sartorius, (5) Gracilis. To **lock home** the joint at the completion of extension.—The extensor muscles as a whole cause a slight rotation outwards. To **unlock** the joint at the commencement of flexion—(1) The sartorius, (2) The gracilis, (3) The semi-tendinosus.

Dislocations of the Knee Joint.—This is a rare form of accident for reasons already stated, and when it does occur it is usually complicated with such injury to the popliteal vessels as to necessitate amputation. Other complications are also likely to arise from the force required to dislocate it, such as rupture of ligaments and muscles, and gangrene may result, or the joint may fall into a state of suppurative or destructive inflammation, so that dislocation of the knee joint is more liable to complications than any other joint. Diastasis of the condyloid part of the femur in young children may resemble dislocation of the knee joint.

Ankle Joint.—*Class*, Diarthrosis; *Sub-Class*, Ginglymus. *Ligaments*—(1) Anterior, and (2) Posterior—these two are very thin; (3) Internal lateral or deltoid; (4) External lateral, which consists of three strong fasciculi—(*a*) The *anterior* passes from the anterior part of the external malleolus to the front part of the astragalus; (*b*) the *middle* passes from the tip of the external malleolus to the outer surface of the os calcis; (*c*) The *posterior* passes backwards horizontally from the pit on the inner side of the malleolus to the posterior surface of the astragalus. **Movements.**—The movements at the ankle joint are chiefly flexion and extension (*flexion* being the bending of the dorsum of the foot towards the front of the leg, while extension is the opposite movement). There is also a certain amount of movement from side to side when the foot is extended, because the posterior part of the articular surface of the astragalus is narrower than the anterior, but in the *erect* position there is no lateral movement possible. There

are other two movements spoken about as occurring at the ankle—viz., Eversion and inversion; the first of these movements is not very free, the second form is much freer. In *eversion*, the outer border of the foot is raised and drawn outwards. In the production of this form of club foot (*talipes valgus*) there is, in the first instance, a tendency to obliteration of the arch of the foot so that the sole becomes perfectly flat (*talipes planus* or flat foot), and as the disease advances, eversion of the foot takes place. The flattening of the foot is due to the relaxation of the ligaments that support the arches of the foot; the ligaments that support the *transverse* arch are chiefly the interosseous ligaments between the cuneiform and the cuboid bones; those that support the *longitudinal* arch are—(1) The long plantar ligament (inferior calcaneo-cuboid); (2) The short plantar ligament (the short calcaneo-cuboid); (3) The calcaneo-scaphoid ligament which supports the head of the astragalus; (4) The plantar fascia also assists to maintain the arch. *Inversion* is a much freer movement. It takes place at three points—(1) To a slight extent at the ankle joint proper; (2) At the articulation between the astragalus and the os calcis, but chiefly at (3) the transverse articulation of the foot, that is, at the astragalo-scaphoid and calcaneo-cuboid articulations. We have an example of this form of movement in *talipes varus* where the foot is twisted inwards and the sole is contracted.

Flexors of the ankle joint.—*Direct*—(1) The tibialis anticus, (2) Peroneus tertius; *Indirect*—(1) Extensor longus digitorum, (2) Extensor proprius hallucis. **Extensors.**—*Direct*—(1) Muscles of the calf (gastrocnemius, soleus, and plantaris); (2) Tibialis posticus; (3) Peroneus longus; (4) Peroneus brevis. *Indirect*—(1) Flexor longus digitorum; (2) Flexor longus hallucis. Note that the indirect *flexors* of the ankle joint are *extensors* of the toes; while the indirect *extensors* are *flexors* of the toes. **Evertors.**—(1) The peroneus longus; (2) The peroneus brevis; (3) The peroneus tertius. **Invertors.**—(1) The tibialis anticus; (2) The tibialis posticus.

Simple dislocation of the ankle joint is rare; it is usually associated with fracture of the fibula, or tibia, or of both.

FRACTURES.

Of the Femur.—(1) Neck—(*a*) Intra-capsular, (*b*) Extra-capsular; (2) Of shaft; (3) Of condyles. The following table will assist the diagnosis between intra and extra-capsular fractures of the neck of the femur—(From ERICHSEN)—

Intracapsular.	*Extracapsular.*
1. Cause—generally slight and indirect, such as catching the foot in the carpet or slipping off the curb stone.	1. Cause—usually severe and direct violence, such as falling from a height or blow on the hip.
2. Force—usually applied longitudinally or obliquely.	2. Force—usually applied transversely.
3. Age—rarely below fifty, most commonly in feeble, aged persons.	3. Age—usually below fifty, chiefly in vigorous adults.
4. Pain and constitutional disturbance, slight.	4. Pain and constitutional disturbance, usually considerable.
5. No apparent injury to soft parts about the hip.	5. Considerable extravasation, ecchymosis and signs of direct injury to hip.
6. Crepitus often obscure.	6. Crepitus (when not impacted) very readily felt.
7. Shortening usually at first not more than one inch.	7. Shortening (when not impacted) at least two inches or more.

There is usually marked *eversion* in both cases, partly perhaps because this is the natural position of the limb, but chiefly from the action of the psoas and iliacus muscles, the adductors, the glutei and other external rotators of the hip joint. The shortening of the limb is caused by the glutei muscles, rectus femoris, and ham-string muscles (biceps, semi-tendinosus, and semi-membranosus).

Fractures of the Shaft.—If the fracture be through the *upper* part of the shaft, the upper fragment is tilted forwards by the psoas and iliacus, and drawn outwards by the external rotators

and glutei muscles; the lower fragment is drawn upwards by the rectus femoris in front, and the hamstring muscles behind, and drawn inwards by the pectineus and adductor muscles. In fracture through the *middle* of the shaft, the lower fragment is drawn inwards and upwards by the adductor fibres attached to it, and rotated outwards, while the upper fragment projects forwards usually from the same causes as in fracture of the upper part of the shaft. In fracture in the *vicinity of the condyles* the lower fragment is tilted backwards by the gastrocnemius, plantaris, and popliteus muscles, and can be felt deep in the popliteal space; the upper fragment is drawn inwards by the pectineus and adductors, and tilted forwards by the psoas and iliacus. In all cases of oblique fracture of the shaft of the femur there is shortening and external rotation—shortening being caused by the contraction of the flexors, extensors, and adductors of the limb, while external rotation is caused by the external rotators being more powerful than the internal. In children fractures of the shaft of the femur are frequently transverse, and, in such cases, the well-marked displacement is absent; and, in connection with fractures in the vicinity of the condyles in children, it should be borne in mind that diastasis of the condyloid end of the femur may take place—the lower epiphysis of this bone not uniting with the shaft till the twentieth year.

Fractures of the Tibia and Fibula.—If the tibia alone be broken, or if the fibula alone be broken, there is usually little displacement because the sound bone acts as a splint to the fractured one. The weakest part of the shaft of the tibia is about its lower fourth, and the weakest part of the shaft of the fibula is about its upper fourth, and at these points, therefore, the bones are most likely to give way. In *transverse* fractures there will be little displacement, muscular action simply keeping the fractured ends in apposition; if, however, the fracture is oblique, the lower fragment is drawn upwards and backwards by the muscles of the calf (gastrocnemius, plantaris, and soleus), and this is more marked if the fracture be situated at the lower part of the shafts of the tibia and fibula; while the upper fragment is tilted forwards by the *tendo patellæ* (the tendon of insertion of the quadriceps extensor cruris)—rectus,

the two vasti and the crureus—and rotated inwards by the sartorius, gracilis, and semi-tendinosus, and this displacement of the upper fragment is more evident if the fracture be at the upper part of the shaft. "*Pott's Fracture.*"—By "Pott's" fracture is meant, fracture of the lower end of the fibula and rupture of the internal lateral ligament of the ankle joint with displacement of the tibia. The fractured point of the fibula is about one and a-half or two inches above the external malleolus, that is, through the upper part of its triangular subcutaneous surface. The foot is everted by the three peronei muscles so that the foot almost looks directly outwards, while the heel is drawn up by the muscles of the calf.

EXCISION OF JOINTS.

The Hip Joint.—This joint may be excised—(1) By a long curved incision with its concavity directed forwards, along the posterior aspect of the great trochanter, or (2) by a longitudinal incision, and then a cross one a little above the great trochanter—T-shaped incision. The flaps are then dissected, and the limb is carried obliquely across the opposite one, and rotated inwards so as to render the trochanter prominent. The attachments of the glutei muscles are then divided, and also the muscles inserted into the upper surface of the great trochanter—viz., The obturator internus and the two gemelli, pyriformis, and the tendon of the obturator externus in the digital fossa; a small part of the vastus externus will also probably be divided. The capsular ligament is next opened and the ligamentum teres divided; and by adducting and forcibly pushing upwards, the head of the bone is projected, and the necessary amount removed. Any bleeding vessels must be secured; and the vessels most likely to be divided are those in the neighbourhood of the upper part of the great trochanter—viz., Branches from the deep division of the gluteal artery, branches of the sciatic artery, and the ascending branches of the external circumflex branch of the profunda, and probably also branches of the obturator, and the internal circumflex branch of the profunda, all of which arteries give nutrient branches to the hip joint.

The Knee Joint.—Three forms of incision may be used

in excision of this joint—(1) The H-shaped—a longitudinal incision at the outer and inner sides of the joint united by a transverse one across the patella; (2) A single longitudinal incision in the axis of the limb, from three inches above the patella to below the ligamentum patellæ; (3) A horse shoe-shaped incision with its convexity downwards and extending from one condyle of the femur to the other, and passing below the ligamentum patellæ. This is the best form of incision, as there is not the same objection to cross incisions in excision of the knee joint as there is in excision of the elbow joint; the object aimed at in the former (the knee joint) is not a movable articulation, and, consequently, a cross incision is an advantage, as the cicatrix tends to contract and keep the parts tight in front. By the last form of incision the integumentary structures and the ligamentum patellæ are divided, and the patella turned up in the elliptical flap; the crucial ligaments, and the other ligaments of the joint (see p. 81) are next divided, and the ends of the bones cleared of the surrounding muscles—the femur from the gastrocnemius, plantaris, round tendon of the adductor magnus, and the popliteus; in the case of the tibia the semi-membranosus is probably the only muscle that will require to be divided to any great extent, the insertion of the quadriceps extensor cruris (the ligamentum patellæ) having already been divided. The operation of clearing the bones must be conducted very carefully, keeping the edge of the knife close to the bone, on account of the proximity of the large popliteal artery and its articular branches, of which the *superior internal articular* passes round the femur above the internal condyle and *under* the tendon of the adductor magnus, and the *superior external articular* passes round immediately above the outer condyle; the *inferior internal* passes below the internal tuberosity of the tibia between the bone and the internal lateral ligament of the joint, and the *inferior external* passes above the head of the fibula, but beneath the external lateral ligament and the tendon of the biceps. The azygos articular enters the joint by piercing the ligament of Winslow. The bones having been cleared, and the knee forcibly flexed, they are next to be sawn; it is usual to saw the end of the femur first, and

about one inch to an inch and a-half of this bone may be removed, and afterwards about half an inch of the tibia. The arteries likely to be divided are those taking part in the general anastomoses around, or in the joint—viz.:—The five articular branches of the popliteal already mentioned, together with branches from the anastomotica magna of the femoral, and the recurrent articular branch of the anterior tibial artery.

The Ankle Joint.—Excision of this joint may be performed by means of two lateral incisions passing below the two malleoli—one beginning about two and a-half inches above the internal malleolus and passing below it, and then curving forwards round it towards the tendon of the tibialis anticus; the other is of the same extent and is made along the outer margin of the fibula, curving forwards towards the tendon of the peroneus tertius. Another form of incision is, a semi-lunar one about four inches in length along the outer and anterior aspect of the joint passing below the external malleolus and carrying it well forwards. The peronei tendons (longus and brevis) are separated from their groove on the back of the fibula, and the tibialis posticus, and the flexor communis digitorum separated from the back of the tibia, and the posterior surface of both bones are then cleared, keeping the edge of the knife close to the bone to avoid wounding the posterior tibial artery which lies about a finger's breadth behind the internal malleolus. A broad copper spatula is then passed between the bones and the soft parts. The flaps of skin are then dissected forwards and upwards, and the extensor tendons and the dorsal artery of the foot raised from the front of the joint, taking care in doing so not to wound the artery; the extensor tendons and the soft parts are then held away from the front of the joint, by passing a fold of bandage beneath them, and the lateral ligaments of the joint divided. The tibia and the fibula are then sawn through about an inch above the malleoli, and next the projecting articular part of the astragalus is also sawn off, or, if very much diseased, the entire bone may be removed.

AMPUTATIONS.

At the Hip Joint.—This may be performed (1) by antero-

posterior flaps—the anterior one being large and thick, and formed by transfixion, and a short posterior one from the gluteal region; or (2) by lateral flaps. The first is said to be the simplest, more easily and quickly performed, and to leave a better stump. In using the first form of incision, the landmarks in the operation are the *tuber ischii* and the *anterior superior iliac spine.* In operating upon the *right* leg the operator should stand on the *inner* side of the limb; while if operating on the *left* he ought to stand on the *outer* side—*i.e.*, he always stands on the left side of the limb to be removed. On the *left* side the knife is entered about two fingers' breadth below the anterior superior iliac spine (or almost midway between it and the great trochanter), and carried deeply in the limb, behind the vessels and obliquely across the joint, keeping the back of the knife *parallel to Poupart's ligament*, and bringing its point out just in front of the tuberosity of the ischium, or immediately below (as the patient lies on the operating table) the ridge formed by the projecting edge of the adductor longus, taking care not to transfix the scrotum or the opposite thigh at the same time. The knife is then made to cut downwards and forwards for about five inches, and in this way the anterior flap is formed. The capsule of the joint is then opened and the head of the bone disarticulated; and the knife is next passed behind the bone, and the posterior flap (about four inches in length, being a little shorter than the anterior) is formed by cutting downwards and backwards. If the *right* leg is to be removed, the point of the knife must be entered where it comes out on the left side; that is, it must be entered just above the tuberosity of the ischium and brought out midway between the anterior superior iliac spine and the great trochanter. The immediate danger to life in amputation at the hip joint is excessive hæmorrhage. To obviate this risk as far as possible, Lister's aorta compressor should be used; and the femoral artery at the same time should be compressed against the brim of the pelvis, and an assistant should be ready to grasp the femoral vessels at once as they are cut in the formation of the anterior flap. In this way there will be a threefold security against hæmorrhage from the femoral artery.

Chief Structures Divided.—(1) The integumentary coverings. (2) *Muscles*—(*a*) Pectineus, (*b*) The three adductors, (*c*) The gracilis, (*d*) The sartorius, (*e*) The tensor fasciæ femoris, (*f*) The upper part of the quadriceps extensor cruris, (*g*) The obturator internus and the two gemelli, (*h*) The obturator externus, (*i*) The pyriformis, (*j*) The three hamstrings (the biceps, semi-tendinosus, and the semi-membranosus), (*k*) The three glutei muscles, (*l*) The quadratus femoris, (*m*) The psoas and iliacus. (3) *Vessels*—(*a*) the long saphenous vein, (*b*) The femoral vessels (in the anterior flap), (*c*) The sciatic vessels, (*d*) The gluteal vessels (the gluteal and sciatic vessels are found in the posterior flap). (4) *Nerves*—(*a*) Branches of the anterior crural, (*b*) Branches of the obturator, (*c*) The great sciatic, (*d*) The small sciatic, (*e*) The external cutaneous, (*f*) Branches of the superior gluteal. (5) *Ligaments*—(*a*) The capsular ligament, (*b*) The ligamentum teres, (*c*) The ilio-femoral band.

Through the Middle of the Thigh.—This may be performed by any of the seven methods described on pp. 58—59. The operator stands on the left side of the limb to be amputated. *Chief Structures Divided.*—(1) The integumentary coverings. (2) *Muscles*—(*a*) The quadriceps extensor cruris, (*b*) Sartorius, (*c*) The adductor longus, (*d*) The adductor magnus, (*e*) The gracilis, (*f*) The hamstrings. (3) *Vessels.*—(*a*) Femoral vessels (about this point these will be found at the inner side of the posterior flap), (*b*) The profunda vessels (these will also be found in the posterior flap, close to the posterior surface of the femur), (*c*) The long saphenous vein. The position of the femoral will vary with the point of section; for, as has already been pointed out, the vessel as it passes down the thigh gradually inclines from the anterior to the posterior aspect of the bone, so that it may be found at some parts in the inner side of the anterior flap. (4) *Nerves.*—(*a*) The great sciatic; and also small branches of—(*b*) The obturator, (*c*) The anterior crural, (*d*) The small sciatic, (*e*) The external cutaneous. (5) The femur.

At the Knee Joint.—This may be performed (1) By a short anterior, and a long posterior flap, cut from the upper part of the calf of the leg; (2) By a short posterior and a long

anterior flap to which the patella is left attached. *Chief Structures Divided.*—(1) The integumentary coverings. (2) *Muscles*—(*a*) The lower part of the quadriceps extensor cruris, (*b*) The adductor magnus, (*c*) The gracilis, (*d*) The hamstrings, (*e*) The sartorius, (*f*) The gastrocnemius, (*g*) The plantaris, (*h*) The soleus, (*i*) The popliteus. (3) *Vessels*—(*a*) The popliteal vessels (in the posterior flap) with its lower articular branches, (*b*) Branches of the anastomotica magna of the femoral. (4) *Nerves*—(*a*) The internal popliteal with its *ramus communicans tibialis*, (*b*) The external popliteal with its *ramus communicans fibularis*, (*c*) Cutaneous nerves of this neighbourhood, (*d*) Branches of the obturator nerve supplying the knee joint; (5) The ligaments of the knee joint (see p. 81).

Through the Middle of the Leg.—This may be performed in four ways—(1) By the modified circular method (Syme's); (2) By a long posterior flap; (3) By Teal's method; (4) By Carden's method. *Chief Structures Divided.*—(1) The integumentary coverings. (2) *Muscles*—(*a*) Tibialis anticus, (*b*) Extensor communis digitorum, (*c*) Extensor proprius hallucis, (*d*) The peroneus longus, (*e*) the peroneus brevis, (*f*) The gastrocnemius, (*g*) Soleus, (*h*) Plantaris, (*i*) The flexor longus digitorum, (*j*) The flexor longus hallucis, (*k*) Tibialis posticus. (3) *Vessels*—(*a*) The long saphenous vein, (*b*) The short saphenous vein, (*c*) The anterior tibial vessels, lying on the interosseous membrane, (*d*) the posterior tibial vessels lying on the tibialis posticus, (*e*) The peroneal vessels (about the middle of the leg these will be found in the substance of the flexor longus hallucis, higher up they will be found lying on the tibialis posticus). (4) *Nerves*—(*a*) The short saphenous, or the nerves going to form it, (*b*) the anterior tibial nerve, (*c*) The posterior tibial nerve, (*d*) The peroneal nerve. (5) Tibia and fibula. (6) The interosseous membrane.

At the Ankle Joint.—(1) By Syme's method. According to Mr. Syme, the incisions are as follow:—"The foot being held at a right angle to the leg, the point of the knife is introduced immediately below the malleolar projection of the fibula, rather nearer its posterior than anterior edge, and then carried across the bone, slightly inclining backwards, to the inner side of the ankle where it terminates at the point

exactly opposite its commencement," (that is a little below and behind the internal malleolus.) "The extremities of this incision thus formed are then joined by another passing in front of the joint." (2) By M'Kenzie's method, that is, by a large internal calcanean flap. The knife in this operation is inserted over the tendo achillis, and is carried obliquely across that tendon towards the outer and plantar aspect of the heel, and is then curved inwards across the sole, and upwards in front of the internal malleolus, till it crosses the tendon of the tibialis anticus, and is then continued across the dorsal aspect of the foot, one inch below the ankle, till it joins the first incision. (3) By Pirogoff's method. The peculiar feature of this operation is the preservation of the posterior part of the os calcis in the heel-flap. To a certain extent the incisions resemble Syme's incisions: an incision is carried across the sole of the foot, *from one malleolus to the other*; and the front part of this incision must extend well forwards, at least *an inch in front* of a line drawn across from the tip of one malleolus to the other. This flap is dissected backwards to slightly beyond the line of the *ankle joint* (not beyond the heel, as in Syme's amputation), and the os calcis is then sawn through. *Chief Structures Divided.*—(1) The integumentary coverings and plantar fascia. (2) *Muscles*—(*a*) Tibialis anticus, (*b*) The extensor communis digitorum and peroneus tertius, (*c*) The extensor proprius hallucis, (*d*) The peroneus longus and brevis, (*e*) The tendo Achillis and plantaris, (*f*) The tibialis posticus, (*g*) The first layer of muscles of the foot (abductor hallucis, flexor brevis digitorum and the abductor minimi digiti), (*h*) Part of the second layer (the tendons of the flexor longus digitorum and flexor longus hallucis, and accessorius muscle). (3) *Vessels*—(*a*) The dorsal artery of the foot, (*b*) The internal and the external plantar vessels, or else the posterior tibial close to the point where it divides into these vessels. (4) *Nerves*—(*a*) The posterior tibial or plantar nerves, (*b*) The anterior tibial, (*c*) The musculo-cutaneous or peroneal. (5) The ligaments of the ankle joint. (6) The ends of the tibia and fibula, and, in Pirogoff's amputation, the os calcis.

Amputation of the Foot at the Tarso-Metatarsal Articulation.—This is commonly called "Hey's amputation." Disarticulation of the metatarsus is performed as far as the internal cuneiform bone, and then the projecting part of that bone sawn off. The disarticulation requires to be accomplished with care, as the end of the second metatarsal bone, in its articulation with the middle cuneiform, projects backwards between the external and internal cuneiforms. Lisfranc's modification of this operation consists in the complete disarticulation of the tarsal bones, leaving the projecting part of the internal cuneiform. The reason for this modification is the supposed advantage gained by leaving the whole of the internal cuneiform bone to which the tendons of both the tibialis anticus and the tibialis posticus are partially attached. But even in Hey's operation the attachments of these muscles are not destroyed; for, although anatomists figure certain points on *bones* as the attachments of the muscles in question, yet it is found practically that they have extensive attachments to the deep ligamentous structures in their neighbourhood; so that this disadvantage, as urged against Hey's operation, is more imaginary than real. The landmarks in this operation are the prominences caused by the first and the fifth metatarsal bones.

Chopart's Amputation.—This operation consists in the amputation of the foot at its transverse articulation—*i.e.*, the articulations between the astragalus and the scaphoid on the inner side, and the cuboid and the os calcis on the outer side; in other words, the removal of that part of the foot that lies in front of the os calcis and astragalus. The guide to this operation is the tubercle of the scaphoid bone, the line of disarticulation being immediately behind this. A curved **incision**, with its convexity towards the toes, is made across the dorsum of the foot, about an inch and a-half in front of a line drawn transversely across the foot from the scaphoid tubercle; the plantar flap is then formed, which must be of considerable length, in order to fold over the anterior surface of the bones—reaching forwards almost to the roots of the toes. Syme's amputation at the ankle joint is to be preferred to this operation; but if it be performed, it is advisable to

divide the tendo Achillis at the same time, as otherwise the gastrocnemius and soleus, having nothing to counteract them, draw up the heel, so that the patient does not rest on the heel, but on the point of the stump. Another disadvantage is the possible recurrence of the disease in the astragalus or os calcis. *Chief Structures Divided.*—(1) The integumentary coverings and plantar fascia. (2) *Muscles*—(*a*) Tibialis anticus and extensor brevis digitorum, (*b*) The extensor communis digitorum and peroneus tertius, (*c*) The extensor proprius hallucis, (*d*) Peroneus longus and brevis, (*e*) The tibialis posticus, (*f*) The first layer of muscles of the sole of the foot (flexor brevis digitorum, abductor hallucis, and abductor minimi digiti), (*g*) The second layer of muscles (the tendons of the flexor longus digitorum and flexor longus hallucis, accessorius, and lumbricales), (*h*) The most of the muscles of the third layer (flexor brevis hallucis, adductor hallucis, flexor brevis minimi digiti, and transversus pedis). (3) *Vessels*—(*a*) The internal plantar artery, (*b*) The external plantar artery, with the plantar arch and its digital branches, (*c*) The dorsal artery of the foot, with its tarsal and metatarsal branches. (4) *Nerves*—(*a*) Anterior tibial or its branches, (*b*) The plantar nerves, (*c*) Digital branches of the musculo-cutaneous or peroneal nerve, (*d*) The digital branch of the external saphenous nerve. (5) The *ligaments* of the various joints opened into; and, further, we may specially mention the long and the short plantar ligaments and the inferior calcaneo-scaphoid. The structures divided in *Hey's* operation are almost the same as the above, with the following exceptions—the tibialis anticus and posticus are not divided, and part of the internal cuneiform bone is removed. In *Lisfranc's* operation this bone is not divided.

Structures at the Ankle Joint.—For convenience we begin at the internal malleolus and pass outwards over the front of the ankle joint, and thus round the ankle. (1) Tibialis anticus muscle; (2) Extensor longus hallucis; (3) Anterior tibial vessels; (4) Anterior tibial nerve; (5) Extensor longus digitorum and peroneus tertius; (6) Fibula; (7) Peroneus longus, with the brevis beneath it; (8) Tendo Achillis and the tendon of the plantaris; (9) Flexor longus

hallucis; (10) Posterior tibial nerve; (11) Posterior tibial artery, with its venæ comites; (12) Flexor longus digitorum; (13) Tibialis posticus; (14) Tibia. Of course, it is only the *tendons* of the above muscles that we find in this situation.

Synovial Membranes of the Foot and Ankle Joint.—They are seven in number: (1) One at the ankle joint proper; (2) One in the posterior calcaneo-astragaloid articulation; (3) One in the calcaneo-talo-scaphoid articulation; (4) One between the os calcis and the cuboid bone; (5) One between the scaphoid and the three cuneiform bones, and also between the cuneiform bones themselves and the bases of the second and third metatarsal bones; (6) One between the cuboid and the bases of the fourth and fifth metatarsal bones; (7) One between the internal cuneiform bone and the first metatarsal bone.

Club Foot.—There are four primary varieties of this deformity—(1) Talipes varus (or more usually talipes equino-varus; the sole of the foot looking inwards, and the heel being usually a little raised); (2) Talipes equinus (in this form the heel alone is raised); (3) Talipes valgus; and, (4) Talipes calcaneus. It may either be congenital or acquired, and is said to be more common in boys.

(1) **Talipes Varus.**—This is the most common form of congenital club foot, and when it is so, usually both feet are affected, and it is frequently associated with *spina bifida*. In some cases, however, it is acquired, and, when it is so, usually only one foot is affected. *Causes*—Contraction of (*a*) tibialis anticus and posticus, (*b*) The muscles of the calf, and (*c*) the plantar fascia. *Treatment*—The treatment is division of the contracted structures; as to the *order* in which they should be divided there is considerable variety of opinion. The tendons of the tibialis anticus and posticus require great care in their division on account of the close relation of the posterior tibial vessels, and the long saphenous vein. The tendon of the tibialis anticus passes downwards and forwards to be inserted into the *anterior* part of the internal cuneiform bone and the base of the first metatarsal; the tendon of the tibialis posticus grooves the inner side of the posterior surface of the tibia just above the malleolus, and then passes downwards

and forwards to be inserted into the tubercle of the scaphoid, and the *posterior* part of the internal cuneiform bone. The position of the tendons may be ascertained by trying to evert the foot, and thus making them tense, if not already rendered tense and evident by the deformity. The tendon of the tibialis posticus is divided immediately above the internal malleolus, and, in doing so, be careful to avoid wounding the posterior tibial artery which lies about a finger's breadth behind it; to save the artery a blunt pointed tenotomy knife may be used after the first incision.

(2.) **Talipes Equinus.**—This form has never been known to occur as a congenital deformity. *Causes*—(*a*) Contraction of the gastrocnemius and soleus, (*b*) Paralysis of the anterior group of muscles from infantile diseases, (*c*) Irritation caused by worms, (*d*) Nervous disturbances during teething, (*e*) Abscess in the calf of the leg crippling the muscles of the calf. *Treatment*—Division of the tendo Achillis.

(3.) **Talipes Valgus.**—In this case the foot is everted, the outer side of the foot being raised, and sometimes the heel also (*calcaneo-valgus*). In this deformity the tendency in the first instance is to obliteration of the arches of the foot, giving rise to flat or splay foot (talipes planus), and afterwards the outer side of the foot is raised by contraction of the peronei muscles (see p. 84). *Causes*—(*a*) Relaxation of the ligaments supporting the plantar arches with contraction of the peronei; (*b*) Over fatigue in standing (and, therefore, likely to occur in young women in shops where the *barbarous* custom is enforced of *standing* from morning till night behind the counter, with but little intermission), and carrying heavy weights on the head, etc.; (*c*) Sliding the foot in walking, or twisting it so as to press on its inner side; (*d*) It may be hysterical. *Treatment*—(*a*) Constitutional aided by rubbing, galvanism, etc.; (*b*) If not very pronounced it may be cured by adapting the sole of the boot so as to restore and support the arch of the foot; (*c*) It may be necessary to divide the peronei tendons. The *peroneus tertius* passes below the anterior annular ligament of the ankle joint, and is inserted into the *inner side* of the base of the fifth metatarsal bone; the *peroneus longus* lies in the groove behind the external malleolus, curves

forwards and downwards on the outer side of the os calcis below the peroneal tubercle, curves inwards, lying in the groove of the cuboid, and passes to be inserted into the *outer* side of the base of the first metatarsal and internal cuneiform bones, (it is inserted into the same two bones as the *tibialis anticus*); the *peroneus brevis* also lies in the groove on the back of the lower end of the fibula, but passes along the side of the os calcis *above* the peroneal tubercle, and is inserted into the prominent tip of the fifth metatarsal bone. It is rarely necessary to divide these tendons; it will generally be found sufficient to forcibly draw the foot inwards so as to overcome the tension of the peronei, and then fixing the foot by a properly constructed splint. If, however, it be found necessary to divide them, the tendons of the peroneus longus and brevis may be divided as they lie one above the other in the groove on the back of the fibula—*i.e.*, behind the external malleolus; the tendon of the tertius may be divided near its insertion on the outer side of the dorsum of the foot by rendering it tense, and inserting a tenotomy knife between it and the skin, and dividing it in the usual manner.

(4.) **Talipes Calcaneus.**—In this form the toes are raised by the extensors, and the patient walks upon his heel. It is very rare to find this form congenital—(SPENCE)—although some London Surgeons say that it is usually congenital, and very frequently associated with *spina bifida*. *Causes*—(*a*) Contraction of cicatrices, following burns on the anterior aspect of the leg; (*b*) Contraction of the flexor tendons of the ankle joint and the extensors of the toes (indirect flexors of the ankle joint); (*c*) Paralysis or crippling of the muscles of the calf. *Treatment*—Division (if other means fail) of the tendons that pass through the anterior annular ligament—the tibialis anticus on the inner side of the foot, the peroneus tertius on the outer side (these two are *direct* flexors of the ankle joint), the extensor longus digitorum and the extensor proprius hallucis (these two are *indirect* flexors of the ankle joint). They are divided as they pass over the dorsum of the foot, and their position may be readily ascertained by rendering them tense. Care must be taken not to wound the dorsal artery of the foot, which will be found between the tendon of

the extensor proprius hallucis on the tibial side, and the innermost tendon of the extensor longus digitorum on its fibular side; neither of these, however, lie close to the vessel. The anterior tibial nerve lies to the outer side of the artery.

Deep Fascia of the Thigh.—The deep fascia of the thigh, from its great extent, is known as the *fascia lata*. It is attached above to the body of the pubis and pubic arch, Poupart's ligament, crest of the ilium, and margin of the sacrum and coccyx; it passes downwards, forming a complete sheath for the whole of the thigh, which varies in thickness at different parts, and is *firmly* attached below to all the prominent points around the knee joint, such as the condyles of the femur, tuberosities of the tibia, and head of fibula. After this, it forms the deep fascia of the leg, but there is no direct communication between the sheath of the muscles of the thigh and those of the leg; and, on account of this firm connection of the fascia to the bony prominences around the knee joint, fluid matter, such as pus, gathering about the joint will necessarily tend to pass upwards. At the outer side of the limb there is a specially strong band known as the *ilio-tibial band* which stretches from the ilium above to the head of the tibia below, and into which is inserted the greater part of the gluteus maximus, and the whole of the tensor fasciæ femoris, and through it these two muscles act indirectly on the knee joint, and are believed to be specially brought into use in maintaining the erect posture. From the deep surface of the fascia, ensheathing processes are given off to every muscle, blood vessel and nerve in the limb; two of the processes given off are specially strong, and are known as the inter-muscular septa. The *external* septum is the strongest, and extends from the insertion of the gluteus maximus along the outer side of linea aspera to the outer condyle of the femur, along the outer edge of the popliteal surface of that bone. It separates the vastus externus in front from the biceps behind. The *internal* septum is thinner, and extends from the lesser trochanter, along the inner side of the linea aspera and popliteal surface of the femur, to the inner condyle; it separates the vastus internus from the adductor muscles, and is incomplete at one point to allow the passage

of the femoral vessels into the popliteal space, where they become the popliteal vessels. It is possible, therefore, that matter collecting around, or in the joint, and escaping on account of destruction of its ligaments, and collecting in the upper part of the popliteal space behind and between those layers, and beneath the general sheath of the limb, would find its way up the limb towards the trochanters. But there is another way in which pus may pass from the knee joint up to the trochanter minor. There is a considerable portion of the inner surface of the shaft of the femur, extending from the small trochanter above, to the condyles below, and from half an inch to three-fourths of an inch in breadth, from which no muscular fibres arise. This interval lies between the origins of the crureus and the vastus internus, and is bridged over by the conjoined fibres of those muscles. In suppuration, therefore, within the joint, where the suppurative action destroys or perforates the ligaments, or the large synovial membrane of the articulation which extends upwards beneath the extensor muscles of the thigh, the escaped pus easily finds its way up the thigh in the direction named.

The Great Sciatic Nerve.—This nerve leaves the pelvis by the great sacro-sciatic foramen, below the pyriformis muscle, and a little external to the sciatic artery. The nerve will, therefore, be found beneath a point a little external to the point that indicates the situation of the sciatic artery on the surface of the body (see p. 77). Its course is indicated by a line drawn from the point where it emerges from the pelvis to the middle of the upper part of the popliteal space. The nerve, however, is not straight, but is curved with the convexity outwards, and at its upper part is found almost midway between the great trochanter and the tuber ischii, but a little nearer the ischium. The nerve is covered by the gluteus maximus and the long head of the biceps, and slightly by the pyriformis, and it lies upon all the muscles found beneath the gluteus maximus below the pyriformis, viz.—tendon of the obturator internus and the two gemelli, obturator externus, quadratus femoris, and adductor magnus. It is important to remember its course in connection with the operation of *acupuncture* for sciatica; further, it is important to bear in mind,

in the operation of stretching this nerve, that it can be exposed without cutting through any muscular structure, at the lower border of the gluteus maximus, (indicated by the fold of the nates) in the interval between that muscle and the long head of the biceps. Cut through the superficial structures and deep fascia in the line of the nerve at this point, and, if it is not then seen, raise the lower border of the gluteus maximus, when it will now be brought into view.

Superficial Glands of the Groin.—These glands are arranged in two rows—one disposed irregularly along Poupart's ligament, the other disposed vertically along the inner side of the thigh, or grouped irregularly around the saphenous opening. The first of these receives the lymphatic vessels from the genital organs, abdominal, perineal, and gluteal regions; the other group receives the lymphatic vessels from the lower extremity. These glands frequently become enlarged in diseases implicating the parts from which their lymphatics spring (bubo). Thus, in malignant or syphilitic affections of the genital organs, abscess of the perinæum, etc., the glands along Poupart's ligament will be implicated, while the vertical set will be enlarged in affections of the lower limb and foot.

Hip Joint Disease.—It is a fact worthy of notice in connection with the conduction of nervous impulses in sensory nerves, that when a stimulus is applied to any part in the course of a sensory nerve—as to the nerve trunk, or to sensory filaments supplying parts nearer the central nervous system than the final distribution of the nerve—that the impulses appear to be conveyed to, or to spring from, its terminal filaments (in fact the sensory nerve *appears* to be able to conduct impulses *both* ways). Thus, if we compress the ulnar nerve at the elbow joint (the "funny bone," probably so named by some facetious anatomist, on account of its proximity to the humerus [*humorous*]) we feel the painful impression conveyed to the terminal filaments of the nerve, supplying the little finger and the ulnar side of the fourth finger. We also find an example of the same phenomenon in connection with hip joint disease in its earlier stages; for at first the patient does not feel pain in the hip itself, but on the inner side of the knee

or in the knee joint itself. This is no doubt due to the fact that the obturator nerve supplies sensory filaments to both the hip and knee joints; and also because there is frequently found on the inner side of the lower third of the thigh, a plexus of nerves known as the "obturator plexus," which is formed by filaments from the internal cutaneous, long saphenous, and obturator nerves.

Division of Contracted Tendons at the Knee Joint.—To remedy the deformity of contraction of the knee joint, division of the hamstring tendons is sometimes necessary. The biceps is inserted into the head of the fibula, the other two are towards the inner side of the joint—the semi-tendinosus being inserted into the upper part of the inner surface of the tibia, the semi-membranosus into a groove in the back of the internal tuberosity of the tibia. It is the biceps tendon, however, that most frequently requires division; and it is in the division of this tendon that the greatest care is necessary. In division of the biceps tendon, the structures that must be avoided are —(1) The external popliteal or peroneal nerve; (2) The inferior external articular artery; in connection with the other two tendons we have merely to avoid the articular arteries, which, however, are not in very close relation to the tendons in question. The external popliteal nerve passes obliquely downwards and outwards, lying *close to the tendon of the biceps*, and passes between it and the outer head of the gastrocnemius to a point below the head of the fibula, where it divides into its terminal branches. The articular arteries are arranged as follows:—(1) The superior internal passes round the femur, above the inner condyle, under the tendons of the *adductor magnus*, semi-membranosus, and semi-tendinosus muscles; (2) The superior external passes round just above the outer condyle *beneath the tendon of the biceps;* (3) The inferior internal passes down below the internal tuberosity of the tibia beneath the lateral ligament and the tendons of the sartorius, semi-tendinosus, and the gracilis; (4) The inferior external passes *above the head of the fibula* (and, therefore, higher up than the internal) beneath the external lateral ligament and *tendon of the biceps.* The biceps tendon is divided near its insertion into the head of the fibula; the other tendons are then put upon the stretch and also divided near their insertions.

SURGICAL ANATOMY OF THE TRUNK.

THE CHEST.

Fracture of the Ribs.—The two upper and the two lower ribs are rarely fractured—the upper two being protected by the clavicle, while the mobility of the lower two renders their fracture less likely. The ribs may be fractured (1) by direct violence; (2) By indirect violence, as from pressure in a crowd, etc. In indirect violence they usually give way at the angle or near it, or at their junction with the cartilages. The great danger in fracture of the ribs is injury to the pleura and lungs from sharp fragments projecting inwards, but this is far more likely to occur in fracture due to *direct* violence than in fracture due to *indirect* violence. In simple fracture there will be difficulty in respiration, and crepitus may be detected either by placing the hand over the fractured part and directing the patient to take a deep breath, or by applying the stethoscope. If the lung tissue be much injured there will be expectoration of blood mixed with air, a constant hacking cough from irritation of the pulmonary branches of the vagus nerve, as the most prominent symptoms. The chief *complications* likely to arise from wounds of the lung are—(1) Bleeding, especially internal, giving rise to *hæmothorax*, and leading to compression of the lung and dyspnœa; (2) *Emphysema*, an infiltration of air into the cellular tissue, indicated by puffy swelling and crackling when pressed upon; (3) *Pneumothorax*, an accumulation of air in the pleural cavity; (4) *Hydrothorax*, an accumulation of serous fluid in the pleural cavity; (5) Suppuration and accumulation of pus in the pleural cavity (*empyema*); (6) There is always a risk of pleurisy and pneumonia; (7) The intercostal artery is sometimes ruptured, so that there is hæmorrhage into the cellular tissue.

Paracentesis Thoracis.—This is an operation for the removal of serous or purulent fluid from the chest. It is best performed with an ordinary trochar of moderate size; and the point chosen for the introduction of the trochar is

either in the fifth or sixth intercostal spaces, at the line of the insertion of the serratus magnus—that is, about midway between the sternum and the angles of the ribs. The skin is first punctured with a scalpel, and then the trochar is pushed into the chest, close to the edge of the *lower* rib of the space in which it is performed, to avoid wounding the intercostal artery, which lies near the lower border of the *upper* rib. Thus, suppose the operation is performed in the fifth intercostal space, the trochar is pushed over the upper edge of the *sixth* rib. It is necessary to thrust in the trochar with considerable force, so as to make sure of its piercing the pleura, which is usually thickened; otherwise it might simply drive the thickened pleura before it. In *hydrops pericardii* the pericardium may be tapped in the fifth intercostal space, in the cardiac region, in the same manner; the point of the greatest accumulation of fluid being determined by percussion.

THE ABDOMEN AND PERINÆUM.

Ligature of Arteries.

The Abdominal Aorta.—This vessel has been tied several times immediately above its point of bifurcation, or between that point and the origin of the inferior mesenteric artery, but without success; all the patients having died within periods varying from a few hours to ten days, the greater number having died within twenty-four hours. It is usually tied behind the peritoneum, although Sir Astley Cooper, who was the first to tie the vessel, made his incision through the peritoneum. **Origin.**—It is the direct continuation of the descending thoracic aorta. **Extent.**—From the front of the body of the last dorsal vertebra to the left side of the body of the fourth lumbar vertebra, where it bifurcates into the common iliacs, a little to the left of the mesial line. Its point of bifurcation corresponds very nearly to the highest part of the crest of the ilium, or a little below and to the left of the umbilicus. **Course.**—From the middle line, at its origin, to a point a little to the left of the same line at its bifurcation; or, from the apex of the arch formed by the tenth rib on the left side to a point

slightly internal to the anterior superior iliac spine. **Relations.**—In *front:* (1) Transverse part of the duodenum; (2) Peritoneum; (3) Aortic plexus of nerves. On its *left* side—The left gangliated cord of sympathetic. On its *right* side—(1) The inferior vena cava; (2) Vena azygos major; (3) Receptaculum chyli and thoracic duct. *Behind* it there is—(1) The left lumbar veins; (2) The vertebral column. **Incision.**—A semi-lunar incision six inches long on the left side of the abdomen, commencing two inches below the anterior superior iliac spine, and an inch above Poupart's ligament, and carried at first upwards and outwards, and then curving slightly forwards towards the umbilicus, and ending a little below the tenth rib. The structures divided and the method of operating, are similar to those described under ligature of the common iliac arteries *(quod vide).*

Collateral Circulation.—(1) The deep epigastric branch of the external iliac anastomosing with the terminal branches of the internal mammary branch of the first part of the subclavian and the aortic intercostals; (2) The circumflex iliac branch of the external iliac and ilio-lumbar of the internal iliac anastomosing with the lower intercostals and lumbar arteries of the aorta; (3) The superior hæmorrhoidal termination of the inferior mesenteric anastomosing with the lateral sacral and middle hæmorrhoidal branches of the internal iliac and middle sacral of the aorta; (4) The extra-peritoneal plexus of Turner, which is described by that distinguished anatomist as "a wide-meshed plexus of small arteries" lying in the fat outside the peritoneum. Above, it communicates with the perforating branches of the renal arteries, small twigs of the capsular, spermatic, colic, and pancreatic arteries, and below with the lower lumbar arteries, and with the ilio-lumbar, circumflex iliac, and epigastric branches of the iliac arteries.

Common Iliacs.—Origin.—From the bifurcation of the abdominal aorta at the left side of the body of the fourth lumbar vertebra. **Extent.**—From its point of origin to the sacro-iliac synchondrosis, where it divides into internal and external iliac arteries. Each common iliac is from two to two and a-half inches in length; the *right* is necessarily a little longer than the left, because the point of division

of the abdominal aorta is slightly to the left of the median line. **Course.**—Its course corresponds to the upper third of a line drawn from a point three-fourths of an inch below and a little to the left of the umbilicus, to a point midway between the symphysis pubis and the anterior superior iliac spine. **Relations.**—The relations differ somewhat on the two sides. *Right Common Iliac.*—This vessel *rests* on its own vein at the lower part, and at the upper part crosses the vein of the opposite side. In *front* there are—(1) The small intestines (end of the ileum, and cæcum); (2) Peritoneum; (3) Sympathetic nerves; (4) Crossed by ureter near its termination. On its *outer* side are—(1) The right common iliac vein; (2) The commencement of the vena cava inferior. Its *internal* relations are unimportant. *Left Common Iliac.*—The left common iliac *rests* on the psoas magnus. In *front* are—(1) The rectum and sigmoid flexure; (2) Peritoneum; (3) Sympathetic nerves; (4) Crossed by the ureter near its termination, and the inferior mesenteric vessels. On its *outer* side is the psoas magnus. On its *inner* side, the left common iliac vein. The relation of the common iliac veins to their corresponding arteries should be noted. The inferior vena cava is formed by the union of the two common iliac veins on the *right* side of the vertebral column, and both the veins lie on the *right* side of, and on a plane posterior to, their corresponding arteries. On the *right* side the vein is at first beneath and then to the outer side of the artery. The *left* vein lies entirely to the inner side of the left artery, and then passes beneath the right common iliac vein to unite with that vein in the formation of the inferior vena cava at the right side of the fifth lumbar vertebra.

In ligature of the common iliac, the patient should be laid on his back, and the pelvis of the side to be operated upon raised a little. **Incision.**—Make a semi-lunar incision about five inches in length, and so placed that its centre will be opposite to the anterior superior iliac spine. Enter the knife two and a-half inches below the anterior superior iliac spine, and an inch above Poupart's ligament, and carry it at first upwards and outwards parallel to the ligament, and then upwards and slightly inwards towards the umbilicus. *Parts Cut Through.*—(1) The skin; (2) Superficial fascia; (3) The

aponeurosis of the external oblique muscle; (4) Internal oblique; (5) Transversalis muscle; (6) Transversalis fascia—in dividing this fascia, raise a small part with the forceps, and cut out a little piece with the edge of the knife held horizontally, and afterwards enlarge this opening with a probe-pointed bistoury, a finger being introduced and the peritoneum detached; the opening enlarged to the required extent by the bistoury. This care is necessary in opening the transversalis fascia lest the peritoneum be wounded. The peritoneum is then separated carefully from the iliac fossa until the brim of the true pelvis is reached and the external iliac found, which will guide to the parent trunk. The position of the spermatic vessels, as they cross the external iliac, must be kept in mind, and also the ureter which crosses the end of the common or the beginning of the external iliac; but this duct is usually more or less adherent to and follows the peritoneum. The needle should be passed *from* the vein—that is, in ligature of both vessels, from right to left. The incision must not be carried too low down, or too far forward, lest the circumflex iliac or the deep epigastric arteries be wounded, or even the structures passing through the internal abdominal ring. A branch of the circumflex iliac (or the artery itself) will be found between the transversalis and the internal oblique muscles.

Collateral Circulation.—(1) The deep epigastric branch of the external iliac anastomosing with the internal mammary branch of the subclavian and the aortic intercostals; (2) The circumflex iliac branch of the external iliac and the ilio-lumbar of the internal iliac anastomosing with the lower intercostals and lumbar branches of the aorta; (3) The lateral sacral from the internal iliac anastomosing with the middle sacral of aorta and the superior hæmorrhoidal of the inferior mesenteric; (4) The pubic branch of the deep epigastric with the pubic branch of the obturator; (5) Visceral branches of the internal iliac of the side tied anastomosing with the corresponding branches of the opposite side.

The Internal Iliac.—Origin.—From the bifurcation of the common iliac at the sacro-iliac synchondrosis. **Extent and Course.**—From its point of origin it passes down almost immediately into the pelvis, and at the level of the great

sacro-sciatic notch it divides into anterior and posterior trunks, which supply the pelvic walls and viscera. **Relations.**—In *front* are—(1) The peritoneum; (2) It is crossed by the ureter. *Behind* are—(1) The internal iliac vein; (2) The lumbo-sacral cord; (3) Part of pyriformis. On the *outer* side it rests against the psoas magnus. To its *inner* side, at the upper part, is the internal iliac vein (the internal iliac veins both lie internal to their corresponding arteries). The steps in the operation for the ligature of this vessel are precisely similar to those for the ligature of the common iliac *(quod vide)*, and the bifurcation of the common iliac being found, the internal iliac is traced from it down into the pelvis. Great care is necessary, when the artery is exposed, in passing the ligature, on account of the close relation of—(1) The ureter (which crosses it, but is usually turned aside with the peritoneum); (2) The external iliac vein, on its outer side; and (3) The internal iliac vein, on its inner side.

Branches.—(*A*) From the *anterior* division—(1) Visceral, to pelvic viscera—(*a*) Superior vesical, (*b*) Inferior vesical, (*c*) Middle hæmorrhoidal; and in the female there are two additional arteries—uterine and vaginal; (2) Parietal, to walls of pelvis—(*a*) Obturator, (*b*) Pudic, (*c*) Sciatic. (*B*) From *posterior* division they are all parietal—(*a*) Gluteal, (*b*) Ilio-lumbar, (*c*) Lateral sacral. The most important branches, in regard to aneurism, are the gluteal, sciatic and pudic, and these we have already seen in the gluteal region, and also their situation as regards the surface of the body (see p. 77). The branches of the pudic may be enumerated here—(1) Inferior hæmorrhoidal; (2) Superficial perinæal; (3) Transverse perinæal; (4) Artery to the bulb; (5) Artery to the corpus cavernosum; (6) Dorsal artery to the penis. The three arteries (gluteal, sciatic, and pudic) are simply covered by the integumentary structures and the gluteus maximus, and may be reached by incisions three inches long, in the direction of the fibres of the gluteus maximus, over the points indicating their position; but in the greater number of cases the guide to the arteries will be the pulsating aneurismal tumour. When they are tied, the collateral circulation is carried on by anastomoses between the gluteal and sciatic arteries with the external and

internal circumflex branches of the profunda femoris; and in the case of the pudic by the anastomoses of its branches with the corresponding branches across the middle line. In ligature of the *internal iliac*, the collateral circulation is the same as in ligature of the common iliac.

The External Iliac.—Origin.—From the bifurcation of the common iliac at the sacro-iliac synchondrosis. **Extent.**—From its point of origin to Poupart's ligament. **Course.**—It runs along the brim of the true pelvis, and its course is indicated by the lower two-thirds of a line drawn from a point three-fourths of an inch below, and a little to the left of the umbilicus, to a point midway between the anterior superior iliac spine and the symphysis pubis. The artery, with its accompanying vein, are bound down to the psoas muscle in a common sheath of fascia. **Relations.**—In *front*—(1) The intestines; (2) Peritoneum; (3) A process of iliac fascia; (4) Spermatic vessels; (5) Vas deferens (4 and 5 are more especially at its lower part); (6) Genital branch of the genito-crural nerve; (7) Circumflex iliac vein. To its *inner* side—(1) The external iliac vein; (2) The vas deferens. To its *outer* side, the psoas magnus. *Behind* it—(1) The external iliac vein (on the right side); (2) The psoas magnus. On the *left* side the vein is to the inner side of the artery in the whole of its course, but is beneath its upper part on the right side. **Incision.**—A lunated incision three or four inches long, about one inch above, and parallel to Poupart's ligament, commencing about two inches external to the spine of the pubis. The structures divided and the steps of the operation are the same as in ligature of the common iliac (*quod vide*). The aneurism needle must be passed from within outwards to avoid injury to the vein. The incision must not be carried too far forwards lest the epigastric vessels, or the internal abdominal ring, and the structures passing through it, be implicated. Special care must be taken not to include the genital branch of the genito-crural nerve in the ligature, or wound the peritoneum. In four cases of ligature of this artery, the patients died from *tetanus*, probably from implication of the nerve in question.

Branches.—Two branches are given off from this artery

just above Poupart's ligament—(1) The deep epigastric; (2) The deep circumflex iliac.

Collateral Circulation.—(1) The deep epigastric branch anastomosing with the terminal branches of the internal mammary and aortic intercostals; (2) The circumflex iliac branch, and the ilio-lumbar branch from the internal iliac, anastomosing with the lower intercostals and lumbar branches of the aorta; (3) The gluteal artery from internal iliac anastomosing with the external circumflex branch of the profunda femoris; (4) The sciatic artery from internal iliac anastomosing with the internal circumflex branch of the profunda; (5) The obturator artery from internal iliac anastomosing with the internal circumflex branch of the profunda.

Gastrotomy.—This operation may be rendered necessary in consequence of impermeable stricture of the œsophagus, to prevent the patient dying of starvation. There are three varieties of stricture—(1) The nervous or spasmodic—this form is usually intermittent, and if the patient can be induced to forget about it for the time being, the food passes quite easily; (2) Fibrous stricture, the result of swallowing corrosive fluids—this form may be dilated by passing bougies; (3) Cancerous—this is the most common form. The bougie seems to pass over a *roughened* surface, and its introduction is followed by the coughing up of blood, or blood and pus; the cervical glands will also probably be enlarged, and other signs of the "cancerous cachexia present." By these means it may be diagnosed from fibrous stricture, and this will also be assisted by the history of the case. As long as possible the patient may be fed with slops, or through a catheter, or by the use of artificially digested foods per rectum, and if these are not sufficient, the stomach may be opened.

The patient is laid on his back, and, according to Sédillot, a crucial incision—each limb of which is about one inch and a-half in length—should be made on the left side, two fingers' breadth to the inner side of the costal cartilages, and one third nearer the ensiform cartilage than the umbilicus. A simpler form of incision is, to make a single longitudinal incision along the outer border of the left rectus over the stomach, its position being readily ascertained by percussion. *Chief Struc-*

tures Cut Through.—(1) Skin and fascia; (2) The external oblique; (3) The internal oblique, and (4) Transversalis muscles; (5) Transversalis fascia; (6) Extra-peritoneal fat; (7) The peritoneum; (8) The stomach wall itself. The stomach is fixed to the edges of the wound, and an opening made through its walls, but no nutritive injections are to be made into it for a few days until the parts have become consolidated, and a true fistulous opening formed, which is afterwards to be kept open by a silver tube.

Difficulty in swallowing (*dysphagia*) may arise from other causes than stricture, such as—(1) Tumours in the pharynx, such as polypi or abscess; (2) Œdema about the back of the epiglottis; (3) Tumours in the neck outside the œsophagus; (4) Aneurism of the innominate artery; (5) Aneurism of the aorta; (6) Dislocation of the sternal end of the clavicle backwards; (7) Impaction of a foreign body in the gullet; (8) Inter-thoracic tumours, such as enlarged bronchial glands, cancerous masses, etc. These tumours must be carefully distinguished from aneurisms. In aneurism there is dullness on percussion, dyspnœa, dysphagia, a fixed gnawing pain between the shoulders, shooting pains down the arms or side of head, and distension of the superficial veins of the chest.

Posterior Abdominal Wall and Colotomy.—The posterior abdominal wall (between the last rib and the iliac crest) is formed by two large muscles and the *fascia lumborum* or the posterior abdominal aponeurosis. The fascia lumborum is formed thus: The aponeurosis of the transversalis muscle splits into three layers, one is attached to the roots of the transverse processes of the lumbar vertebræ, a second is attached to the tips of the transverse processes, (between these two layers the quadratus lumborum is situated), a third passes to the tips of the spinous processes of the vertebræ, and between this and the second layer, the erector spinæ is placed. These three layers are also known as the anterior, middle, and posterior layers of the lumbar aponeurosis; but, in addition, however, to these structures, there is attached to the posterior layer of this aponeurosis the tendons of origin of other three muscles, and through it these muscles may be said to arise from the tips of the transverse processes.

The muscles are—(1) The latissimus dorsi; (2) The serratus posticus inferior; and, (3) The internal oblique. By this means the strong fascia lumborum is formed, which protects the part below the ribs, a part which, in the skeleton, seems very weak. In this region we find the "triangle of Petit." It is bounded in *front* by the posterior edge of the external oblique: *behind*, by the anterior edge of the latissimus dorsi. The *base* is formed by the crest of the ilium (about its middle third), while the *apex* is formed by the crossing of the above two muscles. In connection with the subject of colotomy, it will be well to say a few words about the relations of the descending colon, kidney, and ureter. The *descending colon* lies in the left lumbar region, and is attached by loose areolar tissue to the outer border of the left kidney, and then to the fascia covering the quadratus lumborum—at first lying to the outer edge of that muscle; but as it passes downwards it inclines inwards, and lies more to the front of the muscle. It is only covered at the front and at the sides by peritoneum. The *kidneys* are situated in the right and left lumbar regions, opposite three and a-half vertebræ—from the last dorsal vertebra to the middle of the third lumbar vertebra; the *hilus* of the kidney is opposite the first lumbar vertebra. They lie entirely *behind* the peritoneum, embedded in loose areolar tissue, and are placed somewhat obliquely, the upper ends of the kidneys inclining towards the vertebræ. Each kidney rests on the corresponding crus of the diaphragm, quadratus lumborum, and psoas—or, rather, on the fascia covering these muscles. In *front* is the colon; at the *upper* end is the supra-renal capsule; the *lower* end is a little above the crest of the ilium. The above relations are common to the two kidneys; but there are certain special relations: In front of the right kidney is the second part of the duodenum; in front of the left, the pancreas; at the upper end of the right kidney is the right lobe of the liver; at the upper end of the left, the spleen. The right kidney is a little lower than the left, probably because the liver presses it down somewhat. The *ureters* arise at the hilus of the kidney, from the dilated pelvis, and also pass down behind the peritoneum, and at the upper part of their course rest on the psoas muscle. In

colotomy, or Amussat's operation, the descending colon is opened in the left lumbar region. The colon lies, according to Allingham, half an inch behind a point midway between the anterior and the posterior superior iliac spines: to reach it, three forms of incision have been used—the *transverse*, the *oblique*, and the *vertical*. In the **transverse** form the incision is made two finger-breadths above and parallel to the middle third of the crest of the left ilium, making the middle of the incision as nearly as possible over the colon. By this incision the structures divided are—(1) The integumentary coverings; (2) The edge of the latissimus dorsi; (3) The external oblique; (4) The internal oblique; (5) The transversalis muscle; (6) The transversalis fascia; (7) Loose areolar tissue and extra-peritoneal fat, in which the gut is embedded. It may also be necessary to cut across the outer border of the quadratus lumborum.

The **vertical** incision is made along the outer edge of the erector spinæ, between the last rib and the iliac crest, and in this case the structures divided are—(1) The integumentary coverings; (2) The posterior layer of the fascia lumborum—and in doing so the compartment containing the erector spinæ is opened into, and this muscle is then drawn inwards; and (3) The middle layer is next divided, and with its division the compartment containing the quadratus lumborum is opened, and this muscle in turn is drawn well inwards; (4) The anterior layer of the fascia lumborum; (5) The fascia transversalis; (6) The loose areolar tissue and fat in which the gut is embedded. The gut may be recognised at the bottom of the wound by its greenish and distended appearance. In performing this operation it is necessary to avoid—(1) Wounding the peritoneum; (2) Allowing the contents of the gut being effused into the areolar tissue of the wound—and for this purpose, on opening the gut, a wide india-rubber tube should be introduced into the opening, to allow the contents to escape gradually through it. After this, the sides of the opening in the gut are stitched to the sides of the incision. This operation may be rendered necessary on account of—(1) Malignant stricture of the rectum, such as from cancer; (2) Other strictures, such as from pressure of a tumour; (3)

Imperforate anus. By performing this operation in the same way on the opposite side the caput cæcum may be reached.

The **oblique** incision is a middle path between the transverse and the vertical, and the structures divided are practically the same as those cut in the transverse form. From the relations already pointed out, one will see that, by the vertical incision, it would be comparatively an easy matter (anatomically) to expose the lower end of the kidney. The colon, as we have said, descends in front of that viscus, and by passing a little further up than is necessary for colotomy, we may expose the kidney; and, having got it, by working carefully inwards and upwards, to reach its hilus (opposite the first lumbar vertebra) and expose the ureter.

Hernia.

By this term is meant a protrusion of a part of the viscera through some point of the abdominal wall. A hernia consists of a *sac* (that is the prolongation of the peritoneum which overlies the hernia) and *contents*. Hernia is said to be *inguinal* when it comes through the opening or canal situated in the inguinal region of the groin; and *femoral* when it comes through the opening or canal situated in the femoral region of the groin.

Inguinal Hernia.—This form is much more common in males, because in them the inguinal canal is larger, while the crural ring is smaller, than in females, on account of the less expanded iliac crests. The space concerned in inguinal hernia is triangular, corresponding to the inguinal region of the groin, and has the following boundaries:—*Below*, by Poupart's ligament; *internally*, by the linea alba; and *above*, by a line drawn from the anterior superior iliac spine to the linea alba. In connection with the subject of hernia, it will be well to consider the structure of the abdominal wall at this point; the two longitudinal muscles (the rectus and pyramidalis) may be left out of account for the time being. If we were to examine the triangular space, mentioned above, from the inside of the abdomen, we would find that it is subdivided into two triangular parts by the deep epigastric artery—the artery, in fact, almost bisecting the triangle in question—an outer triangular part, and an inner triangular part known as Hesselbach's

triangle. In dissecting the abdominal wall in the region of the outer triangular part, we find—(1) Skin; (2) Superficial fascia; (3) Tendon of the external oblique; (4) The internal oblique; (5) The transversalis muscle; (6) Fascia transversalis; (7) Sub-peritoneal fat; (8) Peritoneum. In the inner triangular space (that is, Hesselbach's triangle) the structures met with are similar, except that the tendons of the internal oblique and transversalis muscles are inseparably united, forming the "conjoined tendon," which is attached to the crest of the pubis and the pectineal line, and which, therefore, takes the place of the above muscles in this space.

The Inguinal Canal.—This is an oblique opening through the anterior abdominal wall, and is directed downwards and inwards, lying parallel with and a little above the inner half of Poupart's ligament. It commences at the internal abdominal ring, and ends at the external ring, and is about an inch and a-half to two inches in length. The *external* abdominal ring is oval or triangular in shape, directed upwards and outwards; the base is formed by the crest of the pubis, and the lateral boundaries are known as the *pillars* of the ring. The upper or *internal* pillar or column consists of a flattened part of the tendon of the external oblique, passing downwards to be fixed to the front of the symphysis pubis; the lower or *external* pillar is chiefly formed by the inner end of Poupart's ligament, and is thicker and more rounded than the other pillar, and is attached to the spine of the pubis. At the upper part of the ring there are some fibres seen passing in a transverse direction, and these are called the *intercolumnar fibres*. Poupart's ligament is attached internally to the spine of the pubis, and also into the pectineal line forming Gimbernat's ligament, and is regarded as part of the insertion of the external oblique; a part, however, of its tendon of insertion, springing from the pectineal line and pubic crest, passes behind the internal pillar of the ring, and decussates in the linea alba with the tendon of the opposite side, forming the "triangular fascia." The ring transmits the spermatic cord in the male and the round ligament in the female. The internal ring is an opening in the fascia transversalis, and is situated about half an inch above the *middle* of Poupart's

ligament. *Boundaries of the Canal.*—In *front*—(1) The external oblique (throughout its whole length); (2) The internal oblique (for its outer third); (3) The cremaster muscle. *Behind*—(1) Fascia transversalis (throughout its whole length); (2) The conjoined tendon (for its inner third); (3) The triangular fascia; (4) The deep epigastric artery. The *floor* is formed by Poupart's ligament, and the *roof* by the free arched lower border of the transversalis muscle.

The Descent of the Testicles.—The testicles are originally situated in the abdominal cavity, below the kidneys and behind the peritoneum; but before birth they pass down into the scrotum. Up to about the end of the sixth month of fœtal life they are found below the kidney, at the posterior part of the abdominal wall; but as the process of development becomes more and more complete, they gradually descend, so that, by the seventh month, they are situated behind the internal abdominal ring. During the eighth month they pass through the canal, and by the end of the ninth month they have reached the bottom of the scrotum. The means by which this descent is effected is rather obscure, and was formerly believed to be due to the contraction of certain muscular bands—the "gubernaculum testis"—which piloted the testicles into their proper haven, but is now commonly believed to be the result of a general process of development. A process of peritoneum—the *processus vaginalis*—passes down into the scrotum, and precedes the testicle by some time in its descent; and as the testicle originally lies behind the peritoneum, and still retains this position in its descent, both layers of this pouch of peritoneum necessarily lie in front of the testicle. But, as the testicle passes down it receives certain coverings from the layers of muscle and fascia forming the anterior abdominal wall: thus it receives—(1) The *intercolumnar* or *external spermatic fascia* from the external oblique, as it passes between the pillars of the ring; (2) The *cremasteric muscle* or *fascia* continuous with the internal oblique; (3) The *infundibuliform* or funnel-shaped fascia from the fascia transversalis (also called the *internal spermatic fascia*). The transversalis muscle gives no covering to it, as the free arched border of the muscle is too high, the testicle passing through below it.

All these coverings are continued over the testicle as it lies in the scrotum. The pouch of peritoneum preceding the testicle at first communicates with the peritoneal cavity; but a little time before birth its narrow neck becomes closed, while the unobliterated lower end forms the tunica vaginalis, which is in this way entirely shut off from the abdominal cavity. We have described the descent of the testicle at this point because one form of inguinal hernia takes exactly the same course, and receives similar coverings.

The Direct and Oblique varieties of Inguinal Hernia.—**The Oblique.**—This form is named oblique from the direction it takes—passing through the oblique inguinal canal; it is also called external from its relation to the deep epigastric artery, which lies to its inner side. It takes the same course as the testicle did—that is, it enters at the internal abdominal ring, passes through the whole length of the canal, and escapes by the external ring into the scrotum; it passes through that part of the triangular space concerned in inguinal hernia that lies to the outer side of the epigastric artery, and whose structure has already been described. The hernia usually passes down in front of the cord, between the cord and its coverings. The *coverings* of this form of hernia are—(1) Skin; (2) Superficial fascia; (3) Intercolumnar fascia; (4) Cremasteric fascia or muscle; (5) The infundibuliform fascia; (6) Subperitoneal fat; (7) The peritoneal sac. The sac, as here seen from the outside, may be recognised by its *rough* and *bluish* appearance.

The Direct form.—It is called direct from the direction it takes; it is also called internal, from its relation to the deep epigastric artery, which lies to its outer side. This form does not pass through the whole length of the inguinal canal, but escapes from the abdomen through that part of the triangular space concerned in inguinal hernia known as Hesselbach's triangle (the boundaries of which, and a description of the structures forming the abdominal wall at that point, have already been described), enters the inguinal canal, pushing the conjoined tendon before it (unless, as is sometimes the case, the conjoined tendon is small, and does not fill up all the triangle in question), passes through the lower part of the canal, and escapes by the

external abdominal ring. The *coverings* in this form of hernia are almost the same as in the oblique form; the only difference being that, instead of reading "cremasteric fascia or muscle," as in the oblique variety, read "conjoined tendon." This tendon, as we have said, is the tendon of the conjoined internal oblique and the transversalis muscles; but, as the transversalis gives no covering to any form of inguinal hernia, it may simply be read in place of the cremasteric muscle, which is continuous with the internal oblique: in other respects the coverings of the two forms are exactly the same. In practice, it is extremely difficult, and often impossible, to distinguish between the oblique and the direct forms; because in the oblique form the internal abdominal ring is apt to be drawn towards the middle line, more especially if the hernia be of long standing. The diagnosis would not be important were it not from the different relations of the two forms to the deep epigastric artery—the oblique being external and the direct internal to that vessel; and this might have an influence in determining the direction of the incision in the operation for strangulated hernia, it being necessary to cut from the artery—or, at least, not to cut towards it. But, from the difficulty in diagnosis above indicated, the best rule is, in *every* case, to cut upwards and slightly inwards parallel to the deep epigastric artery; and by this means the artery escapes injury. The vessel in the normal condition, as we have already stated, almost bisects the triangular space concerned in inguinal hernia—passing from near the middle of the base (Poupart's ligament) to its apex, which is formed by the meeting of the horizontal line with the linea alba (see p. 114). The seat of strangulation may either be—(1) In the neck of the sac becoming thickened and constricted by plastic deposit, and its subsequent organization; (2) By the intercolumnar fascia; or (3) By the transversalis fascia; and in the operation for its relief (when "taxis" fails to reduce the hernia) the surgeon dissects carefully through the various coverings of the hernia, and, when the sac is exposed, feels with his finger for the stricture, and then passes the hernia knife along his finger (as director), and introduces it, flat-wise, beneath the stricture, and then cuts in the direction above indicated. In old-standing cases the *sac* of the hernia

is not reduced; and in no case should the hernia be pushed into the abdomen *en masse*, lest the constricting point should not be divided, and the gut returned to the abdomen, therefore, still in a state of strangulation. If there be any doubt on this point it is better to open the sac and *see;* or, if reduced by the extra-peritoneal method, the sac should be emptied first, and each returned separately, so as to make sure that the constriction is relieved. In the operation of taxis (that is, reducing the hernia by manipulation), the parts should be relaxed as much as possible; and for this purpose the body should be bent forwards a little, and the lower limbs raised, and pressure made in the direction of the canal. In children, however, it is important to remember that the canal is not oblique.

Radical Cure of Hernia.—The object of the various operations devised for the radical cure of hernia is to obliterate the inguinal canal. The principal operations are, (1) Wurtzer's and (2) Wood's. (1) **Wurtzer's.**—This consists in the agglutination of the neck of the hernial sac by exciting inflammation in it, and closure of the canal by the invagination of the scrotum which is fastened into the inguinal canal by a plug of wood; along the interior of the plug (which is hollow) a flexible steel gilt needle is pushed, and is made to traverse the invaginated scrotum, hernial sac, (the contents of the sac being previously reduced), and the anterior abdominal wall through which it protrudes. A concave wooden case is then passed over the projecting point of the needle, and screwed tight, so as to compress the enclosed tissues; inflammation is thus excited, and the scrotal plug may remain *in situ* for a time. *Objections.*—(1) It is apt to set up dangerous peritonitis; (2) Frequent failure in complete occlusion of the canal, the plug almost always descending after any exertion. For these reasons the operation is now generally abandoned. **(2) Wood's operation** consists in drawing together the tendinous structures forming the boundaries of the canal by subcutaneous wire suture, with or without the invagination of a piece of the scrotal fascia, detached subcutaneously from the skin, to protect the sac, and held there by the wire suture till adhesion occurs. The left forefinger is passed

beneath the margin of the conjoined tendon and triangular fascia (these two being in the posterior wall of the canal), and a needle is thrust through, armed with a wire suture, and afterwards through two points of the anterior wall of the canal—the internal and external pillars of the ring—and these four points are then drawn together, thus occluding the canal.

Other varieties of Inguinal Hernia.—(1) *Congenital*, or hernia in the sac of the tunica vaginalis. The hernia in this case lies inside the tunica vaginalis, and therefore in contact with the testicle; it is always oblique, and takes the same course as the testicle. The possibility of its occurrence is due to the fact that the upper part of the process of peritoneum (processus vaginalis) which passes down before the testicle into the scrotum, has not become obliterated as in the normal condition, but remains open, and thus serves as a medium of communication between the general cavity of the peritoneum and the tunica vaginalis through which the congenital hernia descends. (2) *Encysted, or Infantile Hernia.*—The hernia in this case passes down *behind* the tunica vaginalis, and is due to the fact that the upper part of the *processus vaginalis* is not properly obliterated, or in such a way that a pouch is left above, which is protruded down behind the tunica vaginalis. Should strangulation occur in this form, in the operation for its relief, the surgeon will have to pass through *both layers of the tunica vaginalis* before he reaches the neck of the sac.

The *contents* of the hernial sac vary. If it consist of the intestine alone, it is called an *Enterocele.* It is usually some part of the small intestine, most frequently the ileum, sometimes the caput cæcum of the large. Hernia of the omentum is called *Epiplocele.* Hernia of both intestine and omentum together, is called an *Entero-epiplocele.*

Femoral Hernia.—It will be well at this point to say a word or two about the anterior part of the fascia lata of the thigh and the saphenous opening. The fascia consists of (1) An *iliac* part lying external to the saphenous opening; and, (2) A *pubic* part lying internal to the same opening. The *iliac* part is attached to the crest of the ilium, anterior superior spine, Poupart's ligament, and the pectineal line,

and becomes continuous below with the pubic part. From the pectineal line and spine of pubis it is reflected down, forming the superior cornu and the falciform process of the saphenous opening. The *pubic* part is attached above to the pectineal line, internally to the margin of the pubic arch; it passes *beneath* the sheath of the femoral vessels binding down the psoas and iliacus muscles, and is then lost in the capsule of the hip joint. At the lower part it becomes continuous with the iliac part, and at the point where the two meet they form the inferior cornu of the saphenous opening. The iliac part thus passes in *front* of the femoral vessels, while the pubic part passes *behind* them, and between the two is the *saphenous opening*. This is an oval opening at the upper and inner part of the thigh, just below the inner end of Poupart's ligament, and is produced by the above splitting and folding of the fascia lata of the thigh. It is directed obliquely downwards, forwards, and inwards; its length is an inch and a-half, and its width about half an inch. Its lower margin is well defined, and is called the *inferior cornu;* its upper margin, the *superior cornu;* its outer edge, the falciform process of Burns or ligament of Hey; its inner edge, however, is ill defined, and lies, as we have seen, on a plane posterior to the outer edge passing behind the femoral vessels. This so-called opening, however, in the recent state is covered by the *cribriform,* or sieve-like fascia—this fascia being perforated by a large number of lymphatic vessels, hence the name. If the fascia lata and the cribriform fascia be reflected, the *femoral sheath* is exposed; the anterior part of this sheath is a continuation of the fascia transversalis lining the abdominal wall, and passing down beneath Poupart's ligament; the posterior part of the sheath is a continuation of the fascia iliaca also from the abdomen. On the anterior part of this sheath there are a few thickened transverse bands of fascia just below Poupart's ligament, which are called the "*deep crural arch,*" (the "*superficial crural arch*" is Poupart's ligament.) The *femoral* or *crural* sheath is funnel-shaped, being too wide just beneath Poupart's ligament, but closely adherent to the vessels about one inch below the saphenous opening; it is divided into three compartments by septa passing from the anterior to the posterior

wall—the *external* contains the femoral artery, the *middle* the femoral vein, while the *inner* contains, and is closed by condensed areolar tissue, a lymphatic gland and some lymphatic vessels and fat, the whole mass being called the *septum crurale*, and the compartment containing them the *crural canal*. This canal is, therefore, situated between the femoral vein and the inner wall of the crural sheath. It extends from the *crural ring* to the upper part of the saphenous opening, and is about half an inch in length. **Boundaries of the Canal.**—*Anterior wall*, the fascia transversalis, Poupart's ligament, and the falciform process of the fascia lata; *posterior wall*, the iliac fascia and the pubic part of the fascia lata; *outer wall*, the fibrous septum covering the inner side of the vein; the *inner wall*, the inner side of the femoral sheath. **Boundaries of the Crural Ring.**—In *front*, Poupart's ligament, and deep crural arch; *behind*, the body of the pubis, covered by the pectineus and the fascia iliaca; on the *inner* side, the sharp border of Gimbernat's ligament, conjoined tendon, and fascia transversalis; on the *outer* side, the femoral vein, covered by its sheath. Femoral hernia is more common in women, (1) because the distance between the iliac and pubic spines is greater, and Gimbernat's ligament is smaller; and for these reasons the femoral ring is larger; (2) from changes in the abdominal viscera during pregnancy. The *coverings* of this form of hernia are—(1) The skin; (2) Superficial fascia; (3) Cribriform fascia; (4) The femoral sheath; (5) Crural septum; (6) Extra-peritoneal cellular tissue and fat; (7) The Peritoneum. In reducing femoral hernia by taxis, it is necessary (1) to bear in mind the course of the hernia, and (2) to put the limb in such a position that the falciform process of the saphenous opening will be relaxed. The hernia enters the crural ring, passes down the crural canal, and escapes by the saphenous opening—at first passing downwards and forwards, and then upwards; and, therefore, in applying pressure, it must be directed downwards, backwards, and upwards; and, to relax the falciform margin of the saphenous opening, the thigh must be flexed on the abdomen, and rotated inwards. The seat of stricture in femoral hernia is usually the sharp edge of Gimbernat's ligament.

Operation for Strangulated Femoral Hernia.—The superficial structures are divided by a vertical or a T-shaped incision, and the other coverings carefully divided till the sac is reached; and the finger is then passed along the canal till the stricture is found, which is relieved by cutting cautiously inwards, so as to notch or divide Gimbernat's ligament: if this cannot be accomplished by the extra-peritoneal method, the sac must be opened and the stricture divided from within it. The great danger is in the possible abnormal origin of the obturator artery, which may come in the way of the inward incision. The blood-vessels near the crural ring under normal conditions are—(1) The femoral vein, to its outer side; (2) The deep epigastric artery, to the front and outer side of the opening; (3) The pubic branch of the deep epigastric, also in front, and passing inwards over it. The obturator artery usually arises from the anterior division of the internal iliac artery, and escapes from the pelvis by the upper part of the obturator foramen; but sometimes this artery arises from the deep epigastric, and when it does so, it is usually the pubic branch very much enlarged. In order to reach the obturator foramen, it may pass in either of two directions—(1) It may pass down close to the vein, and external to the crural ring, in one out of every four cases (Wood); or (2) It may arch over the crural ring, and descend internal to it, in about one out of every eighty cases. It is in this latter variety that the danger exists, because, in cutting inwards on Gimbernat's ligament, the vessel is also apt to be divided or wounded; but, fortunately, this variety of abnormal distribution of the artery is not very common, and this is all the more fortunate because it is impossible to foresee or avoid the accident. In the diagnosis between this form of hernia and the inguinal form, it is well to remember that the neck of the sac in femoral hernia is situated below Poupart's ligament, and external to the spine of the pubis; whereas in inguinal hernia the neck of the sac is above Poupart's ligament, and internal to the pubic spine.

Dissection of the Perinæum.—The perinæum corresponds to the inferior outlet of the pelvis, and in shape resembles an heraldic lozenge, and has the following *boundaries*:—In *front*,

the symphysis pubis and sub-pubic ligament; *laterally*, in front, the divergent rami of the pubic arch and tuberosities of the ischia; laterally, behind, the convergent great sacro-sciatic ligaments, overlapped by the glutei maximi muscles; and *behind* by the tip of the coccyx. The space is divided into two parts by a line passing from the anterior border of one tuberosity of the ischium to the other: the posterior division is called the rectal part, and the anterior division the urethral.

The Posterior or Rectal Part.—This part is the same in both sexes, and contains the lower end of the rectum and tip of the coccyx; and on either side there is a space known as the "*ischio-rectal fossa.*" Each space is pyramidal in shape, and has the following boundaries:—Its *base* is formed by the skin and fascia covering it; its *apex* by the meeting of the outer and inner walls; the *outer* wall is the obturator fascia covering the obturator internus muscle, and giving a sheath to the internal pudic artery; the *inner* wall is the fascia covering the levator ani and external sphincter muscles; the *anterior* wall is formed by the base of the triangular ligament and transverse perinæal muscle; the *posterior* wall is formed by the gluteus maximus, great sacro-sciatic ligament, and the coccygeus muscle. The *contents* of the space are—(1) Twigs of the small sciatic nerve; (2) Inferior hæmorrhoidal nerve; (3) The fourth sacral nerve, to the external sphincter; (4) Superficial perinæal nerves; (5) Inferior hæmorrhoidal vessels; (6) Much loose granular fat, which forms a movable elastic packing for the rectum. Abscesses may form in this space; and unless they are early and freely opened, they will either burst into the interior of the gut or spread widely upon the nates, being unable to "point" readily at the base of the space on account of the strong fascia covering it. In opening abscesses in this region, the knife should be directed so as to cut towards the anus, parallel to the radii of a circle of which the anus is the centre, to avoid, as far as possible, division of the vessels and nerves of the space, which radiate towards the anus. This space is also concerned in the various forms of fistulo in ano, which frequently arise from abscess in this region; and in the complete form of fistula the structures between it and the rectum must be divided, so as to lay the two cavities into one, before

a cure can be effected. In this operation the structures divided will be—(1) The integumentary coverings; (2) Sphincter ani, and wall of rectum; (3) Fatty tissue; (4) Small blood vessels and nerves. This space is also opened into in the operation of lateral lithotomy.

The Anterior or Urethral Part.—It will be well here to say a few words about the *triangular ligament* of the urethra or deep perinæal fascia. This is a ligament which fills up the pubic arch, and is, therefore, triangular in shape—hence its name; it divides the urethral triangle into superficial and deep parts. The urethra pierces it, but the penis is entirely in front of it, and the bulb lies in contact with its anterior surface. The so-called "posterior layer" of the triangular ligament is simply a part of the parietal layer of the pelvic fascia attached to the posterior lips of the margin of the pubic arch, and below to the base of the true triangular ligament. By this means there is a small space enclosed, which is spoken of as the "space between the two layers of the triangular ligament." In the dissection of this part of the perinæum, after having reflected the skin, we come to the superficial fascia—in this region this has been divided into a superficial and a deep layer; but these two layers are practically one, only the layer has two distinct surfaces. **Attachments of this Fascia.**—*Laterally*, it is attached to the margins of the pubic arch, as far back as the tuberosities of the ischia, beyond this it is firmly blended with the fascia lata of the thigh; *behind*, it bends round the transverse perinæal muscle, and is attached to the base of the triangular ligament of the urethra; in *front* it is unattached, and is continuous with the fascia of the scrotum and penis, and by these means a pouch is formed which is open *above*. From the median line an incomplete septum projects downwards towards the urethra and into the scrotum. From the above attachments it is evident that extravasated urine cannot pass backwards into the posterior half of the perinæum, because of its attachment to the base of the triangular ligament, nor down the thighs, because of its attachments to the pubic arch and fascia lata of thigh; but it will fill the pouch and pass into both sides of the scrotum, and then pass up the front of the abdomen,

along the spermatic cord; and even when it has reached the abdomen it is still unable to pass down the thigh, because the superficial fascia of the abdomen is firmly attached to Poupart's ligament. Thus far in the dissection we have simply removed—(1) The skin; (2) The superficial fascia; and when the pouch above mentioned is opened into, we come to—(3) The long scrotal nerves—(*a*) Anterior superficial perinæal, (*b*) Posterior superficial perinæal, (*c*) The long pudendal; (4) Blood-vessels—(*a*) The superficial perinæal artery, (*b*) The transverse perinæal artery. These structures being reflected, we then expose—(5) The superficial muscles of the space—three in number—which form a small triangle (the perinæal triangle), the floor of which is formed by the triangular ligament. The muscles are—(*a*) The accelerator urinæ, lying on the penis; (*b*) The erector penis, lying on the crus penis; and (*c*) The transversus perinæi. When these are removed, (6) the bulb (the dilated posterior part of the corpus spongiosum) and root of penis are exposed; and if they in turn be removed, (7) The anterior surface of the triangular ligament is exposed. (8) Remove the anterior layer of this ligament, and the structures between its two layers are exposed—viz.: (*a*) The membranous part of the urethra, surrounded by (*b*) The compressores urethræ; (*c*) The artery to the bulb, (*d*) The internal pudic artery, (*e*) Cowper's glands, (*f*) The pudic nerves, (*g*) The dorsal vein of the penis. Reflect these structures and cut through (9) The posterior layer of the triangular ligament, and (10) Reflect the levator ani, and the prostate gland is exposed, surrounded by its capsule and the prostatic plexus of veins; and if the rectum be turned aside, (11) The base of the bladder, with the vesiculæ seminales and the vasa deferentia, are exposed. There are various structures which pierce the anterior layer of the triangular ligament—viz.: (1) The urethra, in the median line, one inch below the pubis; (2) The dorsal vein of the penis, also in the median line, half an inch below the pubis; (3) The internal pudic artery; (4) The dorsal nerve of the penis; (5) The artery to the bulb.

The Anterior Space in the Female.—In the female there is situated in this space the orifice of the vagina, and the parts connected with it—the true perinæum in the female

being that part between the posterior commissure of the labia and the orifice of the anus, and is from an inch to an inch and a-half in length. A work of this kind is not quite the place to take up the subject of development; still, a few words on it will not be amiss, in order to trace out the homologous parts in the two sexes. Up to the seventh or eighth week of fœtal life, in both sexes the genital, urinary, and intestinal tubes open into a common opening or cloaca, a condition which is permanent in reptiles and birds. About this time a transverse partition forms, dividing this cloacal aperture into an anal or posterior division, and an anterior division, called the *uro-genital sinus*. From the part of this sinus lying above the opening of the Wolffian duct in the male, and the Müllerian duct in the female, the prostatic portion of the male urethra, and the *whole* of the female urethra, is developed; the part below this forms the vestibule in the female and the membranous part of the urethra in the male. The uro-genital sinus is, however, further sub-divided by a fold forming in the antero-posterior direction, called the *genital eminence*, and which ultimately forms the penis in the male and the clitoris in the female. The under surface of this body is cleft, and it is further bounded by two folds, which in the male grow down and close in the furrow, forming the corpus spongiosum of the penis; but in the female they remain open, and, diverging from each other, form the nymphæ or labia minora. At the sides of the sinus other integumentary folds arise, which in the male join to form the scrotum; but in the female they remain open, and form the labia majora. In the male, the small prostatic pouch or *sinus pocularis*, seen in the prostatic portion of the urethra, is the homologue of the vagina and uterus in the female. This space further differs from the corresponding space in the male—(1) Because the superficial fascia, owing to the position of the vulva, is divided in the middle line, and becomes continuous with the sheath of the vagina; (2) Situated between the orifices of the vagina and the anus, is a structure known as the "perinæal body," which corresponds in position to the central point of the perinæum, but contains much elastic tissue; (3) The two halves of the muscle corresponding to the accelerator urinæ

in the male, are separated by the vulva, forming the bulbo-cavernosus muscle or sphincter vaginæ; (4) The vagina pierces the triangular ligament of the urethra. (5) From the above it is evident that we cannot get "extravasation of urine" as in the male.

LITHOTOMY.

Lateral operation.—The perinæum is shaved, and the rectum emptied on the morning of the operation; and if the bladder is not full it is better to inject it with six or eight ounces of tepid carbolised water. A staff is introduced, and the surgeon satisfies himself that he *feels the stone at that time;* and if he does so, the patient is tied up in the usual lithotomy position. **Incision.**—It is more convenient to make the incision on the left side. The knife is entered a little to the left of the median raphé, about an inch and a-half in front of the anus, and is carried downwards and outwards to a point between the anus and the tuberosity of the ischium, but rather nearer to the tuberosity than it is to the anus. Authorities differ as to the depth to which the incision should be carried, and it will necessarily vary in individual cases. *Structures cut through.*—(1), The skin; (2), The superficial fascia and fatty tissue; (3), Inferior hæmorrhoidal vessels and long scrotal nerves; protect the rectum, and then divide (4) the transversus perinæi muscle, and so open into the triangular space enclosed by the accelerator urinæ, the erector penis, and the transversus perinæi muscles, and in the floor of which the triangular ligament is situated. The incision is not confined to the urethral triangle, but the ischio-rectal fossa is also opened into; (5) Notch the lower border of the triangular ligament, and open into the space between its two layers, in which the membranous portion of the urethra is situated, push the forefinger of the left hand into this space and feel for the groove on the staff, and then push the knife along the groove into the bladder, protecting the rectum by the index finger of the left hand; by this means there is divided (6) the membranous portion of the urethra surrounded by the constrictor urethræ muscle; (7) A few fibres of the levator ani muscle; (8) The left lobe of the prostate and prostatic por-

tion of the urethra; (9) The internal sphincter of the urethra *(sphincter vesicæ)* and these structures being divided, an opening is made into the bladder.

The following facts are worthy of special note:— In making the deeper incisions the side of the knife should be kept parallel to the ramus of the ischium, because if the edge be turned too much towards the mesial line (1) the rectum may be wounded, and if the edge be turned too much outwards (2) the internal pudic artery may be cut, which is bound down in a strong sheath of obturator fascia under cover of the ramus and tuberosity of the ischium; (3) The artery to the bulb instead of coming off from the internal pudic between the two layers of the triangular ligament, and running transversely inwards to the bulb, sometimes arises further back, and sometimes even in the ischio-rectal fossa, and in this case it is almost certain to be wounded, and this accident is attended with considerable danger to life, from hæmorrhage, for three reasons—(*a*) From its size and from the fact that it is cut (usually) near its origin from the parent trunk; (*b*) It is so deeply placed that it is almost impossible to apply a ligature; and, (*c*) The fibrous nature of the tissues in which it lies at this point tends to prevent its contraction, and the consequent natural arrest of the hæmorrhage. (4) The incision into the prostate should be as limited as possible lest the knife pass beyond it and cut through the reflection of the pelvic fascia from its sides and front (the point of reflection, however, is close to the *upper* part of the prostate), forming the lateral and anterior true ligaments of the bladder, and thus open into the pelvic cavity, which accident is almost certain to be followed by infiltration of urine and diffuse inflammation; (5) The bulb must be avoided; (6) If the knife be thrust too deeply in the last stage of the incision, the posterior wall of the bladder might be wounded. In performing lithotomy in children there are certain differences in the size and position of the parts concerned—(1) The urethra is proportionately larger; (2) The perinæum is more vascular usually; (3) The rudimentary state of the prostate gland; (4) The bladder in children is situated much higher, being rather an abdominal than a pelvic viscus. With these differences in

mind, the operation is performed in the same way as in the adult.

The Median Operation.—In this case the incision is made in the middle line. A staff is introduced and the incision commenced about an inch and a-half in front of the anus, exactly in the middle line, and is carried backwards till within a few lines of the anus; the bulb in front and the rectum behind must be avoided. The incision is deepened till the muscular fibres of the accelerator urinæ are exposed, of which the posterior fibres are divided, and then the bulb is pressed forwards, while the rectum is pressed backwards. The groove on the staff is next felt for in the membranous part of the urethra, and the knife is entered into it with its back towards the rectum, and passed into the bladder. In this operation the structures divided are—(1) The median raphé (skin and fibrous tissue chiefly); (2) Part of accelerator urinæ; (3) The membranous part of the urethra, and compressor urethræ muscle; (4) Prostate gland and the prostatic portion of the urethra; and, (5) Sphincter vesicæ. When the knife has entered the bladder, the cutting edge is then turned downwards and carried through the prostate exactly in the middle line, the rectum being in the meantime protected by the forefinger of the left hand; the wound is then dilated and the stone extracted. In the median operation the hæmorrhage is very trifling, but the bulb and the rectum are very liable to be wounded.

The Bilateral Operation.—In this operation a curved transverse incision is made half-an-inch above the anus, towards which its concavity looks, the extremities of the incision extending for about two-thirds of the distance between the anus and the tuber ischii on each side. By this incision there is divided—(1) Skin; (2) Superficial fascia; (3) Superficial nerves of the perinæum; (4) Superficial vessels of the perinæum; (5) The superficial muscles of the perinæum (see dissection of perinæum); (6) Membranous portion of the urethra and the compressor urethræ muscle. Into this opening the double *lithotome caché* is introduced and passed into the bladder along a grooved median staff, with its concavity upwards; but when once in the bladder the concavity is turned downwards, the

spring in the handle is pressed, and the blades, previously "set," are made to cut their way out in withdrawing the instrument. Through the opening thus made in the prostate the stone is extracted.

The High or Supra-Pubic Operation.—It may be necessary to perform this operation—(1) On account of the large size of the stone; (2) Rigid hip joint; (3) Contracted pelvic outlet. The bladder must be distended so that it can be felt above the pubes, and then an *incision* two and a-half or three inches is made in the median line immediately above or partly over the pubes, so as to reach that part of the bladder which is uncovered by peritoneum. In cutting down to the bladder at this point, the *structures divided* are—(1) The skin; (2) The superficial fascia; (3) Sheath of the recti, and the adjoining edges of the recti and pyramidales are then separated, and with the finger or the handle of the knife separate the loose cellular and fatty tissue, and divide (4) the transversalis fascia, and the anterior surface of the bladder is exposed. Make out, if possible, the reflection of the peritoneum, and enter the knife into the bladder a little above the pubes, and exactly in the middle line and cut *towards* the pubes to avoid wounding the peritoneum; after this, the forceps is introduced and the stone extracted. The chief dangers of this operation are—(1) The risk of infiltration of urine into the cellular tissue of the wound; (2) The risk of wounding the peritoneum.

Lithotrity.—In this operation the stone is crushed in the bladder, and the pulverised fragments expelled or extracted through the urethra. The instrument used for this purpose is called a *lithotrite*; the operation is performed at several sittings, and the shorter these sittings are the better, because the long continued contact of instruments with the mucous membrane of the bladder is apt to produce cystitis, leading to pyæmia or even death. At the first sitting the stone is simply crushed and the fragments are left to be pulverised and extracted at subsequent sittings. But the crushed stone thus left is apt to produce great irritation in the mucous membrane of the bladder, and unless care be taken in the treatment of the patient between the sittings, small fragments of the stone are apt to be driven into the neck of the bladder,

or even into the urethra, causing great pain and injury to the tissues; and, even with the greatest care in the *final exploration*, small fragments are apt to be left which form the nuclei of subsequent calculi. Quite recently a new operation has been introduced, called **Litholapaxy**, by Bigelow, who was the first to plan and carry out the operation. For its performance the following instruments are required—(1) A lithotrite; (2) A large evacuation catheter; (3) An aspirating syphon. The following advantages are claimed for this operation—(1) The stone is crushed and removed at a *single sitting*, so that the bladder is thus freed from the irritation caused by small fragments of stone retained in its interior for a lengthened period, and the urethra is also freed from the irritation of their possible passage between the sittings (as in lithotrity); and, further, the fragments are completely removed, so that no fragments are left to form the nuclei of subsequent calculi; (2) The *lithotrite* lock is more easily closed than in the ordinary lithotrite, being closed by a simple turn of the wrist without displacing the hands, and the blades are so formed that they allow of the easy escape of detritus, so that laceration of the neck of the bladder is prevented in the withdrawal of the instrument; (3) The stone need not be *pulverised*, because, (4) The catheter used is very large, its inventor taking advantage of the fact that the urethra admits of great dilatation.

Calculus in the Female.—Stone is of rare occurrence in women. When it does occur it may be removed—(1) By *lithectasy*, *i.e.*, through the dilated urethra, dilated either—(*a*) By sponge tent, or dilator, or (*b*) by incising the mucous membrane; (2) By *lithotomy*—(*a*) Suprapubic operation as in the male, (*b*) The urethral operation, by introducing a grooved staff and cutting along it into the bladder, (*c*) The *vaginal* operation, by cutting through the anterior wall of the vagina and base of the bladder; (3) By *lithotrity* or *litholapaxy*.

The Urethra.

Length.—The length of this canal in the male is from eight to nine inches; in the female it is only about an inch and a-half in length, and corresponds, as we have seen, to the prostatic portion of the male urethra.

Divisions.—In the male it is divided into three parts. (*a*) *The prostatic portion.* This part is about an inch and a quarter in length, and passes almost directly downwards, but slightly forwards. It is situated about the middle of the prostate gland, but rather nearer its anterior surface, and is in front of the middle lobe. In connection with it we notice the following parts,—(1) As it opens into the bladder there is a transverse fold of mucous membrane called the "uvula vesicæ." (2) Continuous with this there is a median ridge called the *crest* of the urethra, *caput gallinaginis* or *verumontanum.* (3) On either side of this crest there is a depression called the *prostatic sinus,* and in it may be seen the openings of numerous prostatic ducts; (4) At the summit of the crest there is a median opening called the *sinus pocularis*; and, (5) At each side in the walls of the sinus are seen the openings of the *common ejaculatory ducts.* (*b*) *The membranous portion.*—The length of this part is—anterior wall, three-quarters of an inch; posterior wall, half an inch. It is directed forwards and downwards, extending from the apex of the prostate gland to the bulbous portion of the urethra, and is contained between the two layers of the triangular ligament, the anterior layer of which it pierces, and is about an inch below the symphysis pubis. It is surrounded by the compressor urethræ muscle, and is the most frequent seat of *spasmodic* stricture. (*c*) *The spongy portion.*—The posterior part of this portion is sometimes called the *bulbous portion* from the fact that it is surrounded by the bulb of the urethra (which is simply the dilated posterior part of the corpus spongiosum, just as the glans penis is the dilated anterior part). The length of the spongy portion is from five to six inches (the bulbous part occupies about one inch of this). The direction of this part necessarily varies with the state of the penis; the bulb, however, is the lowest part of the whole canal, and into it the ducts of Cowper's glands open. The bulb is, further, the most frequent seat of *organic* stricture, probably because, being the lowest part, the inflammatory products tend to accumulate at this point. Along the floor of the spongy portion proper numerous mucous follicles open, their orifices

being directed towards the meatus; there is also a large one in the roof of that part of the urethra situated in the glans penis, and is called the *lacuna magna*, and this one must be avoided in passing a catheter.

Size and Shape of the Urethra.—The urethra, as we have already pointed out, admits of considerable dilatation, so that no exact measurement is obtainable of its absolute size; we can, however, compare the size of one part with another. When closed, it is simply a slit—at the anterior part the slit is *vertical*, further back, the slit is *transverse*, while in the prostatic portion, the slit is *curved* with its concavity downwards, as seen on transverse section. It is narrowest at the meatus, and the next narrowest part is at the junction of the membranous with the spongy portion—*i.e.*, as it pierces the triangular ligament (anterior layer). If the *prostatic* part be distended it is seen to be fusiform in shape, being widest in the middle, and a little contracted at each end; the *membranous* portion is the narrowest. The *bulbous* part of the *spongy* portion is dilated; it then grows somewhat smaller, but expands again in the glans penis to form the *fossa navicularis*, and then contracts to form the meatus.

Curves of the Urethra.—In the flaccid condition of the penis, the general course of the urethra somewhat resembles the letter S lying on its side, but when the penis is erect the anterior curve is obliterated, and hence this is called the *temporary* curve; the *permanent* curve, however, remains under all circumstances, and we have thus two curves—(1) the temporary, and (2) the permanent, and to this latter the curve of the catheter corresponds. The permanent curve is maintained by—(1) The pelvic fascia fixing the neck of the bladder and the prostate gland; (2) The connection of the root of the penis with the pubis by means of the suspensory ligament of the penis; (3) The two layers of the triangular ligament fixing the membranous part; (4) The connection of the base of the triangular ligament with the superficial fascia of the perinæum, and through it to the "central point of the perinæum." It is of importance to remember that, with the finger in the rectum, the bulb, membranous part of the urethra,

prostate gland, and even the base of the bladder beyond, may be felt. These parts are more easily distinguished if a catheter be previously introduced; and in this way the fact of having made a false passage may be detected, the catheter not being found in the bladder, nor bearing the proper relation to the parts in question.

The Prostate Gland.—This gland is situated behind and below the pubis, embracing the neck of the bladder, and *lying against* the anterior wall of the rectum, the recto-vesical layer of pelvic fascia being the only structure that is interposed between the two. In size and shape it resembles a chestnut. It is closely connected with the anterior and lateral true ligaments of the bladder (pelvic fascia), which join it at its upper part, and for this reason the anterior ligament is called, at this point, the "pubo-prostatic" ligament. It has also attached to it the anterior fibres of the levator ani muscle, these fibres being called, for this reason, the "levator prostati." It consists of three lobes—a median and two lateral. The middle lobe is the smallest of the three, and lies immediately below the prostatic portion of the urethra; it is pyriform in shape, and when prominent the base projects into the bladder, forming the *uvula vesicæ*. In elderly men the prostate frequently becomes enlarged, and it is the middle lobe that seems to enlarge most, or whose enlargement gives rise to the most serious consequences. This is probably partly from its position, as its base will tend to grow in the direction of least resistance, that is, up into the bladder. The results of such enlargement are: (1) A pouch is formed behind the projection, so that the urine tends to dribble away after it has passed in a full stream; in many cases, also, the urine lies in the pouch, and cannot be entirely expelled, and the unexpelled portion soon becomes decomposed and ammoniacal, and irritates the mucous membrane of the bladder, leading to chronic cystitis. (2) The projecting part may overlap the orifice of the urethra (which is normally the *lowest* point of the bladder), and act like a valve, preventing the passage of the urine through the urethral orifice, and the more the patient strains the tighter it becomes. (3) It alters the direction of the urethral tube,

forming a little recess, and this must be kept in mind in passing a catheter.

The Testicle: its Coverings.—*Hydrocele.*—The testicle lies obliquely in the scrotum, suspended by the spermatic cord and its coverings. It is oval in shape, and its front, sides, upper and lower ends, are smooth; but the *posterior* part, where the spermatic cord is attached, and where the vessels enter and leave, is not smooth, not being covered by the serous membrane (visceral layer of the Tunica vaginalis). The gland itself is enclosed in a strong capsule—the *Tunica albuginea*—which is a dense, fibrous membrane. *Coverings of the testicle as it lies in the scrotum.*—(1) The skin, which is thin and dark coloured, and usually in rugæ; (2) The superficial fascia, which in this region is peculiar in the fact that it contains no fat, but has a layer of non-striped muscular fibres—the *dartos muscle*; (3) The intercolumnar or external spermatic fascia; (4) The cremasteric muscle or fascia; (5) The infundibuliform fascia; (6) The *Tunica vaginalis,* the special serous membrane of the testicle, which under normal conditions is entirely cut off from the peritoneal cavity. It consists of a visceral and a parietal layer: the *visceral* layer covers the front, sides, upper and lower ends of the testicle; but towards the posterior part it is reflected from the testicle, and becomes continuous with the parietal layer. The *parietal* layer is attached to the infundibuliform fascia by loose areolar tissue, and is more extensive than the visceral part, extending higher up and lower down than the testicle. The Tunica vaginalis, like other serous membranes, is a closed cavity, and it is of importance to remember that it is towards the *front* and *sides* of the testicle, so that the testicle seems suspended at the back of this serous sac; in the normal condition, however, its two layers are in contact. *Hydrocele of the Tunica vaginalis* consists of a collection of serous fluid *within the cavity* of this sac; as the fluid accumulates it forms a swelling at the front and sides of the testicle, and also passes up in front of the spermatic cord towards the external abdominal ring; it also passes down below the testicle, so that, if well marked, the testicle cannot be felt at the bottom of the scrotum. In tapping this dis-

tended sac the trochar must be plunged into the most prominent part of the *front* of the scrotum, so as to avoid injury to the testicle which is at the posterior part: it is first plunged in perpendicularly, and then made to pass obliquely upwards. When the sac is emptied, a solution of iodine is injected to set up inflammatory action and prevent the re-accumulation of the fluid. If, however, a communication exist between the cavity of the Tunica vaginalis and the general peritoneal cavity, irritating fluids, like tincture of iodine, should not be injected lest they set up fatal peritonitis. In its passage the trochar pierces the following structures—(1) The skin; (2) The superficial fascia and dartos; (3) The intercolumnar fascia; (4) The cremasteric fascia; (5) The infundibuliform fascia; (6) The parietal layer of the Tunica vaginalis. The epididymis is situated at the back and outer side of the testicle.

Differential Diagnosis between Hernia and Hydrocele of Tunica vaginalis.

Scrotal Hernia.	*Hydrocele.*
1. Tumour oblique in shape and direction.	1. Tumour, oval or pyriform.
2. The protrusion lies in front of and covers the spermatic cord, and testicle can be felt at the bottom of the scrotum.	2. The cord can be felt free in the inguinal canal at external ring, and the testicle cannot be felt at the bottom of the scrotum, but is situated behind.
3. An impulse is imparted to the tumour if the patient coughs; gurgling sound at attempts at reduction; percussion note clear (if intestine), but dull if omentum.	3. No impulse on coughing; no gurgling at attempts at reduction; percussion note dull.
4. No transparency on examination by the transmitted light of a candle.	4. Is usually transparent when thus examined.

In *Hæmatocele* (that is, a collection of blood in the Tunica

vaginalis) the shape is usually globular, it is heavier than hydrocele, and hard or doughy to the touch, opaque to transmitted light, and dull on percussion. In *sarcocele* (a fleshy enlargement of the testicle) the shape of the tumour is usually *irregular*.

Puncture of the Bladder.—This operation may be performed either from the rectum or above the pubes, and in doing so, advantage is taken of the anatomical facts that there is no peritoneum on the base of the bladder (that is the part towards the rectum) nor on the antero-inferior surface. The part left uncovered varies with the amount of distension of the organ. In tapping above the pubes, the bladder must be distended, so as to raise the reflection of the peritoneum well above the pubes; in tapping from the rectum, it must be done exactly in the middle line, and close to prostate. The part which may be punctured with safety is triangular in shape (the external trigone), and has the following boundaries:—On either side are the vasa deferentia (a vas on each side), and immediately beyond these, the vesiculæ seminales; the base of the triangle is formed by the line of reflection of the peritoneum on to the rectum, and at the apex of this triangle the prostate gland is situated. If the puncture be not in the middle line, the vasa deferentia or vesiculæ seminales may be injured; and unless well forwards towards the apex of the triangle, the peritoneum might be punctured. This operation may be rendered necessary for retention of urine in cases of stricture. For the same reason, the membranous portion of the urethra is sometimes opened from the perinæum; the guide in this operation is the apex of the prostate gland, felt by the forefinger of the left hand through the rectum. A straight bistoury is then plunged into the *middle line* of the perinæum, in front of the anus, with its back towards the rectum, and made to cut into the membranous portion of the urethra—which, under the circumstances necessitating such an operation, will be distended—and the urine then escapes. For the structures cut in this operation, see the dissection of the urethral triangle down to the membranous portion of the urethra.

The Pelvic Fascia.—This fascia consists of a *parietal* part, covering the walls of the pelvic cavity, and a *visceral* part, which connects the various pelvic viscera with each other and with the walls of the pelvis. The *parietal* part is attached to the brim of the true pelvis and the posterior surface of the pubic bones, and passes down into the pelvis, covering the obturator internus muscle, and is attached to the spine and tuberosity of the ischium; on the posterior pelvic wall it covers the pyriformis muscle and the sacral plexus of nerves, but is behind the internal iliac artery, the gluteal, sciatic, and pudic branches of which have to pierce it in order to escape from the pelvis. The *visceral* part is given off from the parietal layer, on a line with the spine of the ischium and the back of the pubes, the point where the two diverge being known as the "white line." The most anterior part passes backward to the *upper* surface of the prostate gland, forming the "pubo-prostatic ligament," and then passes on to the bladder, as the anterior true ligament of that viscus. The lateral part divides into three layers—the most superior forms the lateral true ligaments of the bladder, the middle passes between the base of the bladder and the rectum (the recto-vesical layer), while the most inferior—the rectal layer—passes under the second and third parts of the rectum, and ensheaths the levator ani. The relation of that part of the parietal layer of pelvic fascia above the "white line" (the "undivided" pelvic fascia of some) to the visceral layer, has been compared to that of the wall-paper and carpet of a room; and it is this carpet which must on no account be cut in the operation of lithotomy.

The Rectum.—The rectum extends from the left sacro-iliac synchondrosis obliquely downwards and to the right to the middle of the scrotum, and then curves forwards and inwards in front of the sacrum and coccyx; it then passes downwards and backwards from the tip of the coccyx to the orifice of the anus. It is divided into three parts—the *first* part extends from its commencement to the second or third sacral vertebra; the *second* part from the second or third sacral vertebra to the tip of the coccyx; the *third* part from

the tip of the coccyx to the anal orifice—this part being about an inch and a-half in length. The length of the entire rectum is about eight inches. **Relations.**—The *first part* is surrounded by peritoneum, which also binds it to the front of the sacrum as far down as the second or third sacral vertebra —this fold being known as the *meso-rectum;* in front of this part is the recto-vesical pouch of peritoneum and a part of the bladder in the male, but in the female the pouch of Douglas, the uterus, and the upper part of the posterior wall of the vagina. The *second part* is only partially surrounded by the peritoneum, the front and upper part of its sides alone being in relation to it; at its lower part the peritoneum is reflected, in the male, on to the back of the bladder, but in the female on to the posterior wall of the vagina. In the male, the base of the bladder lies immediately over this part, and between the two are the vesiculæ seminales and the vasa deferentia; but in the female the posterior vaginal wall is in relation to it. This part is attached by loose areolar tissue to the front of the sacrum and coccyx, and is also in relation to the visceral layer of the pelvic fascia. The *third part* has no relation to the peritoneum, but is in close relation to the pelvic fascia and the levatores ani muscles, which support this part of the rectum; the rectal layer of the pelvic fascia joins the rectum about four inches from its lower end, and at the same time ensheaths the levator ani; further, the recto-vesical layer of the pelvic fascia (or recto-vaginal layer in the female) is also in relation to the rectum. The prostate gland in the male is close to the commencement of this part, while in the female the perinæal body is in relation to its anterior surface throughout its whole extent, because at this point the rectum and the vagina diverge.

Paracentesis Abdominis.—A small incision is made with a scalpel in the middle line, a little below the umbilicus (about two inches), and through this opening the trochar is thrust. It is better, however, to keep up pressure on the abdomen as the fluid escapes, lest the abdominal vessels burst on account of being thus suddenly relieved from the pressure of the fluid. This is best done by means of a broad flannel roller, split at

each end to within six inches of the middle, and applied in such a way that the untorn part covers the front of the abdomen, while the ends are crossed behind and given to an assistant on each side to keep up the pressure as the fluid escapes. Another precaution is to make sure that the bladder is empty before the operation. In tapping the abdomen in other situations, the course of the epigastric vessels must be kept in mind (see p. 118).

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