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OPERATIVE SURGERY

ON

THE DEAD BODY

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A MANUAL

OF

OPERATIVE SURGERY

ON

THE DEAD BODY

BY

THOMAS SMITH, F.R.C.S.

SURGEON TO, AND LECTURER ON ANATOMY AT, ST. BARTHOLOMEW'S HOSPITAL
SURGEON TO THE HOSPITAL FOR SICK CHILDREN

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SECOND EDITION

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1876

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PREFACE

TO

THE SECOND EDITION.

THE FIRST EDITION of this Manual has been carefully revised: much has been re-written, some operations have been omitted, many others have been added.

The chief labour of preparing the book has been undertaken by my colleague, Mr. WALSHAM, who has specially endeavoured to make it more complete by frequent and exact references to the anatomy of the parts concerned in the various operations.

It has been our object (as in the first edition) to describe only those operations that can be performed with advantage on the dead subject.

We have again to acknowledge our indebtedness to Mr. GODART for transferring to the wood the various illustrations which have been added.

5 STRATFORD PLACE: *May* 6, 1876.

PREFACE

THE FIRST EDITION.

THE REQUIREMENTS of the medical examining boards of this country seem to imply that a practical knowledge of operative surgery should form an essential part of the education of every surgeon, and that henceforth operative dexterity should be acquired by practice on the dead body.

For this reason, the performance of surgical operations on the subject has been introduced at most of our medical schools; and demonstrators have been appointed to superintend and direct the studies of gentlemen in that department.

The design of the present Manual is to give to students a practical guide to the performance of operations on the dead body, and to lighten the labours of teachers, by enabling them to dispense with much oral instruction, and to substitute the same kind of supervision that is ordinarily exercised in the study of practical anatomy.

Only those operative measures are here treated of which can be advantageously practised on the dead body;

and these are arranged, as far as possible, in the order in which they should be performed—an order rendered necessary in this country by the scarcity of anatomical subjects.

The woodcuts which are here and there introduced in the following pages were, with one or two exceptions, traced from photographs taken from the dead body, during the actual performance of the operations which they represent.

For the original photographs, as well as for their reproduction upon wood, the author is indebted to the artistic skill of Mr. GODART.

BEDFORD ROW: *August* 31, 1859.

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A MANUAL

OF

OPERATIVE SURGERY

ON THE DEAD BODY.

CHAPTER I.

INTRODUCTION.

The Selection of a Subject—Instruments—Assistant—A Table of Operations—Methods of holding the Knife—Sutures.

The Selection of a Subject.—It rarely happens that the student of operative surgery in this country has a choice of bodies for his purpose; to those who have such an opportunity we would recommend the selection of a male subject with a moderate amount of fat about it. An emaciated body gives too low an idea of the difficulties of ligaturing arteries on the living; while the deficiency of subcutaneous tissue renders it difficult to provide sufficient material for the formation of stumps in the practice of amputations. The subject should be placed on a high and narrow table, such as dissecting-rooms are generally furnished with.

Instruments.—In the London Schools the instruments requisite for a course of operative surgery are generally

provided by the demonstrators, the student having merely to choose from their collection those necessary for each particular operation he is about to perform. But should he from any cause have to provide his own instruments he will find all that are requisite contained in the cases supplied to surgeons in Her Majesty's service; an old case of this description will be found most serviceable, as in it the knives will have been worn down by successive sharpenings; for, generally speaking, their blades are originally too wide for some of the more difficult amputations.

Assistant.—Two students usually work together on the same subject, acting alternately as operator and assistant, and we cannot too strongly remind those who officiate in the latter capacity that there is much to be learnt of the important duties of their post from operations even on the dead body.

Table of Operations.—For the use of those who intend having one course only, or who have but one subject at their disposal, we append a table of operations that may all be practised on a single body. This list, which can be modified at the discretion of the operator, will be found to contain most of the operations in common use on the living, and may serve to guide some in the economical use of their material.

TABLE OF OPERATIONS.

The following operations can all be performed upon one body, and are arranged in the order in which they should be practised.

Incisions and sutures. Plugging the nares. Catheterism of Eustachian tube. Mr. Bowman's operation on the punctum and lacrymal duct. Operations for strabismus. Excision of eyeballs. Tenotomy. Division of sterno mastoid, tibialis anticus, ham-string tendons, tibialis posticus, tendo Achillis. Artificial anus. Ligature of all the arteries. Trephining. Tracheotomy. Laryngotomy. Pharyngotomy. Lithotomy. Paracentesis. Gastrotomy.

AMPUTATIONS AND EXCISIONS.

Right side.	*Left side.*
Distal phalanges of fingers and thumb.	Phalanges at all their articulations.
Fingers, *en masse*, at metacarpal joint.	Hand at carpal articulation, leaving the thumb.
Hand at wrist joint.	

On both sides.

Amputation at lower third of forearm. Excision of elbow joints. Amputation of upper arm at lower third.

Right side.	*Left side.*
Resection of the shoulder joint.	Amputation at the shoulder joint.

On both sides.

Amputation of the breasts.

Right side.	*Left side.*
Resection of the upper maxilla.	Resection of half the lower maxilla.
Amputation of the great toe at its tarso-metatarsal articulation.	Amputation of phalanges of toes at their various joints.
Chopart's amputation.	Lisfranc's amputation.
Pirogoff's ditto.	Syme's ditto.

On both sides.

Amputation of the legs in their middle thirds.

Right side.	*Left side.*
Resection of knee joint.	Amputation through condyles (*Cardens*).
Amputation at lower third of the thigh.	Amputation of thigh, middle third.
Resection of the hip joint.	Amputation at the hip joint.

Amputation of the penis.

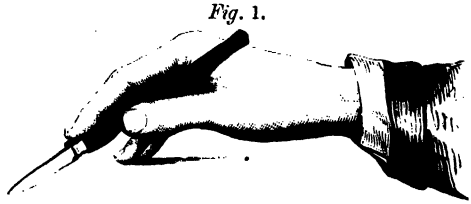
Castration.

We would here, once for all, state that throughout the following pages, wherever distances on the body are expressed by *inches*, it is presupposed that the subject is an adult, and of average size and proportions. Again, whenever the expressions *left-hand side* or *right-hand side* are employed, they always refer to the left, or right-hand side of the body which is being operated upon.

Methods of holding the knife.—The positions in which the knife is held in operative surgery necessarily vary much; we shall, therefore, only attempt to describe some of the principal.

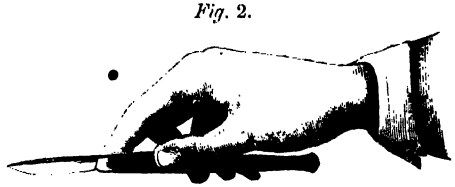
The first (fig. 1), where the scalpel is held as a pen in writing, is an easy, elegant way of holding the knife, and is adapted for any delicate dissection, and for incisions of inconsiderable extent, where the parts to be divided offer

Fig. 1.



no great resistance. It is used chiefly in the ligature of arteries, in the removal of small tumours, and in nearly all small operations. In figure 2, the knife is held as the

Fig. 2.



bow of a violin; this position gives great freedom and a

wide range of motion, though it requires greater dexterity than the former, as the hand cannot be steadied on the neighbouring parts. It is made use of in the removal of the breast, or in the excision of any tumour of large size. The knife may be grasped as an ordinary dinner-knife, as seen in fig. 3, a method well suited for amputations about the carpus and tarsus.

Fig. 3.

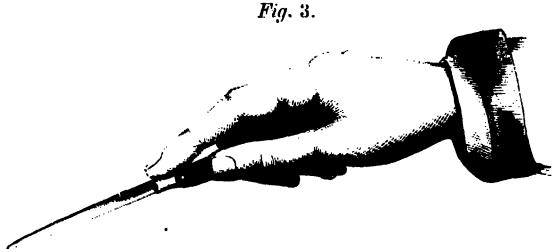
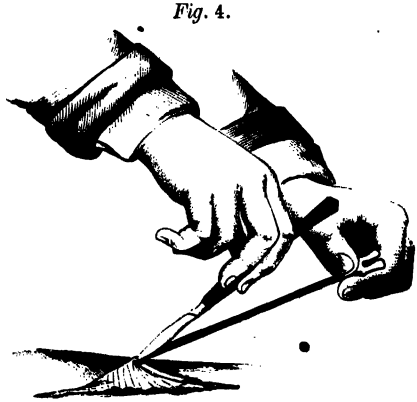


Figure 4 represents the manner in which the scalpel should be held in laying open fasciæ or aponeuroses, on the grooved director.

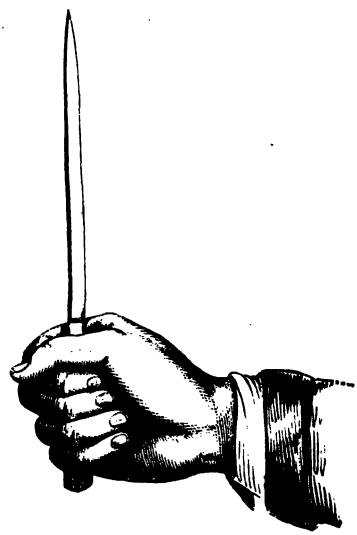
Fig. 4.



In figure 5, the knife, which in this case is always a large one, is held in the full grasp of the hand; it is

thus used in circular amputations, and in certain other instances to which we shall hereafter have occasion to refer.

Fig. 5.



Sutures.—Sutures are of various kinds, and are generally classified as—(1) interrupted; (2) uninterrupted; (3) twisted; and (4) quilled. The above-named modifications owe their existence to the varying necessities of wounds, as the latter occur in one or another part of the body. Thus the (1) interrupted is used for wounds where absolute apposition of every portion of their surface is either undesirable or unnecessary; as in stumps after the removal of limbs; in the wounds left by the removal of tumours, or amputation of the breast.

(2.) The uninterrupted, continuous, or Glover's suture best secures the accurate apposition of thin edges, and is therefore used in wounds of the eyelid and intestines.

(3.) The twisted suture will retain in absolute contact the whole surface of a wound of considerable depth; it suits its purpose well in hare-lip, in wounds laying open the cavity of the mouth, or in extensive division of the abdominal walls.

(4.) The quilled suture maintains the deep parts of a wound in firm contact, while it tends to evert the cutaneous edges; it is therefore generally used in combination with interrupted sutures, which keep the superficial parts of the wound together. It is employed chiefly in the cure of ruptured perineum.

The *continuous*, or uninterrupted suture, consists in the simple sewing together of the edges of a wound, taking care that the needle penetrates, at right angles to the surface, the whole thickness of the skin at each stitch. The thread, to prevent it pulling through, should be knotted at its end before commencing; the needle should be curved at its extremity.

In passing the *interrupted* suture, precisely the same method may be employed, except that after each complete passage of the needle through the wound, the thread should be divided, leaving an end on either side sufficiently long to be tied in a double knot. This knot should fall a little to one side of the line of contact between the edges of the wound.

In passing the needle in the two foregoing methods, if possible, the edges of the wound should be held in contact, with the forefinger and thumb of the left hand; or the edges of the wound may be put on the stretch, so as to bring them parallel with each other, that their opposite parts may exactly coincide.

If silver or iron wire be used, as is now the custom, instead of thread, it must be fastened by first crossing and then twisting the opposite ends of the suture together; or it may be tied in a single or double knot; it should not be cut off too near the wound, as on the living body it would be removed with difficulty.

To apply the *twisted suture*, hare-lip pins, silk, or twine, and the cutting wire pliers, are necessary.[1] The pins must be carefully passed in, about half an inch from one edge of the wound; they must traverse it, and appear at the same distance beyond its opposite margin.

When the requisite number of pins have been introduced, a piece of silk or twine is taken and twisted over each in the form of the figure 8, so that the point of crossing of the thread lies over the line of contact of the edges of the wound. The thread may be secured by tying its opposite ends together, and the pin may be cut so as to leave about half an inch projecting at either end, beyond the thread.

The *quilled suture* is best applied with a strong curved needle, fixed in a handle, and having an eye near its point. This should be threaded with a double thread, and having been passed through the wound from side to side, the looped end of the ligature is detached from the needle's eye, and held with the left hand, while the needle is withdrawn.

The needle should pierce the skin an inch from the edge of the wound, should traverse the deep parts, and emerge at the same distance from its opposite margin.

[1] This suture is best applied to the wound in the face, left after the removal of the upper jaw.

When withdrawn, there will be a double thread remaining in the wound having a loop at one extremity and two free ends at the opposite. Through the loop or loops, if more than one suture be used, a piece of gum catheter should be passed and the thread drawn tight over it, while the opposite ends are tied firmly over a similar piece of catheter.

To maintain perfect apposition in the more superficial parts of the wound, it is necessary to add a few interrupted stitches.

If it be thought desirable to practise the application of any of the foregoing methods, the front wall of the abdomen should be used for the purpose, where also [1] the method of making incisions with the scalpel held in the first position may be practised.

[1] For this see the preliminary remarks on Ligature of the Arteries.

CHAPTER II.

SOME OPERATIONS IN MINOR SURGERY.

Plugging the Nostrils—Catheterisation of Eustachian Tube—Mr. Bowman's Operation on the Lacrymal Punctum—Operation for Strabismus—Removal of the Eyeball—Paracentesis Thoracis—Paracentesis Abdominis.

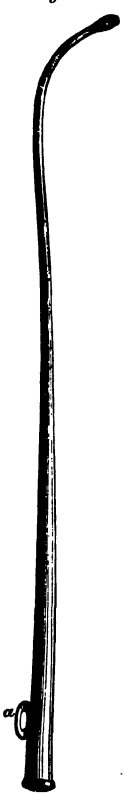
PLUGGING THE POSTERIOR NARES.

THIS operation, sufficiently disagreeable on the living, is still more so on the dead body; yet we venture strongly to recommend its practice, for though it presents no particular difficulties to those who have once performed it satisfactorily, yet a first attempt to plug the posterior nares is less easy of execution for the operator and more irksome to the patient than might be supposed.

The subject being on its back, and the head slightly raised on a block, artificial means must be used to keep the jaws apart. The operator must provide himself with cotton wool or lint, some strong twine, a pair of forceps, and a bent catheter, or, better still, Bellocq's cannula, the proper instrument for passing a ligature from the posterior nares into the mouth. A firm oblong plug should be made of cotton wool, twisted together, about the size of the last joint of one's thumb; to this should be tied by its centre a piece of doubled twine two feet in length, so that there may be four ends attached to the cotton wool. One of these should be cut off closely, another left about six

inches long, and two may remain as they were. The whole should now be smeared with oil. The instrument for passing a ligature into the pharynx being armed with a piece of twine, should be passed along the floor of the nostrils until it reaches the pharynx, when, the watch-spring being projected, it will appear in the mouth. The end of the string being held with the forceps, the instrument may be withdrawn and the string brought out of the mouth.

Fig. 6.



To this string attach the two longer strings of the plug, and pull at the nasal end of the string until the plug sticks fast against the soft palate; introduce the forefinger of the left hand into the mouth, and push the plug backwards, at the same time gently pulling the end at the anterior nares. In this way the cotton wool may be adjusted to one of the posterior nares; the two strings which will be found hanging out at the anterior nostrils being separated, a piece of lint or wool should be stuffed in between them and the strings tied over it. This will fix the posterior plug, and entirely close one side of the cavity of the nostrils. The shorter piece of twine attached to the plug may either remain hanging out at the mouth, or, in a living patient, may be swallowed and allowed to hang down into the pharynx; its use is to withdraw the plug when no longer needed; and this is effected by first cutting the knot at the anterior nostrils and taking out the

anterior nasal plug, the posterior being withdrawn through the mouth by means of the aforesaid string.

If the operator be desirous of performing the catheterisation of the Eustachian tube and lacrymal duct, he should proceed at once to their execution.

PASSAGE OF THE EUSTACHIAN CATHETER.

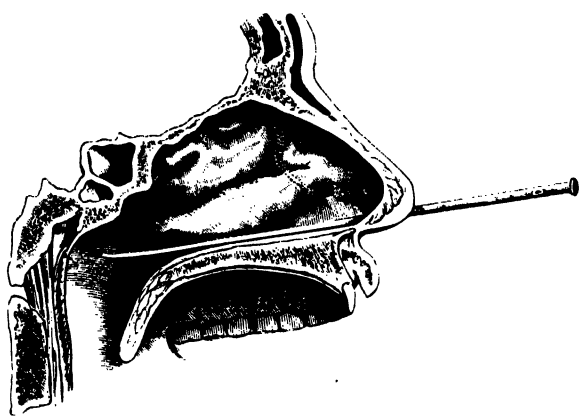
The head of the subject being supported on a block, the operator should stand on the right-hand side facing the subject.

The catheter, fig. 6, being oiled, should be held with a very light hand between the fore-finger and thumb with its concavity downwards; its point should be inserted into the nostril, while the handle slopes towards the chin. As the point is gently pushed along the floor of the nostrils the handle should be raised until it has gained a horizontal position, when the instrument can be passed straight on until its point can be felt to drop over the posterior edge of the hard palate into the pharynx.[1] The instrument should now be withdrawn until its point can be felt to rise up again on to the posterior edge of the hard palate; having arrived at this point, the catheter should be pushed onwards about an inch, and during its passage its point should be rotated outwards through a quarter of a circle. This turning of the point should commence as the instrument leaves the hard palate and should be complete rather before the onward movement has ceased.

[1] Should any obstacle be met with in passing the catheter through the lower meatus into the pharynx, no force of any degree should be employed, but the obstacle must be evaded. Occasionally, when the septum nasi diverges much from the median line, the catheter cannot be passed.

The point of the catheter will usually be felt to hitch in the pharyngeal orifice of the Eustachian tube during this manœuvre. Should it not do so, the movement may be repeated.

If at the commencement of the rotation the point seems to catch, it is probable that the instrument is too much curved; it should then be withdrawn and somewhat straightened at the point. If, on the other hand, the rotation is completed without the point of the catheter touching



anything, the catheter requires bending somewhat more. When the point is fairly within the orifice of the tube it cannot be rotated by gentle force any farther in the same direction, and it will be found to be directed towards the outer angle of the orbit on the same side.

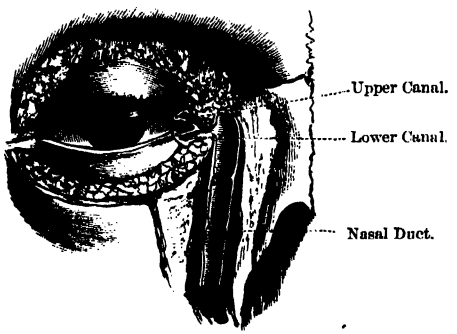
CATHETERISATION OF NASAL DUCT FROM ABOVE.

The operation for opening the lacrymal duct through the cheek having been justly abandoned, as both unsightly

and unsurgical, we shall proceed to describe Mr. Bowman's practice of slitting up the lacrymal puncta, and dilating the duct from above downwards.

We would first direct attention to the accompanying woodcut, which will give a better idea of the anatomy of

Fig. 8.



the lacrymal passages than the most elaborate description, and will, we trust, assist the operator in the performance of the following operation.

This proceeding consists in the slitting up of the punctum and in the passage of a probe through the lacrymal canal into the nasal duct, and so on to the inferior meatus of the nose. The instruments required are furnished by instrument-makers all together in a small case. They are, a small grooved probe-pointed director for opening the punctum upon, and three probes of a different size at either end, running from No. 1, the smallest, to No. 6, the largest.

The directions we are about to give for performing the operation are taken from Mr. Bowman's paper on 'Lacrymal Obstructions,' in the Ophthalmic Hospital Reports for October, 1857.

The head of the subject being raised, the surgeon stands behind and bends over. For dividing the left lower punctum, the ring-finger of the left hand is placed on the skin on the lower edge of the orbit, and fixes it there, while tightening or relaxing the lower canal by a sliding movement of the skin upon the bone—the punctum being at the same time everted. The right hand now inserts the probe-pointed director while the canal is relaxed, and then places the director between the index-finger and thumb of the left hand, which holds it in the canal and further everts the punctum, by turning the probe downwards on the cheek, while the ring-finger stretches and fixes the canal by a sliding movement of the skin outwards towards the malar bone. A fine sharp-pointed knife, held in the right hand,[1] now slits up the canal on the everted conjunctival aspect, from the punctum as far as the caruncle, and the probe is raised on its point out of the canal to make sure that the edge of the punctum has not escaped division.

In passing the probe through the canal, the instrument should be handled very delicately, and the canal held by the surgeon in the same way as when the puncta have to be slit, and he should, of course, have in his mind's eye at the moment the anatomy of the parts with which he is dealing. No *force* should be used.

If No. 6 will not pass, No. 4 or No. 2 may be tried. The canal should be stretched lengthwise as the probe reaches it, as its passage is thereby facilitated, for it is easy to fold the canal before the point of the probe. The greatest care should be taken to proceed gently and not

[1] See fig. 4, p. 5, for the manner of holding the knife.

too rapidly, as a false passage may easily be made, or the walls of the canal torn. If the probe is arrested at the point where the canals coalesce and join the sac, the fact may be known by noticing that the skin near the tendo oculi is moved when the probe is moved, and an elastic resistance is experienced; whereas, if the probe has entered the sac, it hits against the inner bony wall, and the skin is motionless.

When the probe is introduced in this method from the canal, it enters the sac *behind* the tendo oculi, and is in a better position for *finding*, as it were, the orifice of the nasal duct. But to make this more easy the larger probes (Nos. 5 and 6, which are only used for this purpose) are slightly curved at each end in two different directions, while the central part (that held by the finger and thumb) is straight, and they are cylindrical in their whole length.

The effect of this is that when the probe is inserted into the sac, and brought into a vertical position, a slight rotation of it on its long axis makes the lower point, which is in search of the orifice of the duct, describe a small circle; and by slightly varying the inclination of the probe, and making gentle pressure at the same time with slight rotation, the point never fails to enter the duct. The point is known to have reached the nostril by the depth it has entered, compared with the external position of the nostril, and by its coming in contact with the floor of the nose.

OPERATION FOR STRABISMUS.

Division of the internal rectus muscle of the eye.—We have selected this muscle for the description of the operation for strabismus, as its division represents the proceeding usually required in that affection.

Instruments required.—A spring-wire speculum, a pair of small blunt-pointed scissors, two pair of forceps, the one for holding the eye, the other being ordinary dissecting forceps, and a blunt hook, comprise the list of instruments necessary for the operation.

Position of Operator and Assistant.—The operator should stand facing the subject, and the assistant behind the head, facing the operator.

Operation.—Having introduced the wire speculum between the lids, the assistant should, with the broad-pointed forceps, grasp a fold of the conjunctiva on the outer aspect of the eye and rotate the ball outwards so as to expose the inner part of the white of the eye. Let the operator now pinch up with the forceps the conjunctiva, about one-third of an inch to the inner side of the cornea, and below the situation of the tendon of the inner rectus muscle; this fold of conjunctiva should be divided to the extent of about a quarter of an inch, in a direction radiating from the circumference of the cornea, and parallel with the lower border of the rectus. Having cut through the subconjunctival tissue in the same direction, pass the blunt hook into the wound, gliding its extremity on the eyeball, downwards, backwards, and lastly upwards, so as to pass beneath the lower border of the tendon of the rectus. Lift the tendon up-

wards, away from the ball of the eye, and pass the scissors down the hook into the wound, and divide the tendon beneath the conjunctiva by a series of snips, cutting from below upwards. The hook may be again inserted, and any remaining fibres caught up and divided in a similar manner.

The difficulty in this operation is to pass the point of the hook beneath the lower border of the muscle; this may be obviated by passing the hook some distance backwards before attempting to catch the tendon.

The foregoing proceeding may be applied to any of the recti muscles of the eye; the incision in the conjunctiva being made in each case in a direction radiating from the circumference of the cornea.

REMOVAL OF THE EYEBALL.

As this operation is now no longer confined to the speciality of ophthalmic practice, but has become one of general operative surgery, and since it can be advantageously practised on the dead body, we shall describe the method of its performance, adopting Mr. Dixon's modification of the operation. A curved pair of scissors, a blunt hook, forceps, and a spring-wire speculum, are necessary for its performance. Having inserted the spring speculum between the lids, make a circular division of the conjunctiva with the scissors, about a quarter of an inch behind the cornea. Raise the external rectus muscle, and cut it across; an assistant should seize the divided tendon and draw the eye inwards,[1] 'sliding one blade of the scissors beneath the superior rectus and oblique muscles,

[1] Dixon, *Diseases of the Eye*, 2nd ed., p. 393.

they are divided, and then the inferior rectus; the optic nerve is next snipped through, and the globe starts forwards. Two or three strokes of the scissors divide the internal rectus, vessels and bands of areolar tissue, and the operation is complete.'

PARACENTESIS THORACIS.

Various sites have been recommended as the most suitable for tapping the chest, and many different methods of procedure have been adopted. The usual situation for this operation is at a spot in the sixth or seventh intercostal space midway between the spine and the sternum. The only instrument required on the dead subject is a trochar and canula, but when operating on the living Dieulafoy's aspirator will be found applicable in the majority of cases. The operation is exceedingly simple, and merely consists, on the dead subject, in thrusting the trochar and canula into the pleural cavity through the intercostal space at the spot previously selected. When operating on the living, care should be taken to keep the instrument as near the lower part of the space as possible, so as to avoid injuring the intercostal artery, which runs in a groove on the lower border of the rib above. The trochar should be held with the thumb placed about an inch from its point, so as to prevent it going too far into the chest, and possibly wounding the lung. When the trochar and canula have entered the pleural cavity, the trochar should be withdrawn and the canula pushed farther into the chest. On the living it is sometimes desirable to gently draw up the skin, covering the intercostal space with the

left hand before puncturing, so that a valvular aperture may be left when the canula is withdrawn.

Some surgeons make a small incision parallel to the rib through the skin with a scalpel before thrusting in the trochar. We do not consider this at all necessary.

If Dieulafoy's aspirator is used, the needle may be thrust into the chest in a similar manner.

PARACENTESIS ABDOMINIS.

This simply consists in thrusting a trochar and canula through the linea alba into the peritoneal cavity at a spot midway between the umbilicus and pubes.

On the living subject the surgeon should previously to operating make sure that the bladder is not distended.

As in puncturing the chest, some surgeons make a preliminary incision through the skin before using the trochar.

CHAPTER III.

TENOTOMY.

Tenotomy—General Remarks—Instruments required—Mode of Operating—Duties of Assistant—Division of the Tibialis Posticus, Tibialis Anticus, Tendo Achillis, Hamstring Tendons, Sterno Mastoid, Abductor Pollicis, Plantar Fascia.

TENOTOMY is an operation which in all practicable cases must be performed subcutaneously; it is with this object that a series of knives have been invented, allowing of the division of tendons with but little exposure of the wound to the external air.

Instruments required.—The only instruments required for the performance of the following operations, are a sharp-pointed and a blunt-pointed tenotomy knife. The former is used for perforating the skin over tendons, and for dividing tendons themselves where there is no important parts within reach of injury. This knife is held as a pen;[1] it should penetrate the skin on the flat, that is with the flat of the blade parallel to the line of the tendon. When in contact with the tendon, its edge should be turned at right angles to it, and in this position the tendon should be divided. The blunt-pointed knife is for dividing tendons, such as those of the tibial muscles, where there are important parts in the neighbourhood

[1] Page 4, fig. 1.

which are exposed to injury; it is held and used in the same manner as the sharp-pointed knife.

Mode of Operating.—In dividing a tendon, the end of the thumb should be placed over it while the knife is beneath it. In this manner the operator can ascertain when the division of the tendon is nearly completed, and can thus exercise greater care to guard the skin from injury as the knife approaches the surface. The completion of the section can be ascertained by the sudden relaxation of the parts, by the creaking of the tendinous fibres under the knife, and often by the obvious gap remaining in the course of the tendon from the retraction of its end.

Duties of the Assistant.—The duties of an assistant in this operation are, firstly, to put the tendon on the stretch, to enable the operator to ascertain its exact position; secondly, to relax it, allowing of the insertion and adjustment of the knife; thirdly, to tighten the tendon while the operator divides it.

The following operations should be undertaken while the body is yet fresh, either before or immediately after the operations on the arteries.

Position of the Subject.—For the division of the tibialis posticus, tibialis anticus, and tendo Achillis, the body may lie on its back; during the division of the hamstrings, on its face.

DIVISION OF THE TIBIALIS POSTICUS.

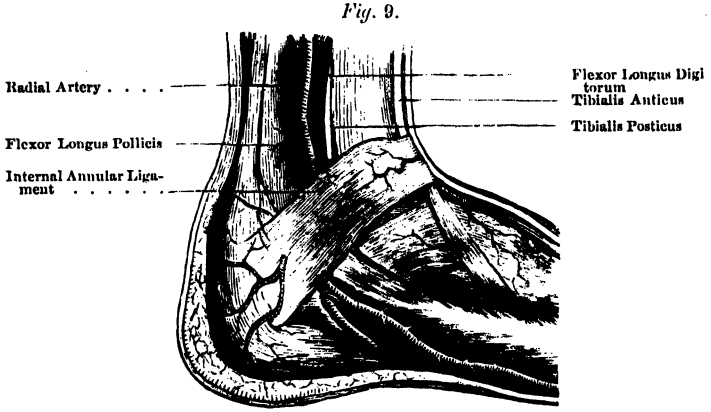
Anatomy.—The tendon of this muscle is found behind the inner ankle, in a groove on the tibia, and nearer to the inner malleolus than the other tendons; it is separated

from the posterior tibial artery and nerve, which lie behind it, or nearer to the os calcis, by the flexor longus digitorum.

Whilst passing round the inner ankle, this tendon runs through a distinct sheath in the internal annular ligament.

The following woodcut illustrates its relational anatomy in this part of its course :—

Fig. 9.



Parts about the Inner Ankle.

Places eligible for dividing the tendon.—This tendon may be divided in one or two situations, viz. :—

1. Above the annular ligament.
2. Below the annular ligament.

Where it passes under the ligament its division would be attended with considerable difficulty, as it is here, as before stated, contained in a separate sheath of dense ligamentous tissue.

The operation above the ligament is generally preferred; a spot about an inch and a half above the internal malleolus being usually selected, immediately

behind which point of bone the tendon is found; but as some prefer the lower operation we shall describe both methods.

1. ABOVE THE INTERNAL ANNULAR LIGAMENT.

Position of Operator.—The body lying on its back, the operator should stand on the opposite side of the leg to that of the tendon, with his back turned towards the body when operating on the right, but facing it when operating on the left foot.

Position and duties of Assistant.—The assistant should stand opposite the operator, grasping the foot with one hand, and the leg a little above the ankle with the other. The leg being rotated outwards, he should first flex and firmly abduct the foot to put the tendon on the stretch, so that the operator may more easily determine its situation. He should next slightly extend and adduct the foot, relaxing the tendon, whilst the operator inserts the knife. At a signal from the operator he should again make the tendon tense to facilitate its division, relaxing the pressure somewhat as he feels the fibres give, so that the division may not be too suddenly accomplished and the skin over it be possibly divided.

Operation.—The operator should first endeavour to make out the position of the tendon by directing the assistant to put it on the stretch. In very fat children it is often quite impossible to feel this tendon, or even the posterior border of the tibia. Under these circumstances a spot midway between the anterior and posterior borders of the leg, the limb being laid on its outer side, will sufficiently accurately indicate its position. Having de-

termined the situation of the tendon, the operator should place his left thumb upon the spot at which he intends dividing it; and retain it there during the rest of the operation. He should next take the sharp tenotomy knife, and holding it perpendicularly to the surface of the limb with the blade parallel to the tibia and the edge directed towards himself, introduce its point between the tendon and the bone, and push it on a short distance into the sheath.

The handle should now be depressed to ensure the division of the sheath; the sharp knife withdrawn, and the blunt introduced in its place and pushed under the tendon. The edge should be next turned towards the tendon, which may now be divided by cutting outwards towards the surface.

2. BELOW THE INTERNAL ANNULAR LIGAMENT.

The position of the foot, operator, and assistant should be the same as in the first method. Having made out the position of the tendon, the operator should pinch up the skin over the antragalo-scaphoid joint and introduce the sharp knife between the skin and the tendon, which should be now divided by cutting downwards on to the tubercle of the scaphoid.

The assistant should manipulate the foot as in the former method.

DIVISION OF THE TENDON OF THE TIBIALIS ANTICUS.

This may be divided in one of two places.

1st. In front of the ankle joint.

2nd. At its insertion into the internal cuneiform bone.

1. IN FRONT OF THE ANKLE JOINT.

Anatomy.—The spot which is usually selected for division of this tendon for club foot is just in front of the ankle joint, where the tendon is most prominent. Here it lies on the tibia, in the innermost of the sheaths in front of the ankle, having the anterior tibial artery to its outer side, but separated from it by the extensor proprius pollicis.

Position of the Operator.—The operator should stand in the same position as for the division of the tibialis posticus.

Position of the Assistant.—The assistant should be stationed opposite the operator, grasping the foot with one hand, and the leg just above the ankle with the other hand. He should first make the tendon tense by abducting and extending the foot, so that the operator may determine its position; he should then relax it while the knife is being introduced, and again make it tense during its division.

Operation.—Having made out the position of the tendon the operator should place his thumb upon the spot at which he intends dividing it, and keeping it there introduce the knife, held on the flat, to the outer side of tendon, *i.e.* between it and the extensor proprius pollicis. Having passed it thus on the flat beneath the tendon, let him turn its edge towards the tendon and divide it, while the assistant puts the parts on the stretch. The usual precautions must be adopted for guarding the integuments from injury.

2. AT ITS INSERTION.

Having made out the insertion of the tendon into the internal cuneiform bone, the operator should introduce the sharp-pointed tenotomy knife between the skin and the tendon, and should divide the latter by cutting downwards on to the bone.

DIVISION OF THE TENDO ACHILLIS.

This tendon may be divided at its narrowest part, above its insertion into the os calcis, where it is readily felt under the skin.

Position of Operator.—The operator should stand on the outside of the left, and on the inside of the right foot.

Position and Duties of Assistant.—The assistant should stand facing the operator on the other side of the foot, and should alternately relax and make tense the tendon.

Operation.—When operating on the right side the foot should be rotated outwards, and the tenotomy knife introduced with the blade parallel to and beneath the tendon, a little on its inner side, and the tendon divided as already described.

It is customary with some operators to introduce the scalpel on the dorsal surface of the tendon, and this is best effected by pinching up the skin on the back of the heel, while the parts are relaxed, and subsequently cutting from the superficial towards the deeper aspect of the limb.

SECTION OF THE HAM-STRING TENDONS.

Position of Subject.—The body should lie on its face.

1*st. Division of Biceps.*—The *biceps* may be divided

where it lies in the outer fold of the popliteal space, external to and overlapping the peroneal nerve.

Position of Operator.—The operator should stand on the same side of the limb as the tendon which he is about to divide, with his back turned towards the subject in operating on the right leg, but the reverse when operating on the left leg.

Position and Duties of Assistant.—The assistant should face the operator. His duties are the same as in the former operations.

Operation.—Placing the thumb of the left hand on the prominence of the outer hamstring, an incision should be made immediately over and down to the tendon; through this the blunt-pointed knife should be introduced on the flat, so as to glide along the inner side of the tendon, between it and the peroneal nerve. The edge of the knife being turned towards the tendon, and the leg extended, the operation may be completed in the usual way.

2nd.—Division of the Semimembranosus and Semitendinosus.—The semimembranosus and semitendinosus can be divided in the popliteal space exactly opposite to the spot selected for section of the biceps, *i.e.* opposite the condyles of the femur. These tendons, lying in the inner fold of the space, are not in close relation with any important part; of the two, the semitendinosus is to the outer side, and communicates a more cord-like sensation to the touch.

Position of Operator.—The operator should stand on the same side of the limb as the tendons which he is about to divide, and should face the subject in dividing those of the right limb.

Operation.—In operating on either tendon an incision should be made immediately on its outer[1] side, and the blunt-pointed knife being introduced, the operation may be completed as in the section of other tendons.

DIVISION OF THE STERNO MASTOID.

Anatomy.—This operation is undertaken for the cure of certain cases of wry neck, and is generally put in practice on the lower third of the muscle, which at this part is covered by the skin, platysma, cervical fasciæ, and its own sheath; it is crossed obliquely from within outwards and above downwards by the external jugular vein, though generally at a point higher in the neck than that selected for its division.

The operation may be performed in two ways.

1*st Method.—Instruments required:*—

1. A deeply-grooved director.
2. A narrow probe-pointed grooved bistoury.
3. A small scalpel.

Position of Operator.—The operator should stand, in dividing the muscle of the right side, facing the subject and on the same side of the body as that of the muscle on which he is about to operate.

Position and Duties of the Assistant.—The assistant should hold the head in such a position as will render the muscle tense.

Operation.—Let an incision be made with the scalpel on the anterior border of the sterno mastoid in its lower third, and extending down to the muscular fibres: this wound should be sufficiently large to admit the point of

[1] 'Outer' as regards the median line of the body.

the grooved director. Pass the director into the wound, and turning it round the border of the muscle, push it with a semi-rotatory movement from within outwards under its deeper surface, until the point can be felt in the neck, beyond the outer border of the muscle. The director may now be entrusted to the assistant, and a bistoury be carefully pushed along the groove to its extremity. Divide the muscle from its outer to its inner border, and from its deeper to its more superficial surface; keeping the fingers of the left hand over the skin of the part, to ascertain when the muscle is completely divided, and to guard against the possibility of the bistoury cutting its way through the integuments.

2nd Method.—The more usual method of dividing the mastoid is practised in the following manner: a sharp and a blunt-pointed tenotomy knife being procured, an incision is made down to the anterior border of the muscle; through this the blunt-pointed knife is introduced on the flat, and carefully passed behind the muscle; its edge being turned towards the muscular fibres, they are divided in the same manner and with the same precautions as were recommended in the preceding operation. Great care must be exercised in passing the knife or director, as the case may be, to keep it close to the posterior surface of the muscle, and not allow it to include any of the deeper structures.

Division of the Abductor Pollicis and Plantar Fascia.—The division of the abductor pollicis and plantar fascia is easily accomplished by introducing the knife beneath their narrowest parts, and completing the operation as in the section of other tendons.

CHAPTER IV.

LIGATURE OF ARTERIES IN THEIR CONTINUITY.

General Rules for the Ligature of Arteries in their Continuity—Instruments required—Ligature of Arteries of Upper Extremity: Radial, Ulna, Brachial, Axillary—Ligature of Vessels of Head and Neck: Subclavian, Innominate, Common Carotid, External Carotid, Internal Carotid, Lingual, Facial, Temporal—Ligature of Arteries of Abdomen: Common Iliac, Internal Iliac, External Iliac—Ligature of Arteries of Lower Extremity: Femoral, Anterior Tibial, Posterior Tibial, Peroneal, Popliteal.

GENERAL RULES FOR LIGATURE OF ARTERIES IN THEIR CONTINUITY.

To expose the large vessels of the body with certainty, it is necessary not only to know their relational anatomy as regards the parts with which they are in immediate contact; but accurately to ascertain their position, and the direction of their course with respect to the external conformation and outline of the parts of the body in which they are found. With this object it is usual to take as guides and landmarks to the position of subjacent vessels, either the outline of some muscle, or imaginary lines drawn from one point to another. In all cases where the external conformation of the limb admits of it, we have chosen prominent points of bone as landmarks, as these are more constant in their relative positions, and more easily discovered than the outlines of muscles, which latter are too liable to be obscured by fat, or rendered indistinct from other causes.

It is also as well to be acquainted with the common abnormalities that may be encountered during the operation to prevent embarrassment should the parts not present their normal arrangement.

The part of the artery selected for the application of the ligature should be one free from bifurcation and large collateral branches.

Instruments required.—The subject being placed on its back on a narrow table, the operator will require a scalpel, a pair of dissecting forceps, a grooved steel director, retractors or blunt hooks, and an aneurism needle. The scalpel should be from two to three inches in length in the blade. The groove in the director should run quite to its extremity, and leave no *cul de sac* in which the point of the knife can catch.

As there are certain general rules which must be followed in attempting the ligature of all arteries, we propose to notice them here, to avoid subsequent repetition. The *knife* should be used only for cutting and not for scraping or scratching at the sheath of a vessel; it had best be laid aside so soon as the sheath of the artery has been fairly opened. When the direction and length of incision have been determined, the integuments should be slightly stretched by the middle finger and thumb of the left hand, placed on either side of the line of incision. The *scalpel* should be held as a pen in writing (fig. 1, page 4), and on its first contact with the skin should be held at the same inclination to the surface as a pen; as the integuments are divided, its position should gradually become vertical, so that on the completion of the incision it may be perpendicular to the surface. When

practicable the first incision is always made immediately over and parallel to the course of the vessel to be tied; it should not divide more than the integuments. Each successive cut ought to be of precisely the same extent as the preceding.

The use of the *forceps* is obvious, but it may be well to remark that they are not to be applied directly to the artery itself, or to any large nerve or vessel that may be exposed during the operation.

The *steel director* is used for dividing fasciæ upon, for separating muscular interspaces, and for detaching the artery from its sheath; it is of great service in all those cases in which a silver knife was formerly used by many operators. In exposing a vessel, as a general rule, intervening fasciæ are divided on the director,[1] which is inserted through a small hole, made by pinching up the parts with the forceps, and cutting with the blade of the knife on the flat. Muscular interspaces, if large, are most conveniently separated with the fore-fingers, contiguous tendons with the point of the director. It is important to avoid opening the fasciæ of muscles and the sheaths of tendons, since, in the living, wounds of either may be followed by diffuse suppuration and its consequences.

To free the vessel from its sheath, a small hole must be made in the latter, as in opening a fascia. The margins of this aperture being alternately seized with the forceps, the point of the director should be insinuated between them and the coats of the vessel—by a gentle to-and-fro movement of the point. This separation ought to include

[1] Fig. 4, p. 5.

the whole circumference of the artery, but as little as possible of its length, so as to avoid injuring to any great extent the small vessels (*vasa vasorum*) which nourish the external coats of the vessel; and for the same reason the artery should never be raised from its bed.

An aneurism needle, with a very large curve, will be found most convenient on the dead body; besides its obvious purpose, it may, in its passage round the vessel, separate any remaining adhesion between this and its sheath. In passing the needle, the point is generally inserted between the vessel and any neighbouring structure there may be a risk of including in the ligature.

The operator, seizing one side of the already separated sheath with the forceps held in his left hand, should pass the point of the needle, unthreaded, between it and the artery, and by a gentle to-and-fro movement endeavour to carry the point round the vessel, without including any of the contiguous structures, till the eye projects slightly on the opposite side.

Should any of the loose cellular tissue of the sheath be carried before the point of the needle, this may now be scratched through with the finger-nail, or divided with the scalpel, cutting on the needle with the blade directed away from the artery.

The eye being thus freed, and the operator having ascertained that the vessel is the only structure embraced by the needle, may now thread one end of the ligature through the eye and withdraw the needle, carrying the loop of ligature along with it beneath the artery. Having unthreaded the needle, and left the ligature in position, a single knot should first be formed, and the ends of the

silk be grasped by the thumbs and forefingers passed down as near to the vessel as possible; the knot may now be drawn tight, and secured by a second, tied over it. It is essential to pass the fingers down to the vessel before tightening the ligature, in order to avoid disturbing its connections, and also the more accurately to appreciate the amount of force applied.

On the living subject, the vessel should be compressed between the finger and the ligature before tying the knot, to ascertain if the circulation is controlled and that the ligature has been placed on the right vessel.

The retractors and blunt hooks are for holding aside the edges of the incision, and for guarding other important structures which may be exposed from injury.

We shall describe the operations for ligature of the various arteries in the order in which they should be practised on the dead subject, and shall omit those which rarely, if ever, come under our notice on the living body.

LIGATURE OF ARTERIES OF UPPER EXTREMITY.

We strongly advise the student to begin by ligaturing the vessels of the upper extremity, as he will, by so doing, meet with fewer difficulties and gain much experience before attempting the more difficult operations on the lower extremities and head and neck.

The vessels which may here require ligature are the radial, the ulnar, the brachial, and the axillary.

We shall begin with the radial, that being the easiest vessel to secure.

THE RADIAL ARTERY.

I. *Course and Relations.*—The radial artery commences at the bifurcation of the brachial into the radial and ulna opposite the middle of the bend of the elbow, and after coursing down the fore-arm to the styloid process of the radius, curls over the back of wrist, enters the palm between the first and second metacarpal bones, and terminates by inosculating with the ulnar to form the deep palmar arch.

It is divided anatomically into three parts, viz. :—

1. In front of fore-arm.
2. On back of wrist.
3. In palm of hand.

Surgically, we have to consider the 1st and 2nd parts only; the third being situated deep in the palm and inaccessible to ligature.

1. RADIAL ARTERY IN FORE-ARM.

Course and Relations.—The course of this vessel will be sufficiently accurately indicated by a line drawn from midway between the condyles of the humerus to a point half an inch internal to the styloid process of the radius at the wrist. In the upper third of its course, it lies between and is somewhat overlapped by the supinator longus on the outer side, and the pronator teres on the inner side; but lower down in the fore-arm it is found more superficially, between the tendons of the flexor carpis radialis on the inner, and the supinator longus on the outer side. In the whole of its course under consideration, the vessel is found in the outermost inter-

muscular space of the front of the fore-arm, and is covered by nothing but the integuments and deep fascia, or rather it is only necessary to divide these to expose the artery, except in its upper third, where, in addition, the contiguous muscles must be separated from each other.

It lies upon, from above, downwards—

1. The tendon of biceps.
2. The supinator radii brevis.
3. The pronator teres.
4. The radial origin of flexor sublimis digitorum.
5. The flexor longus pollicis.
6. The pronator quadratus and
7. The radius.

It is accompanied by two venæ comites, and has the radial nerve to its radial side in its middle third only.

Position of Operator and Arm.—The arm should be extended in the supine position and drawn away from the chest, the operator standing facing the subject on the outside of the right arm and on the inner side of the left, as one or the other arm may be the site of operation.

Operations.—A ligature may be applied to this vessel in any part of its course: we propose to tie it in its lower and upper thirds, so as not to injure the fore-arm for amputation in the middle third.

Upper Third.—To tie the artery in its upper third, make an incision three inches long in the course of the vessel, commencing two inches below the bend of the elbow and running towards the wrist, search for the most external white line in the deep fascia; this marks the intermuscular space in which lies the artery; it may be known by the direction of the fibres of the contiguous muscles, those on

the outer side belonging to the supinator longus running straight downwards, whilst those on the inner side, forming part of the pronator teres, run downwards and inwards.[1]

Having opened the fascia at this spot, use the finger or the director to separate the muscles, clear the artery from its connections to as small an extent as possible, and apply the ligature from without inwards, to avoid the possibility of including the radial nerve.

Should the venæ comites be included in the ligature no harm will come. Rules having been already given for opening the sheath and passing the needle, &c., they will not be again repeated under the special directions for tying each vessel.

Lower Third.—An incision should be made in the direction of the line above indicated,[2] commencing three inches above the wrist, and extending downwards for two inches. This should fall between the tendons of the flexor carpi radialis and the supinator longus; immediately beneath the integuments the superficial radial vein is usually found.

Pushing this aside, divide the deep fascia on the director, and the artery will come into view, surrounded by its venæ comites and an imperfect sheath, both of which must be separated with the point of the director, and the ligature passed.

The vessel here rests on the pronator quadratus.

[1] Should the student have made a mistake and found a wrong muscular interspace—say that, for example, between the pronator and flexor carpi radialis, he will easily perceive his error by noticing that the fibres on both sides run downwards and slightly inwards.

[2] Viz., from middle of the bend of the elbow to a point half an inch internal to the styloid process of the radius.

Abnormalities.—Should the vessel not be found in its usual place it will probably be found in one of the following situations:

1. Superficial to the deep fascia.
2. On the supinator longus muscle instead of to its inner side.
3. Above the extensors of the thumb instead of beneath them.

Collateral Circulation.—The collateral circulation between the ulnar and radial is so free that in practice one vessel is never tied without the other being secured at the same time, except in the case of a wound of either vessel, when both ends are secured in the wound.

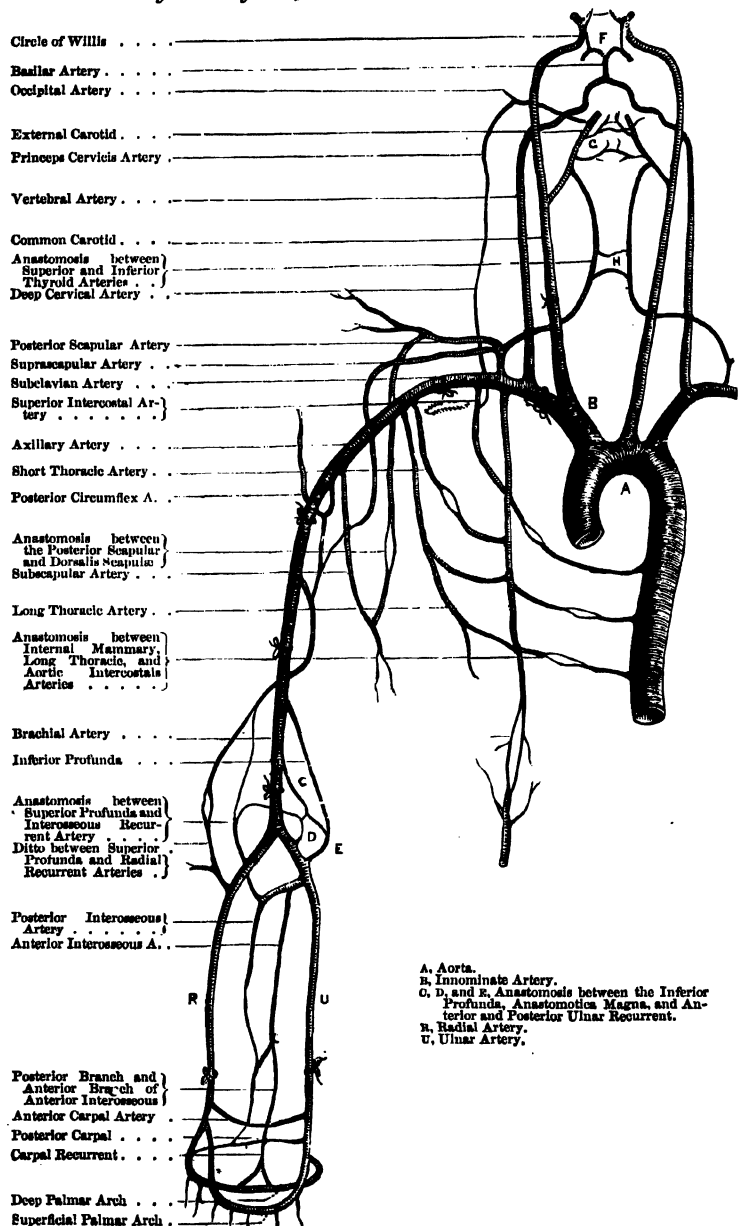
2. RADIAL ARTERY AT WRIST.

Course and Relations.—The course of the radial at the wrist may be roughly indicated by a line drawn over the extensors of the thumb from a point on the front of the fore-arm half-an-inch internal to the styloid process of the radius to the posterior part of the first interosseous space, which can be easily felt on the back of the hand.

It here winds over the external lateral ligament, the trapezium, and dorsal ligaments of carpus, and disappears between the two heads of the first dorsal interosseous muscle.

The vessel is here covered by the skin and fasciæ and some subcutaneous veins and nerves, branches of the radial. It is crossed by the extensors of the thumb, viz.:—the extensor ossis metacarpi pollicis, the extensor primi internodii pollicis, and just before it sinks into the palm by the extensor secundi internodii pollicis, and is contained

Fig. 10. Diagram of the Collateral Circulation of the Arm.



A, Aorta.
B, Innominate Artery.
C, D, and E, Anastomosis between the Inferior Profunda, Anastomotica Magna, and Anterior and Posterior Ulnar Recurrent.
R, Radial Artery.
U, Ulnar Artery.

in a triangle bounded by the extensor secundi, the extensor primi, and the end of the radius.

Operation.—Make an incision through the skin about an inch in length over the course of the vessel from the styloid process of the radius parallel to the tendon of the extensor ossis metacarpi pollicis. Next carefully divide the deep fascia, and the vessel will be exposed and may be secured in the usual way.

This operation can seldom be required except for wounds of the artery in this situation, when the proper treatment would be to tie both ends at the bleeding spot.

ULNAR ARTERY.

The ulnar artery commences at the bifurcation of the brachial a little below the bend of the elbow, and, after running obliquely down the front of fore-arm, crosses the annular ligament and terminates in the superficial palmar arch by anastomosing generally with the superficialis volæ.

Anatomically, it is divided into three parts :—

1. In the fore-arm.
2. At the wrist.
3. In the palm.

Surgically, we have only to deal with the first part.

ULNAR ARTERY IN FORE-ARM.

Course and Relations.—The ulnar artery, in the part of its course with which we are concerned, extends with a slight curve from the middle of the bend of the elbow to the radial side of the pisiform bone. In the upper part of its course it runs obliquely ; being deeply seated and covered by all the superficial flexor muscles excepting

the flexor carpi ulnaris, namely the pronator teres, the flexor carpi radialis, the palmaris longus, and flexor sublimis digitorum.

It rests upon the brachialis anticus and the flexor profundus digitorum, and, close to its origin, is crossed by the median nerve, which previously lies to its inner side for about one inch.

In the lower part of its course it rests on the flexor profundus, and has the flexor carpi ulnaris on its inner side and the innermost tendon of the flexor sublimis digitorum on the radial side.

The artery is accompanied by two venæ comites and has the ulnar nerve to its ulnar side in the lower two-thirds of its course.

It is covered here by skin, superficial and deep fasciæ, and is often slightly overlapped by the tendon of the flexor carpi ulnaris and the superficial ulnar vein.

Operations.—Practically, this artery can only be tied in the lower two-thirds of its course; to expose it between the flexor sublimis and flexor profundus digitorum, in the upper part of the fore-arm, would necessitate a most unwarrantable division of soft parts. It must be approached through the innermost intermuscular space of the front of the fore-arm, that is between the flexor carpi ulnaris and flexor sublimis digitorum.

Position of Operator and Arm.—The same as for ligature of the radial.

Lower Third.—To expose the artery in its *lower third*, an incision should be made in the line of the course of

the vessel,[1] commencing three inches above the wrist, immediately to the radial side of the tendon of the flexor carpi ulnaris, and extending downwards parallel to that tendon for rather more than two inches; care should be taken to avoid injuring the superficial ulnar vein. By dividing the muscular fascia, the border of the tendon of the flexor carpi ulnaris will come into view, beneath which the artery lies. The vessel being cleared, and the veins separated from it, the aneurism needle should be passed from its ulnar to its radial side, to avoid the chance of including the ulnar nerve in the ligature. The operation is much facilitated by bending the wrist directly the above-mentioned tendon comes into view, as this permits the tendon to be drawn inwards without difficulty.

Middle Third.—Here the artery lies more deeply, and is approached by making an incision two or three inches long, to the radial side of the inner margin of the forearm, in the direction of the vessel: beneath this spot the white line which marks the separation between the flexor carpi ulnaris and flexor sublimis must be sought, and here the muscular fascia must be divided. After separating these muscles, the ulnar nerve will probably first come into view; and to its radial side, overlapped by the flexor sublimis, will be found the artery.

This white line may be conveniently found by making the incision in the direction of a line drawn from the front of the inner condyle to the radial side of the pisiform bone.

The student should take care not to mistake the

[1] A line drawn from the front of the inner condyle to the radial side of the pisiform bone.

interspace between the flexor sublimis and palmaris longus for that between the sublimis and flexor carpi ulnaris—this he will best do by keeping his incision well to the inner side of the fore-arm.

After separating to some extent the flexor carpi ulnaris from the flexor sublimis digitorum the student is liable, should he have begun his incision too high in the arm, to fall into the mistake of making his way too far round the inner side of the fore-arm, between the flexor carpi ulnaris and the flexor profundus digitorum, instead of hitting off the proper division between the latter muscle and the flexor sublimis. Under this difficulty the best guide is the presence of some small arterial twigs emerging from between the flexor profundus and flexor sublimis. If these are carefully followed the vessel can be easily found.

Abnormalities.—The chief abnormalities in the position of the vessel are:—

1. It may lie beneath the fascia but above the flexor muscles.

2. It may be superficial to the fascia.

3. It may run above the fascia in the upper part of the fore-arm, but beneath it in the lower part.

Collateral Circulation (see diagram 10).—The same remarks apply to the ulnar artery as to the radial, as to the propriety of securing them separately. When both vessels are tied above the wrist the collateral circulation is carried on by the interosseous arteries anastomosing with the anterior and posterior carpal branches, and by the anterior interosseous with the recurrent branches from the deep carpal arch.

THE BRACHIAL ARTERY.

Course and Relations.—The brachial artery, extending from the lower border of the tendon of the teres major to the bend of the elbow, is covered, except at the last-mentioned place, only by the integuments and deep fascia; at the elbow it has in addition a covering from the tendon of the biceps, generally termed the semi-lunar fascia. A line drawn from the outer side of the axillary space from between the folds of the axilla to the middle of the bend of the elbow would indicate its course; or the inner border of the biceps muscle sufficiently nearly represents it.

In the upper part of its course the artery lies to the inner side of the humerus, resting on the triceps (from which it is separated by the musculo-spiral nerve and superior profunda artery). It then rests on the insertion of the coraco-brachialis, and in the lower part in front of the humerus, on the brachialis anticus. The vessel is accompanied by two venæ comites, and is crossed obliquely by the median nerve where it lies on the coraco-brachialis, the nerve being first on its outer and then on its inner side. These are all contained in the same sheath of fascia. It is worthy of remark that the basilic vein lies over the vessel in the whole of its course; it may be found either in the subcutaneous tissue, or beneath the deep fascia.

Operations.—We propose to tie this artery at the bend of the elbow, and at two points in the upper arm.

Position of Arm.—The arm should be extended from the side and rotated outwards.

Position of Surgeon.—The surgeon should stand whilst tying the artery between the arm and the thorax.

Bend of the Elbow.—Here the artery is very near the surface, being covered by the skin, superficial fascia, and deep fascia, which is blended with the semilunar fascia of the biceps; the vessel lies between the tendon of the latter muscle and the median nerve. To expose it, make an oblique incision, beginning two inches above the bend of the elbow, parallel to the inner border of the biceps, and corresponding to the line of the artery; push aside the median basilic vein, and divide the fascia of the biceps on the director; the artery will be found immediately beneath. In this operation, care is required both in dividing the integuments and the semilunar fascia; for beneath the former is the basilic vein, while the latter covers the brachial artery. The aneurism needle should be passed from within outwards.

Middle Third.—The brachial artery is reached in its middle third by an incision from two to three inches in extent, along the inner border of the biceps muscle. The skin, superficial, and deep fascia will have to be divided, and the basilic vein carefully avoided. The vessel will be found with the ulnar nerve to its inner side, the median nerve either bearing the same relation to it, or lying in front of it. The sheath of the biceps should not be opened in this operation; it is a gratuitous injury, and adds to the difficulty of exposing the vessel, and to the danger when operating on the living.

The upper third of the brachial trunk may be ligatured by making a cut three inches long, beginning beneath the anterior fold of the axilla, and running down the inner

margin of the coraco-brachialis and biceps. The subsequent steps of the operation are precisely the same as those described in the preceding paragraph.

Abnormalities.—The following are the chief peculiarities in the position of this artery. It may be found—

1. In front of the median nerve.
2. Winding round an extra-developed supra-condyloid process, as pointed out by Professor Struthers of Aberdeen.
3. Dividing high up the arm—into radial and ulnar.
4. Covered by various muscular slips.
5. Breaking up into vasa aberrantia.

Collateral Circulation (see diagram 10).—After ligature of the brachial the collateral circulation is carried on as follows:—

1. When the ligature is applied above the superior profunda principally by small vessels running between the subscapular and circumflex above, and the superior profunda below.
2. When between the profundæ. By the superior profunda anastomosing with the radial recurrent—the interosseous recurrent and the anastomotica magna.
3. When below the inferior profunda. By the anastomosis between the superior and inferior profundæ on the one hand with the recurrent branches from the radial, ulnar and interosseous arteries and anastomotica magna artery on the other hand.

THE AXILLARY.

Course and Relations.—The axillary, a continuation of the subclavian, commences at the outer border of the

first rib and terminates at the lower border of the teres major in the brachial. Anatomically it is divided into three parts by the pectoralis minor. In the first and second part it is deeply seated beneath the pectoral muscles, but in the third part it is only partially covered by the greater pectoral muscle, the rest of the vessel being comparatively superficial.

1st Part.—Here the vessel rests on the second digitation of the serratus magnus and first intercostal space, being covered below the clavicle by the integuments, platysma, pectoralis major, and deep fascia, the fascia of the pectoral muscle, and the costo-coracoid membrane. It lies deeply, between the brachial plexus above, and the axillary vein below, and is crossed from above downwards by the two anterior thoracic nerves, and obliquely from without inwards by the cephalic vein; between it and the first intercostal space runs the long thoracic nerve.

Branches.—Two branches are given off in this part of its course, the superior thoracic and the acromial thoracic.

2nd Part.—Here the vessel lies in the loose cellular tissue of the axilla surrounded by the cords of the brachial plexus, the inner one of which separates it from direct contact with the vein. In addition to the integuments and pectoralis major, it is also covered by the pectoralis minor.

Branches.—Thoracica longa; thoracica alaris.

3rd Part.—The artery here rests on the sub-scapularis and the tendons of the latissimus dorsi and teres major (from above downwards). The muscular spiral and circumflex nerves are here also placed behind it. It is covered above by the pectoralis major, and below this

muscle by the integuments and deep fascia only, and the confluence of the basilic vein with the venæ comites. Occasionally the two roots of the median nerve unite in front of the artery at this spot.

On its inner side it has the inner root of the median, the ulnar, the internal cutaneous, and lesser internal cutaneous nerves, and the axillary vein.

On its outer side the outer root of the median, the muscular cutaneous nerve for a short distance, and the coraco-brachialis muscle, which is the guide to it.

Branches.—Subscapular; Anterior circumflex; Posterior circumflex.

From what is stated above, it is evident that the ligature of the axillary trunk is no easy task: it may be well to mention that in the succeeding operations the knife should be used as little as possible, the point of the director being put in requisition for the separation of the deeper parts.

The vessel has been tied in all parts of its course, but, as the ligature of the second part is rarely practised on the living, we shall omit a description of the operation.

LIGATURE OF AXILLARY IN THE FIRST PART OF ITS COURSE.

Position of Operator and Subject.—To tie the axillary artery in the first part of its course, that is, immediately below the clavicle, the arm should be raised, to render tense the pectoralis major. The operator should stand facing the subject, between the arm and the thorax.

Operation.—An incision should be made through the integuments to the extent of three inches, along the

lower border of the clavicle, commencing an inch from its sternal end, and continued for about three inches nearly to the inner border of the deltoid, but not far enough to wound the cephalic vein. The platysma, the upper layer of the fascia of the pectoralis major, the muscle itself, and the lower layer of its fascia, must be divided in succession; this will expose the costo-coracoid membrane, which must be laid open with great care on the director. The arm should now be placed by the side so as to relax the pectoralis minor, which generally crosses the artery immediately below the spot at which we intend to apply the ligature, although it is sometimes found nearly covering the artery in this part of its course. Should this irregularity occur, the insertion of the muscle must be divided to an extent requisite for laying bare the vessel.

The knife may now be laid aside, and the director used for separating the vein, to be plainly seen in the lower part of the wound, from the brachial plexus above; behind and between these two will be found the axillary artery. The vessel being gently separated from its connections, the needle may be passed from below upwards, and the parts examined, to ascertain that none of the brachial plexus is included in the ligature.

In the preceding operation the cephalic vein will probably come into view, after the division of the platysma: it may be most conveniently disposed of by drawing it upwards towards the clavicle.

In this operation especially we cannot too strongly impress upon the student the advantage to be gained by a constant examination of the wound with his finger.

LIGATURE OF AXILLARY IN THIRD PART OF ITS COURSE.

Position of Subject and Operator.—The arm should be drawn away from the side, raised above the head, and rotated outwards, so as to expose the cavity of the axilla, the operator standing as in the former operation. An incision, about three inches long, should be made along the inner border of the coraco-brachialis, in the direction of that muscle, the axillary and deep fasciæ divided on the director, and the knife laid aside: the artery should now be sought and cleared from its connections with the point of the director, and the ligature applied from within outwards.

The structures which here require special care in their separation from the vessel are the various veins which unite to form the axillary trunk.

Abnormalities.—The chief of these is the presence of a larger branch than usual, which often gives off several of the vessels usually arising from the main trunk, and one or more of the arteries of the arm or forearm. This branch when present is occasionally surrounded by the brachial plexus.

Collateral Circulation (see diagram 10.)—When the axillary is tied below the circumflex and subscapular arteries the anastomosing channels will be the same as after ligature of the brachial above the profunda superior (see Brachial, page 47). When the artery is tied above the thoracic axis the anastomosing channels will be the same as after ligature of the subclavian, in the third part of its course (see Subclavian, page 58).

When tied in other parts of its course the thoracic

arteries, in addition to the supra and posterior scapular, carry on the collateral circulation by anastomosing with the intercostal arteries and the subscapular and its branches.

LIGATURE OF ARTERIES OF HEAD AND NECK.

These will comprise the subclavian, innominate, common carotid, external carotid, internal carotid, facial, lingual, and temporal.

LIGATURE OF SUBCLAVIAN ARTERY.

Course and Relations.—The subclavian artery is divided into three parts. The first part is internal to the scalenus anticus, the second part is behind, and the third part is external to this muscle. The subclavian arteries differ somewhat, anatomically, in the first part of their course; hence it will be necessary to describe the first part of each separately.

First Part of Right Subclavian.—This begins at the bifurcation of the innominate behind the right sterno-clavicular articulation, and runs in a curved direction over the apex of the lung, and is covered by the integument and superficial fascia, the cervical fascia, the inner portion of the sterno-mastoid muscle—a deeper layer of fascia, and the sterno-hyoid and sterno-thyroid muscles. It is crossed from above downwards by the pneumogastric nerve and filaments of the sympathetic, and, just external to these, by the internal jugular, and not infrequently by the vertebral vein. Beneath that part of the vessel nearest the trachea, is found the recurrent laryngeal nerve, running upwards and towards the middle line of the body.

It rests upon the pleura. It is about one inch long.

Branches.—Vertebral, thyroid axis, internal mammary.

First Part of Left Subclavian.—This arises almost vertically from the arch of the aorta, and ascends to the margin of the first rib. It is deeply seated in the chest, having in front of it, in addition to those structures mentioned as covering the artery on the right side, the left lung and pleura, and on an anterior plane, and a little to its inner side, the left common carotid artery. It is crossed by the left innominate vein.

The pneumogastric, phrenic, and cardiac nerves run parallel with the vessel, and are in intimate relationship with it.

On its inner side it has the trachea and left carotid, and higher up the œsophagus and thoracic duct.

At its origin, and for a short distance, it has the œsophagus behind it; but nearer its termination it lies on the longus colli muscle and inferior cervical ganglion of the sympathetic.

Its outer side is covered by the pleura. It is about two inches in length.

Branches.—As on right side.

Second Part of Subclavian.—This lies between the two scalene muscles. It is about three-quarters of an inch long and is the highest part of the arch described by the artery. It here rests on the pleura and has the cords of the brachial plexus above it. In front it is in relation with the scalenus anticus muscle, which separates it from the phrenic nerve, and more superficial to it are the sterno-mastoid with the platysma, common integuments, and fasciæ.

Branches.—Superior intercostal.

Third Part of Subclavian.—This portion of the subclavian, which lies external to the scalenus, inclines downwards and outwards over the first rib, at the outer border of which it takes the name of the axillary.

It is covered by the integument and superficial fascia, in which are a few trivial branches of the cervical plexus of nerves; by the platysma and deeper layer of cervical fascia, by more or less of the clavicular origin of the sterno-mastoid, according to the muscular development of the subject. It is here contained in a triangle, bounded by the clavicle, the omo-hyoid, and outer border of sterno-mastoid muscle. In this triangle it is crossed from above downwards by the external jugular vein, and is more or less covered by the supra-scapular, posterior scapular, and other unnamed veins, which often form a plexus very embarrassing to the surgeon in operating on the living subject. A process of fasciæ, prolonged from the omo-hyoid muscle to the first rib, is here stretched in front of it, and the supra-scapular artery runs across the triangle parallel to the clavicle. The nerve to the subclavius muscle, and its accessory branch to the phrenic, also cross the artery at this spot. There is likewise in fat subjects a good depth of cellular tissue and fat between these different layers of fascia. Above the vessel is the omo-hyoid and the brachial plexus. Below, but on an anterior plane, is the subclavian vein. It is about one inch long.

Branches.—As a rule, none; occasionally, the posterior scapular.

Operations.—The subclavian artery, so far as it con-

cerns us in operative surgery, may be considered to commence on *both sides* of the body, behind the sterno-clavicular joint, and to extend in an arched direction as far as the lower border of the first rib; for it is only within these limits that a ligature can be applied.

There are two points at which it is thought justifiable to attempt to expose the vessel—namely, between its commencement and the inner border of the scalenus anticus, and from the outer border of this muscle to its termination.

LIGATURE OF FIRST PART OF SUBCLAVIAN.

The subclavian having been tied on the living body, *internal to the scalenus*, by several surgeons of the highest reputation, we shall not venture to omit the description of this operation. But it is sufficiently obvious that it is a matter of some difficulty to ligature this part of the artery without injury to the neighbouring structures; indeed, on the left side the operation requires the greatest care even on the dead subject, as the vessel lies deeper than on the opposite side, and, being less transverse in its direction, is more completely obscured by the internal jugular and vertebral veins.

Position of Subject.—The head should be thrown back (on living subject as far as possible without impeding respiration) and the arm brought well down to the side so as to depress the shoulder as much as possible.

Position of Operator.—Behind the shoulder of the side on which he is about to operate.

Operation.—Make an incision along the anterior border of the sterno-mastoid muscle, beginning two inches

above its insertion and ending at the sternum; let it be joined at this point by a cut of the same length, running along the inner end of the clavicle and reflect the flap thus formed; divide the fascia and the sternal attachment of the mastoid muscle, the sterno-hyoid and sterno-thyroid; with the point of the director separate the cellular tissue from the deeper parts and search for the vessel just above the sterno-clavicular joint. If the operation be on the right side of the body, in all probability the carotid will be first exposed, and this may be traced down to its origin, on the outer side of which lies the subclavian. The ligature is to be applied to that part of the vessel which is between the internal jugular vein and the origin of the carotid; it should be passed from below upwards, and care should be taken lest the recurrent nerve be included with the vessel. In turning the needle around the vessel, it is well to bear in mind that the sac of the pleura is within reach of injury.

LIGATURE OF THIRD PART OF SUBCLAVIAN.

Position of the Subject.—The subject should be placed horizontally, with the head thrown back and the shoulder depressed as in the operation on the first part.

Position of the Operator.—The same as in the former operation.

Operation.—Having drawn the integuments gently downwards over the clavicle, make an incision three inches in length along the upper border of that bone, commencing at the outer margin of the sterno-mastoid muscle.

When the tension is taken off the skin, the incision

will be found to occupy a line about half an inch above and parallel to the clavicle.

The object of proceeding is to avoid wounding the external jugular vein, which will be now exposed at the inner end of the incision.

The vein should be now hooked to the inner end of the incision, or, should it be much in the operator's way, it may be divided, after a double ligature has been applied.

Occasionally, in muscular subjects, the sterno-mastoid will be found overlapping more or less of the artery, or even in contact with the trapezius, thus leaving little or no interval between these two muscles. Should this be found to be the case, the mastoid must be carefully divided. The deeper layer of the fascia should be now carefully cut through, and the omo-hyoid muscle recognised at the upper part of the wound. This, as before stated, with the clavicle and the outer border of the sterno-mastoid, forms a triangle in which the vessel will be found.

Having laid aside the knife, search in this triangle with the fore-finger of the left hand for the external border of the scalenus anticus, and, having found it, trace it downwards to the first rib, and endeavour to make out the tubercle situated at its insertion into the inner border of this bone.

The tubercle being thus found, the finger should be kept on it, whilst the point of the director is employed to expose the artery, which lies immediately behind and rather external to the point where the scalenus joins the first rib. Detach the vessel from the brachial plexus, and pass the ligature from above downwards, as there is

but little danger of including the subclavian vein, which, indeed, need not be seen during the operation.

Should the supra-scapular artery come into view during the operation, it must be carefully avoided, as the collateral circulation depends in part on this vessel.

The fascia covering the scalenus anticus must not be interfered with, lest the phrenic nerve be injured.

Abnormalities.—1st. As to origin—for these we refer the student to the works on Anatomy.

2nd. As to course—the artery may run in front of the scalenus anticus or through its fibres; the vein has been seen behind the scalenus anticus.

3rd. As to branches—one or more branches may arise from the third part of this vessel.

COLLATERAL CIRCULATION (see diagram 10, p. 60).

I. *When a ligature is applied to the first portion.*—The collateral circulation may be carried on by the superior thyroid anastomosing with the inferior thyroid, the vertebral of one side with the vertebral of the other side, the internal mammary with the thoracic intercostals, the superior intercostal with the thoracic intercostals, and the princeps cervicis with the deep cervical.

II. *When a ligature is applied to the third portion.*—The collateral circulation may be carried on by three chief sets of branches:—

1. A posterior set; consisting of the supra-scapular and posterior scapular, anastomosing with infra-scapular, subscapular, and dorsalis scapular arteries.

2. An internal set; consisting of the internal mammary, superior intercostal, and aortic intercostal arteries,

anastomosing with the short and long thoracic and the infra-scapular, dorsalis scapular, and sub-scapular arteries.

3. A number of small unnamed vessels passing through the axilla from the subclavian above to the axillary below.

LIGATURE OF THE INNOMINATE.

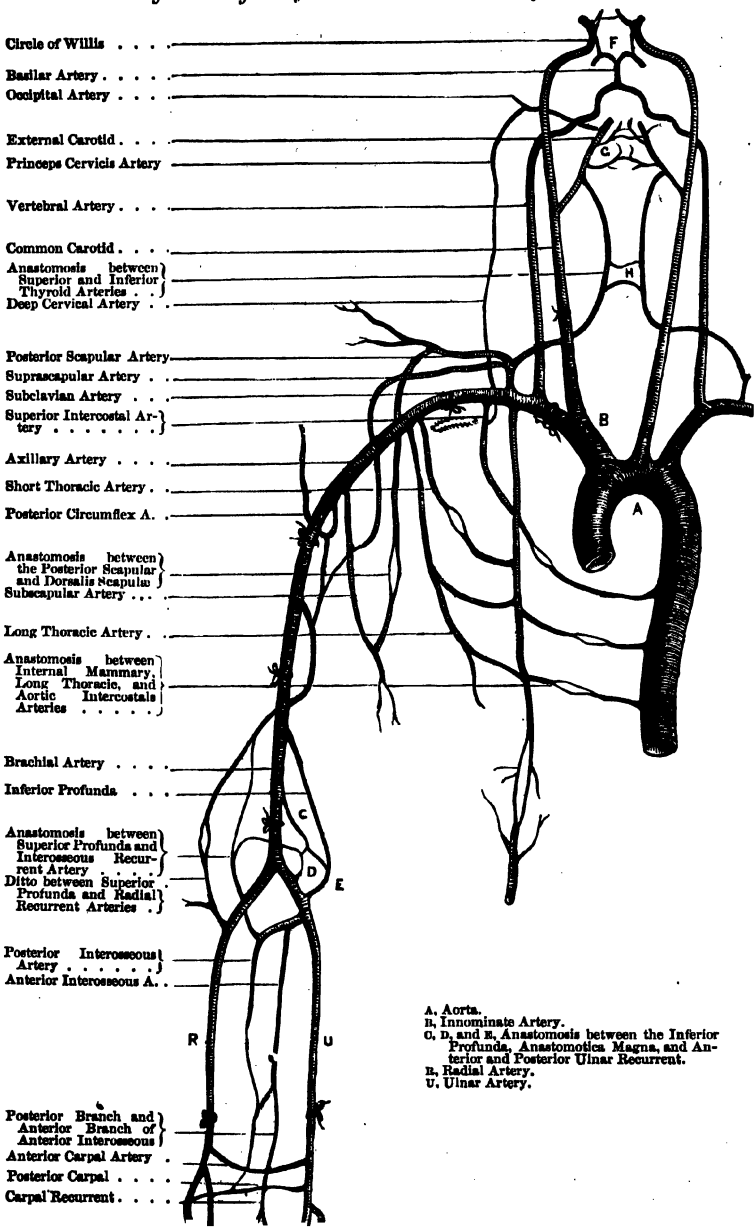
As ligature of the innominate has received the countenance of many eminent surgeons, though only once successful in its result on the living body, we shall describe a method of performing the operation.

Course and Relations.—The vessel in question is from an inch to two inches in length, and runs from the arch of the aorta to the right sterno-clavicular articulation; its course is oblique, from left to right; at first lying in front of the trachea, but subsequently getting to its right-hand side. At its origin it is crossed by the left innominate vein, higher up it has the right vena innominata on its outer side, while behind and between the two is the right pneumogastric nerve. The pleura and right lung are also in close relationship with it behind.

Position of the Subject and Operator.—The head of the subject should be thrown back and its face turned towards the left side; the operator should stand behind the left shoulder.

Operation.—An incision may be made, commencing at the upper border of the sternum in the mesial line, and extending up into the neck for three inches, along the anterior margin of the sterno-mastoid muscle; this incision alone may be employed, or another may be added, which should run for about an inch along the

Fig. 10. *Diagram of the Collateral Circulation of the Arm.*



A, Aorta.
B, Innominate Artery.
C, D, and E, Anastomosis between the Inferior Profunda, Anastomotica Magna, and Anterior and Posterior Ulnar Recurrent.
R, Radial Artery.
U, Ulnar Artery.

upper border of the clavicle and join the first at the top of the sternum. The skin, the cervical fascia, the sternal attachment of the mastoid muscle, the sterno-hyoid, and sterno-thyroid muscles being divided in succession, the point of the director should be used to break away the cellular tissue behind the sterno-clavicular joint, and to search between it and the mesial line for the innominate artery. Should the subclavian or carotid trunks come into view, they will be recognised respectively by their direction, and they may be made use of as guides to the situation of the innominate, around which the ligature should be passed from without inwards.

LIGATURE OF THE COMMON CAROTID.

Course and Relations.—The common carotids, in the study of operative anatomy, may be considered to have the same course and relations on both sides of the body; as that part of the left carotid which differs from the right is beyond the reach of the ligature. We may therefore consider that the carotid commences behind the sterno-clavicular joint, and extends as high in the neck as the upper border of the thyroid cartilage. Its course is indicated by a line drawn from between the angle of the jaw and the mastoid process, to a point half an inch external to the sternal end of the clavicle; the best line to follow, however, in making incisions for exposing the vessel, is that of the anterior border of the sterno-mastoid. The vessel in the lower half of its course lies deeply and is overlapped by the sternal origin of the sterno-mastoid, the sterno-hyoid, and sterno-thyroid muscles, besides the various layers of cervical fascia; after a short distance

these muscles diverge, and it pursues its course more superficially to its termination. At a variable distance above the clavicle, although generally on the level of the cricoid cartilage, the omo-hyoid muscle crosses the artery obliquely from without inwards. In the upper part of the neck the vessel is only separated from the integuments by the platysma, cervical fasciæ, and its own sheath; and is crossed by the facial, lingual, and superior thyroid veins, and the little sterno-mastoid artery, a branch of the superior thyroid. In front of its sheath is the descendens noni nerve, with its communicating branches, while within the sheath, on the outer side of the artery, are the pneumogastric nerve and internal jugular vein, the nerve being behind and between the two.

Internally are the trachea, the larynx, the pharynx, and the thyroid body. Occasionally the lateral lobe of the thyroid body overlaps the artery in the middle of its course.

Behind, it rests on the longus colli, the rectus capitis anticus major, and the sympathetic nerves, and has, crossing behind it low down in the neck, the inferior thyroid artery and recurrent laryngeal nerve.

A ligature may be applied to this vessel in any part of its course between the *above-mentioned limits*. We propose tying it in two places; above and below the spot where it is crossed by the omo-hyoid.

ABOVE THE OMO-HYOID.

Position of Subject and Operator.—The head should be held back and the face turned to the opposite side whilst

making the incision, but when the sterno-mastoid has been exposed, the assistant should slightly raise the head to relax this muscle.

The surgeon should stand behind the shoulder of the side on which he is about to operate.

Incision and Operation.—Make an incision along the

Fig. 11.

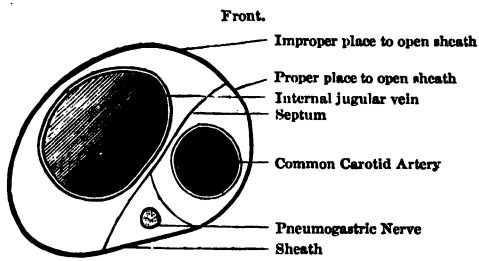


Diagram to show the relations of the common carotid artery to the internal jugular vein and pneumogastric nerve.

A. On the Living Subject.

anterior border of the sterno-mastoid in the line of the vessel, about three inches in length, having its centre

Fig. 12.

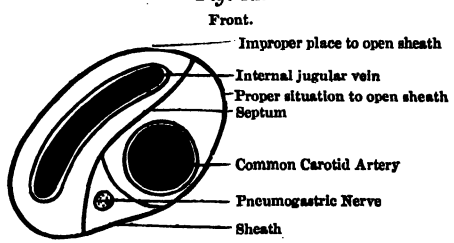


Diagram to show the relations of the common carotid artery to the internal jugular vein and the pneumogastric nerve.

B. On the Dead Subject.

opposite the cricoid cartilage; and after dividing the skin, superficial fascia, and platysma, cautiously divide the deep layer of fascia on a director, and the anterior

border of the sterno-mastoid will be exposed. The head being now slightly raised, the mastoid may be drawn a little outwards, and after some careful separation with the handle of the scalpel the omo-hyoid muscle will be recognised; its fibres forming, with those of the mastoid, an angle, in which the carotid will be felt pulsating by the finger (in the living subject). Should the descendens noni now be seen, it may be held aside with blunt hooks. The sheath should be carefully opened on the inner side, so as to avoid the jugular vein.

The vein, being larger than the artery, bulges over the latter, and may be easily wounded if the sheath is not opened well to its inner side, *i.e.* over the artery. When the sheath is thus opened neither the vein nor the nerve should come into view. The above diagrams (*figs.* 11 and 12) illustrate this.

Should the thyroid veins impede the steps of the operation they may be held aside or divided, and both ends ligatured. The little middle mastoid artery will require tying on the living subject if divided. With the point of the director separate the artery from the vein and vagus nerve on its outer side, and pass the ligature around it from without inwards, to avoid injuring the nerve. In performing this operation on the dead body it is not uncommon for the internal jugular to be mistaken for the carotid sheath, and to be laid open on the director; though there is but little danger of this, except when the vein is flaccid and empty, and overlaps the artery.[1]

[1] I have frequently seen this mistake made by students through neglecting the above rule—to open the sheath well to its inner side.—ED.

BELOW THE OMO-HYOID.

Position of Subject and Surgeon.—The same as for the operation above the omo-hyoid.

Operation.—Make an incision in the same direction as in the former operation, about three inches long, commencing at the lower border of the cricoid cartilage.

Having exposed the inner border of the sterno-mastoid, this should be pulled outward, and the sterno-thyroid and sterno-hyoid inward; the omo-hyoid possibly requiring to be hooked somewhat upwards and outwards.

The deeper layer of fascia having now been divided, the sheath of the vessels will be exposed. On the right side the internal jugular vein will be found low in the neck, at some distance from the vessel, but on the left side the vein approaches the artery, and at the root of the neck is somewhat in front of it. The sheath being opened as before on the inner side, the vessel should be ligatured, the needle being passed from without inwards, taking care not to include the pneumogastric nerve on the right side or to wound the jugular vein on the left.

COLLATERAL CIRCULATION (see diagram 10).

The superior thyroid anastomoses with the inferior thyroid.

The vertebral with the vertebral of opposite side.

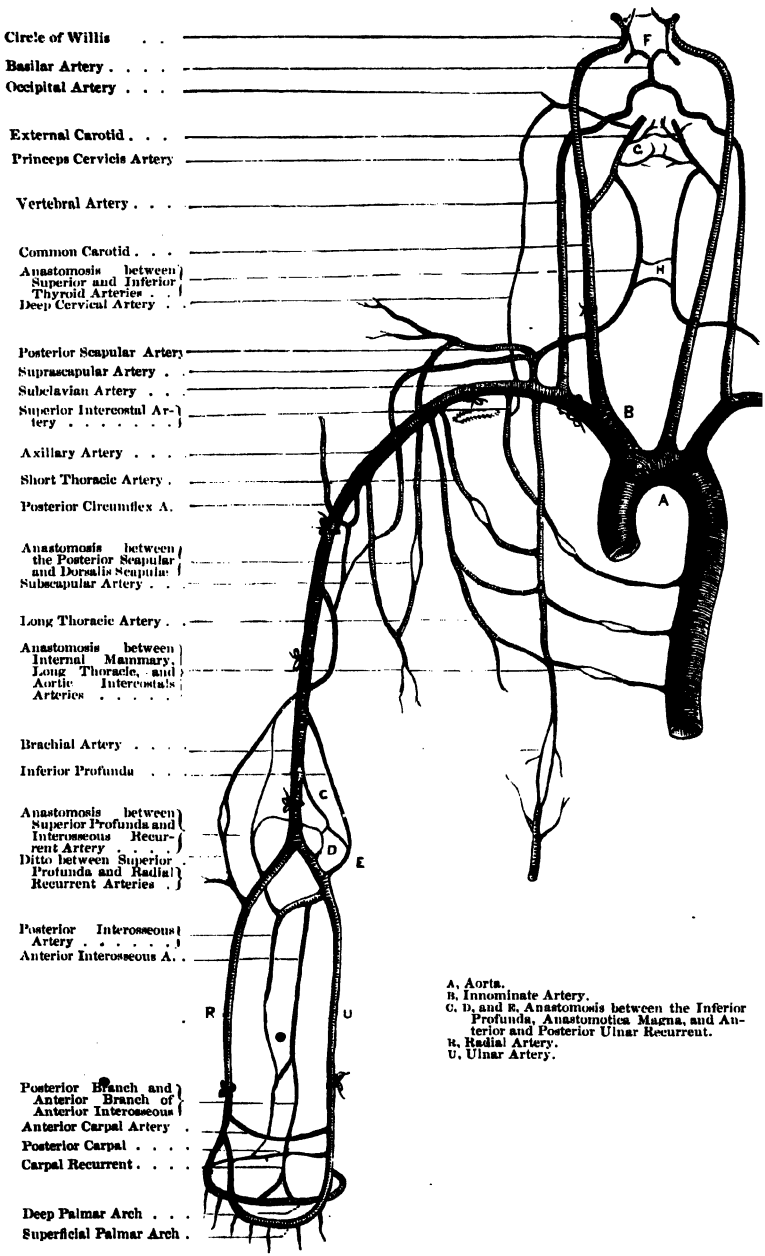
The princeps cervicis of the occipital with the deep cervical, a branch of the superior intercostal.

The internal carotid with the internal carotid of opposite side, through the circle of Willis.

The ophthalmic with the angular.

The superior thyroid, facial, lingual, occipital, and

Fig. 10. *Diagram of the Collateral Circulation of the Arm.*



A, Aorta.
B, Innominate Artery.
C, D, and E, Anastomosis between the Inferior Profunda, Anastomotica Magna, and Anterior and Posterior Ulnar Recurrent.
R, Radial Artery.
U, Ulnar Artery.

temporal, with the corresponding arteries of the opposite side.

Abnormalities.—The chief abnormalities of this vessel with which we are concerned in operative surgery are: 1, Variations in its place of bifurcation; and 2, the occasional existence of branches.

1. *Bifurcation:*—

A. It may divide higher than usual.

B. Rarely it divides lower than usual.

C. Very occasionally two arteries have been found low in the neck.

D. It may not bifurcate, all the branches being given off from a single trunk.

2. *Branches.*—It may give off the superior thyroid, lingual, and facial.

EXTERNAL CAROTID.

Course and Relations.—The external carotid commences at the bifurcation of the common carotid on a level with the upper border of the thyroid cartilage. It ascends beneath the hypoglossal nerve, the posterior belly of the digastricus, and the stylo-hyoid muscle, and entering the parotid gland divides near the neck of the jaw into the temporal and internal maxillary arteries.

It is separated behind from the internal carotid by the stylo-glossus, stylo-pharyngeus, stylo-hyoid ligament, and the glosso-pharyngeal nerve. It lies at first, side by side with the internal carotid, the latter being external. But it soon changes its position and crosses obliquely in front of the internal carotid to reach the space between the mastoid process and angle of jaw.

We propose tying this vessel below the spot where it

is crossed by the digastricus and stylo-hyoid muscles. Here the only structures covering the artery are the integument, platysma, cervical fasciæ, and the hypoglossal nerve which crosses it from without inwards.

The vessel lies side by side with the internal carotid, which is on its outer and posterior aspect. The two vessels may best be distinguished, besides by their position, by the latter being without branches and larger. The anterior border of the sterno-mastoid marks the direction of the external carotid, and serves as a guide in making our incisions.

Position of Subject and Operator.—The same as for tying the common carotid.

Operation.—Make an incision over the anterior margin of the mastoid, commencing opposite the hyoid bone and running upward for about two inches; the skin, platysma, and cervical fasciæ being divided, the director should be used to clear the vessel, care being taken to avoid injuring the hypoglossal and descendens noni nerves. The lingual or facial vein may possibly be exposed during the operation, and should be held aside. The internal jugular vein will be found on the outer side of the artery, and separated from it by the hypoglossal nerve. The ligature should be passed from without inwards.

THE INTERNAL CAROTID.

The internal carotid only admits of being ligatured within a short distance of its origin; subsequently its course lies so deeply among important structures that an attempt to expose it would be unjustifiable. The various steps for exposing this vessel in the first part of its course

are precisely those that are described above as necessary for ligaturing the external carotid. The ligature should be passed from without inwards to avoid the risk of injuring the vagus nerve, or the internal jugular vein.

THE LINGUAL.

Course and Relations.—The lingual artery, after leaving the external carotid, runs upwards and inwards beneath the posterior belly of the digastricus and stylo-hyoideus, to the upper border of the greater cornu of the hyoid bone, along which it pursues its course, lying on the middle constrictor muscle, and beneath the hyoglossus.

The portion of the artery with which we have to deal, is that lying beneath the last-named muscle. Here the vessel is covered by the skin, platysma, superficial and deep cervical fasciæ and hyoglossus muscle.

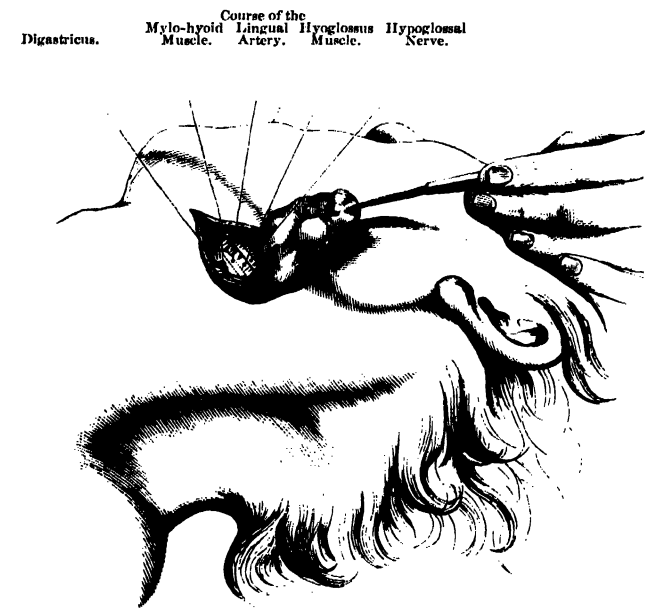
The anterior and posterior bellies of the digastricus at their divergence below, form, with the hypoglossal nerve above, and the mylo-hyoideus on the inner side, a small space with its apex at the hyoid bone and its base above. The floor of the space is covered by the hyoglossus muscle, and immediately beneath this will be found the lingual artery, the course of which is indicated by a dotted line in *fig.* 13.

Position of Operator and Subject.—The operator should stand behind the subject; which should have the head thrown back and chin turned to opposite side.

Operation.—Make a slightly curved incision about two inches in length, commencing at the small cornu of the hyoid bone, and extending outwards and upwards along the upper border of its greater cornu. The skin, platysma,

and cervical fasciæ being divided, the sub-maxillary gland will most likely come into view; this being turned upwards, until the hypoglossal nerve is seen, the junction of the bellies of the digastricus must be sought, and the hyoglossus muscle very carefully divided transversely at the point before indicated: the artery will now be plainly seen, and the ligature can be placed around it. (The lingual vein will usually be seen lying on the hyoglossus.)

Fig. 13.



The lingual artery may be exposed by other methods, but we have selected that operation which we have personally found most convenient and certain of success.

Abnormalities.—This artery has been seen to arise from the facial behind the sub-maxillary gland, and then

pass through the mylo-hyoideus to reach the tongue (Holden). The branches of the lingual are also very irregular in their origin, but this fact does not concern us in operative surgery.

FACIAL ARTERY.

We shall omit any description of the course of the *facial artery*; as the only point at which its ligature is attempted is where it crosses the lower jaw, at the anterior border of the masseter muscle. It is exposed by an incision an inch in length, parallel to the body of the lower jaw; crossing the anterior margin of the masseter muscle at the lowest point of its insertion. The skin, platysma, and fasciæ must be divided, and the artery carefully separated from its vein on the outer side. The direction of the vessel will, of course, be at right angles to that of the wound.

TEMPORAL ARTERY.

The main trunk of this artery, after leaving the parotid gland, passes upwards over the zygoma, just in front of the pinna of the ear. To tie the vessel, an incision should be made an inch in length, just in front of the antitragus, and crossing the zygoma at right angles; the skin and fasciæ must be divided, and the vessel sought for in the dense cellular tissue which is found at this spot; the vein lies posteriorly.

LIGATURE OF VESSELS OF ABDOMEN AND LOWER EXTREMITY.

We propose to proceed with the ligature of the vessels of the trunk and lower extremities, in order, from

above downwards, commencing with the common iliac artery.

LIGATURE OF COMMON ILIAC.

Course and Relations.—The common iliac arteries, commencing at the bifurcation of the aorta on the left side of the fourth lumbar vertebra, extend downwards and outwards, diverging from each other, until just short of the sacro-iliac joint, where they give off the external and internal iliac trunks. The artery of the right side is thus rather longer than that of the left; both lie on the inner border of the corresponding psoas muscle, and are crossed by the spermatic vessels and the ureter; the vessel of the left side has also in front of it the inferior mesenteric artery, and the sigmoid flexure of the colon. The iliac veins are found internal to, and on a lower plane than, their companion arteries, and their junction is effected beneath the upper part of the right iliac artery. Both vessels are covered by the muscles of the anterior abdominal wall, and lie behind the peritoneal cavity and small intestines. A line drawn from the left side of the navel to the centre of Poupart's ligament on either side, pretty nearly indicates the direction of the course they pursue.

Operation.—This vessel has been secured by two different methods of proceeding:—First, that of Dr. Mott, which was founded on the operation adopted by Mr. Abernethy for tying the external iliac; and secondly, that of Sir P. Crampton. The former surgeon secured the vessels by an incision made anteriorly through the abdominal muscles. The latter, by an incision extending from the last rib to the crest of the ilium.

We shall describe both modes of proceeding.

Position of Surgeon.—On the same side as that of the vessel he is about to ligature.

1. *The Anterior Operation.*—To apply a ligature to this vessel, divide the integuments to the extent of five inches, beginning at a point an inch below and two inches nearer the middle line than the anterior superior spine of the ilium, and extending from this point upwards with a slight inclination outwards. The three abdominal muscles must be recognised and separately divided, and the fascia transversalis cautiously cut upon the director, commencing at the lower end of the wound, where this fascia is more easily recognised, and where there is a deeper substratum of fat between it and the peritoneum; the subperitoneal fat ought now to be seen, and from this stage of the operation the knife should be abandoned. An assistant should hold open the wound, while the operator raises the peritoneum and its contents with his left hand, pushing it upwards and inwards, and separating it from the iliac fossa with the point of the director, until the psoas muscle is reached. Immediately internal to this muscle, at the posterior part of the pelvic brim, the artery will be found; its connections being detached to a small extent, the aneurism needle, which should be of a suitable shape, may be passed from within outwards, as this best secures the safety of the corresponding vein.

Little thought need be bestowed, during the operation, on the spermatic vessels and ureter, as they generally rise with the peritoneal sac, and adhering to its under surface, are scarcely observed.

We have described this operation as if performed on

the right side of the body: on the opposite side its difficulty is increased by the presence of the sigmoid flexure of the colon, which crosses the vessel at its bifurcation, and must be raised before a ligature can be applied.

2. *Posterior Operation. Position of Subject and Operator.*—The subject should be placed on the operating-table, with a block beneath the loins on the side on which the artery is to be tied, so as to incline the body over to the opposite side, and the shoulder and trunk bent a little forwards to render the lumbar integuments tense. The surgeon should stand behind the side on which he is about to operate, having his assistant opposite him.

Operation.—Make an incision from the cartilage of the last rib downwards and forwards to the crest of the ilium, about four inches in length; divide successively the external and internal oblique and the transversalis muscles on a director. The external incision may be extended along the crest of the ilium if necessary, and the muscles above-mentioned separated from it.

The fascia transversalis must now be divided, and the peritoneum and intestines raised, and the vessel will be found on inner border of psoas. The ligature can now be passed and the vessels secured as in the former operation.

Abnormalities.—The chief peculiarity concerning us as surgeons is the variation in the length of this vessel; it is usually about one inch and a half long, but it has been found less than half an inch and as long as four inches and a half.

In one instance it has been found wanting the external and internal iliac arising from the aorta.

Occasionally a large branch springs from it, such as the renal, or a lumbar artery.

The place of division of the aorta and the bifurcation of the common iliac vary very considerably.

Collateral Circulation (see diagram 14).—The middle sacral anastomoses with the lateral sacral; the internal mammary with the epigastric; the ilio-lumbar with the lumbar arteries from the aorta; the arteries of the viscera of either side across the middle line; the pubic arteries behind the symphysis pubes.

INTERNAL ILIAC ARTERY.

The internal iliac artery, leaving the common iliac at the sacro-iliac joint, runs downwards and forwards towards the great sciatic notch; it is crossed in front by the ureter descending into the pelvis; behind the vessel is found its corresponding vein with which it is generally pretty closely connected. The same operation is necessary for the ligature of this vessel as was described for the common iliac; the artery, however, must be sought below the pelvic brim, and great caution will be required to clear it from the veins which often unite on its inner side.

Collateral Circulation (see diagram 14).

The lateral sacral anastomoses with the lateral sacral of opposite side and with the middle sacral.

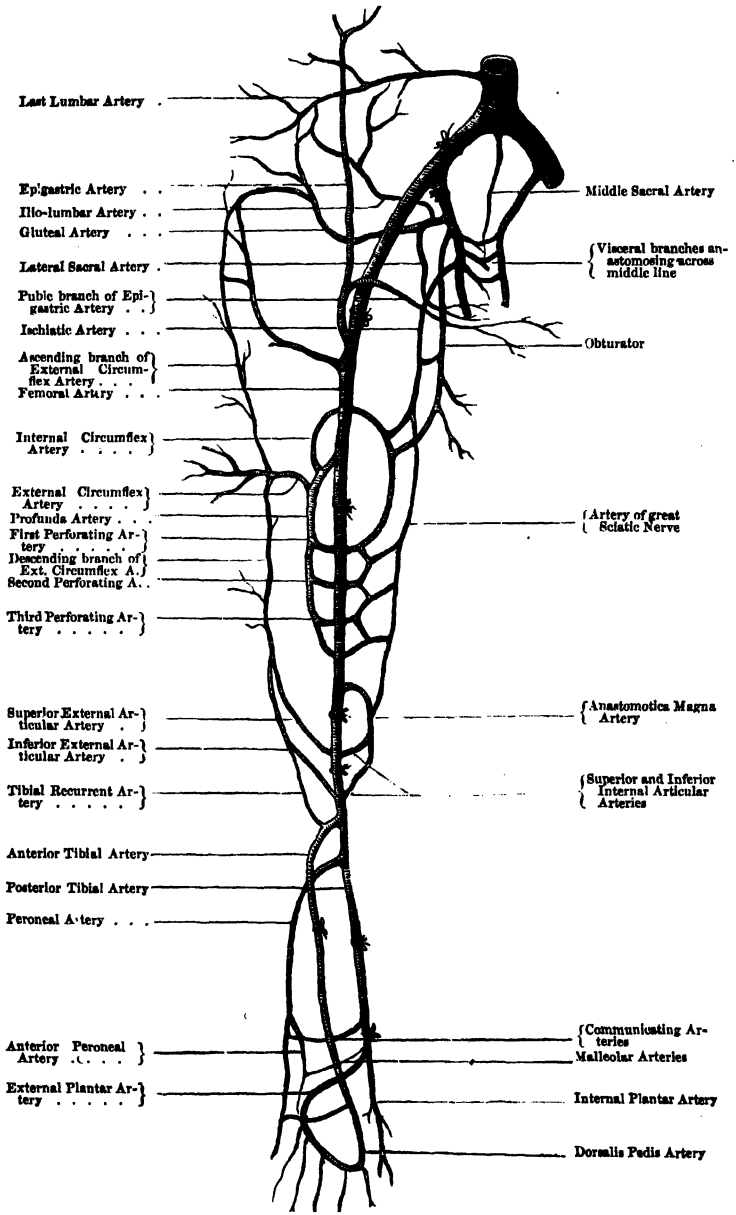
The sciatic with the internal circumflex.

The visceral branches of the internal iliac with those of opposite side.

The inferior mesenteric with the hæmorrhoidal.

The pubic branch of the epigastric with the artery of opposite side.

Fig. 14. Diagram of Collateral Circulation after Ligatures of Arteries of Abdomen and Lower Extremity.



The ilio-lumbar with the last lumbar artery.

The circumflex iliac with the ilio-lumbar and gluteal arteries.

The pudic with the opposite pudic.

THE EXTERNAL ILIAC.

Course and Relations.—The external iliac artery extends from the sacro-iliac joint to the centre of the crural arch; following the brim of the pelvis for some distance, it lies to the inner side of the psoas muscle, and has its own vein internal to it, but on a lower plane. Just before its termination, this vessel is crossed at right angles by the circumflex ilii vein, and obliquely, about the middle of its course, by the genito-crural nerve: it lies behind the peritoneal sac and small intestines. This vessel may be tied at any part of its course; we shall select a part of its trunk, about two inches above Poupart's ligament, as this is a sufficient distance from the origin of its branches, the epigastric and circumflex iliac.

Position of Subject and Operator.—The subject should be placed on its back; the operator should stand on the same side as the vessel he is about to tie.

Operation.—Make an incision about three inches in length, beginning a little external to the centre of Poupart's ligament, and half an inch above it, running in a slightly curved direction, outwards and upwards towards the anterior superior spine of the ilium. Divide separately the external oblique, the internal oblique, the transversalis and fascia transversalis. The subperitoneal fat having been exposed, push the peritoneum upwards and inwards,

and search for the artery on the inner margin of the psoas: it may be easily cleared from its connections, and a ligature applied from within outwards. In this operation the connections of the peritoneum need only be disturbed to a very small extent.

Collateral Circulation (see diagram 14).

1. The ilio-lumbar anastomoses with the circumflex iliac.
2. The gluteal with the external circumflex.
3. The obturator with the internal circumflex.
4. The sciatic with the circumflex and superior perforating arteries.
5. The internal with the external pudic.
6. The epigastric with the internal mammary and inferior intercostals.
7. The arteria comes nervi ischiadici, a branch of the sciatic, with the perforating.
8. Other small branches.[1]

LIGATURE OF THE FEMORAL ARTERY.

Course and Relations.—The femoral artery, a continuation of the external iliac, commences at the lower border of the crural arch, and runs perpendicularly down the front and inner part of the thigh, to the junction of its middle with its lower third, where it passes through the tendon of the adductor magnus and becomes the popliteal.

When the thigh is abducted and in the proper position for tying the vessel, a line drawn from a point midway

[1] See Sir A. Cooper, 'Guy's Hospital Reports,' vol. i. p. 50.

between the anterior superior spine of the ilium and the symphysis pubis to the adductor tubercle on the inner condyle will indicate its course.

In the upper third of the thigh the vessel is superficial and contained in Scarpa's triangle.

In the middle third it is deeply placed amongst the muscles in Hunter's canal.

In Scarpa's Triangle.—This triangle, which corresponds with the natural depression below the fold of the groin, is bounded externally by the sartorius, internally by the adductor longus, and is completed above by the crural arch.

Its apex, where the inner border of the sartorius first comes into contact with the adductor longus, is situated about five inches below Poupart's ligament. It is at this spot that the vessel is generally tied.

The artery runs through the centre of this triangle, and is superficial, being covered by the skin, superficial and deep fasciæ and its proper sheath—a small branch of the internal cutaneous, and a few filaments of the genito-crural nerve ramifying in the superficial fascia are likewise in front of it.

The long saphenous vein is superficial, and well to its inner side.

The femoral vein in the upper part of the space is internal to the artery and on the same plane, but after a course of about two inches it gradually passes behind the vessel, and at the apex of the triangle is almost posterior to it. At first a distinct septum separates the artery from the vein, but lower down this becomes less distinct, and the two vessels are in intimate contact, the vein in the

dead body overlapping the artery behind and externally —as is seen in the accompanying diagram (*fig.* 15).

Hence the common accident of transfixing the vein, if any force be used whilst endeavouring to pass the aneurism needle round the artery.

The anterior crural nerve is external to the artery in the upper part of the triangle, but this soon breaks up into branches, one of which, the long saphenous nerve, remains on the outer side of the vessel.

The length of the femoral artery in Scarpa's triangle is about five inches.

A large branch, the profunda, is given off about one inch and a half below the crural arch.

In Hunter's Canal.—This canal, so called after John

Fig. 15.

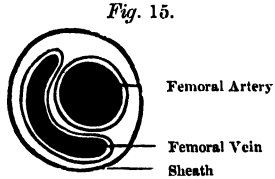


Diagram showing the relation of the Femoral Artery to the Femoral Vein.

Hunter, who first tied the femoral artery here, is formed by the angle of meeting of the vastus internus on the outer with the adductor longus and magnus on the inner side; and is completed above by a strong aponeurosis stretching across from the above-mentioned muscles. In front of the canal is the sartorius, covered by the skin and fasciæ.

In the canal are contained the femoral artery and vein and the long saphenous nerve.

The vein is behind the artery, and a little to its outer side. The nerve is superficial, and commonly internal to

the vessel. At the lower end of the canal the nerve leaves the artery as the latter passes through the adductor magnus, and is accompanied by the anastomotica magna artery, a branch of the femoral. This artery is sometimes of large size, and has been tied in mistake for the main trunk.

Ligature in Scarpa's Triangle. Position of Subject and Surgeon.—The thigh should be abducted and placed, with the leg slightly flexed, on a block, the surgeon standing on the outer side of the limb to be operated upon.

Operation.—Make an incision, two or three inches in length, over the course of the artery, so that the lower part of the incision may be well over the spot where the sartorius comes into contact with the adductor longus—that is, about five inches below the crural arch.

Divide carefully the skin and superficial fascia and the deep fascia on a director. The margin of the sartorius will now come into view, and may be known by its fibres, as seen through its fascia, running downwards and inwards. This may be gently drawn to the outer side of the wound, and the vessel will be felt at the spot where this muscle touches the adductor longus.

Carefully open the sheath of the vessel, and, after having well separated it all round from the artery, but as little as possible in the length of the vessel, pass the needle with great care from the inner to the outer side, keeping the point well turned towards the artery.

The vein is very apt to be wounded in this operation if great care be not taken. Should this accident occur, withdraw the ligature, apply pressure over the wounded vein, and tie the artery higher up.

Ligature in Hunter's Canal.—Position of surgeon and subject the same as in the former operation.

An incision should be made in the line of the artery, commencing about the middle of the thigh and extending downwards for three inches. After dividing the superficial and deep fascia, the sartorius will generally be seen, and must be drawn to the inner side. The first finger should now be passed down the adductor longus towards its insertion into the linea aspera of the femur, until the point of the finger rests against the vastus internus, at the spot where it is blended with the former muscle. Carefully lay open the fascia which connects these two muscles, and separate the artery, which will now be seen, from the vein and long saphena nerve. Pass the ligature from within outwards, taking care that the vein which lies behind be not included, adhering as it does very firmly to the artery.

There is often considerable difficulty experienced in exposing the vessel in Hunter's canal, and this generally arises from one of two causes; namely, either the first incision is made too low down in the thigh, or the line of the vessel, before mentioned, is not correctly ascertained before commencing the operation.

In the former case the vessel has passed through the tendon of the adductor magnus into the popliteal space, and necessarily cannot be found at the spot where the student is searching for it, in front of the adductor tendon.

In the latter case the incision is generally made too much to the outer side of the artery. The sartorius, which is here situated well on the inner aspect of the limb, is not recognised, and some of the fibres of the vastus

internus are generally mistaken for it. These are drawn to the inner side, the vessels being carried with them, and the student vainly endeavours to find the vessel in the substance of the vastus and crureus.

This mistake can always be avoided by remembering that the direction of the fibres of the sartorius are downwards and inwards; and the fibres of the vastus internus downwards and outwards; so that, should the incision be too far outwards after the fasciæ are divided, the student may correct his mistake by noticing that the fibres of the muscle he has exposed do not run in the direction above described.

Collateral Circulation (*fig.* 14).—The profunda anastomoses, by means of its perforating branches, with the articular branches of the popliteal and tibial recurrent; the descending branch of the external circumflex anastomoses with the articular branches of the popliteal and tibial recurrent; the arteria nervi comes ischiatici with the perforating branches of the profunda and articular.

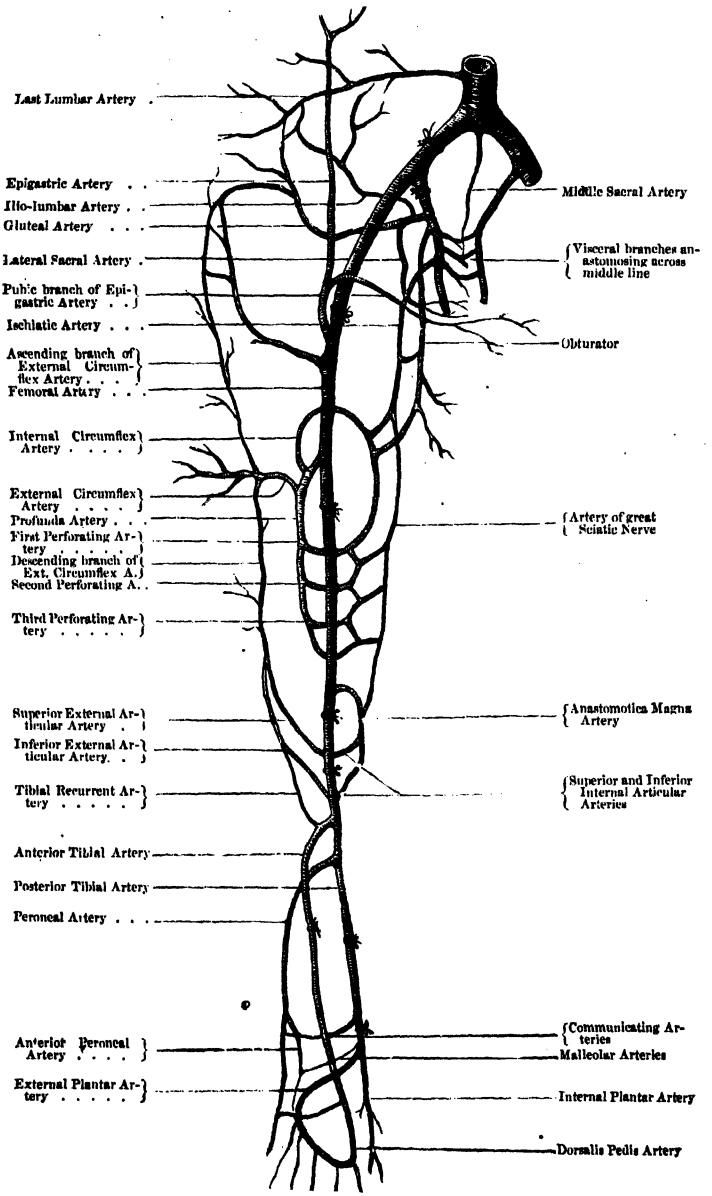
Abnormalities.—In four cases the artery has been recorded as dividing into two below the profunda, and reuniting near the opening in the adductor magnus.

In four instances the artery has sprung from the internal iliac, left the pelvis by the great sacro-ischiatic notch, and accompanied the sciatic nerve into the popliteal space.

The origin of the profunda varies. It may arise in some instances above the crural arch, in other cases it has been found four inches below it.

The origins of the circumflex vessels are very irregular.

Fig. 14. Diagram of Collateral Circulation after Ligatures of Arteries of Abdomen and Lower Extremity.



ANTERIOR TIBIAL.

Course and Relations.—The anterior tibial artery, entering the front of the leg through the interosseous membrane, beneath the head of the fibula, continues its course down the limb, to the first interosseous space on the dorsum of the foot. It lies successively on the interosseous membrane, the tibia, the front of the ankle joint, and over the astragalus, the scaphoid, and the internal cuneiform bone. In the upper third of the leg it is found deep between the tibialis anticus and the extensor longus digitorum; below this it lies between the former muscle and the extensor of the great toe, and on the dorsum of the foot it intervenes between the extensor proprius pollicis and the innermost tendon of the extensor longus digitorum. In front of the ankle joint the artery is crossed from without inwards by the long extensor of the great toe, and on the dorsum of the foot by the first tendon of the extensor brevis digitorum.

A line drawn from below the inner side of the head of the fibula, or rather from the centre of the muscular space between the heads of the tibia and fibula, to a point midway between the malleoli, indicates the course of this artery. The vessel in question is approached in any part of the leg through the innermost intermuscular space, the exact seat of which is indicated by a white line in the fascia, just external to, and nearly parallel with, the spine of the tibia. The artery can be tied in any part of its course; we shall describe the measures necessary for exposing it in its upper, middle, and lower thirds.

Position of Subject and Surgeon.—The leg should be

extended, the foot being turned inwards, and the tibialis anticus put into action, so that the outline of the muscle may be noted before commencing the operation. The surgeon should stand on the outer side of the leg on which he is about to operate.

Ligature in the Upper Third.—An incision, three inches in length, should be made over the artery in the line of its course, beginning an inch below the head of the tibia; the integuments, the superficial and deep fascia being divided, the subjacent muscular fibres must be separated with the handle of the knife, until the interosseous membrane is reached. The artery will be found on the membrane, and its nerve, if it should come into view, will be on the outer side. After clearing the vessel from its companion veins, the ligature may be passed from either side.

The separation of the tibialis anticus from the extensor longus digitorum is not always easily effected, as their contiguous margins are intimately connected. If, however, the line of the vessel be at first correctly ascertained and subsequently be rigidly observed, no difficulty will be found in falling on the artery at the bottom of the wound.

Ligature in the Middle Third.—The integuments having been divided to the extent of two or three inches over this part of the artery in the line of its course, the white line *which lies nearest to the tibia should be sought* in the fascia, and over this spot the fascia should be opened. Separate with the director the tibialis anticus from the extensor longus pollicis, and the artery will be plainly seen with its nerve to the outer side; detach the venæ comites and pass the needle from without inwards.

Dorsum of the Foot.—Here the artery, besides its coverings of skin and fascia, has closely binding it down a peculiarly dense layer of membrane, which connects the sheaths of the contiguous tendons. Its course corresponds to a line drawn from the front of the ankle, midway between the malleoli, to the centre of the first metatarsal space. To tie the vessel an incision should be made over the artery an inch and a half long, and about three inches in front of the ankle joint. Divide the integuments and deep fascia, and the tendon of the flexor longus pollicis will be exposed; lay open the fascia on the outer side of this, turn aside the short extensor of the toes if it cross the vessel at this spot, and apply the ligature from without inwards.

POSTERIOR TIBIAL.

Course and Relations.—The posterior tibial artery extends from the lower border of the popliteus muscle to the internal lateral ligament of the ankle joint; it is covered in the upper two-thirds of its course by the muscles of the calf and the deep fascia of the leg, in its lower third by the integuments and two layers of fascia. The vessel lies between the bones of the leg, being rather nearer to the tibia; in its upper two-thirds it is found on the tibialis posticus, and between the flexor longus digitorum and flexor longus pollicis; lower down it lies on the flexor longus digitorum, and lastly on the posterior surface of the tibia. The posterior tibial nerve, in all that part of the course of the vessel which is within reach, is on its outer side.

We propose tying it in its upper and lower thirds.

Ligature of Posterior Tibial in Upper Third of the Leg. Position of Subject and Surgeon. The leg being flexed and turned on its outer side, the operator should stand outside the leg on which he proposes tying the vessel.

Operation.—An incision should be made parallel to the inner border of the tibia, and half an inch behind that bone. This should be three or four inches in length, and ought only to divide the skin, as the internal saphena vein usually lies beneath this spot; turn the vein aside, and cut through the attachment of the soleus to the tibia; now seek for the deep fascia of the leg which separates the last-named muscle from the tibialis posticus and deeper muscles of the part. Having recognised this fascia, divide it, and the artery will be found beneath, lying on the tibialis posticus, and surrounded by its companion veins, with its nerve to the outer side. Having cleared the vessel, pass the ligature from without inwards. This artery is sometimes tied by an incision made down the centre of the calf, dividing the muscles and deep fascia; but the objection to this operation is the great depth of the wound, and the very extensive division of muscular fibre which it involves.

The student should be careful in dividing the tibial origin of the soleus, lest he divide also the attachments of the deeper muscles to the tibia, and so make his way between the latter and the bone down to the interosseous membrane, and so, of course, miss the artery he is endeavouring to find. This mistake is best avoided by cutting through the soleus at some little distance from the tibia.

Ligature in Lower Third of the Leg.—To tie the

vessel here an incision should be made, about two inches in extent, parallel with the posterior border of the tibia, and midway between it and the tendo Achillis; cut through the superficial and deep fascia, and carefully divide the deeper layer of membrane which binds down the tendons; the artery will be found beneath, lying on the bone, between the tendons of the longus digitorum and the longus pollicis, and surrounded by its veins. The posterior tibial nerve is nearer to the os calcis than the artery. The venæ comites having been separated, the ligature should be passed between the nerve and the artery.

PERONEAL ARTERY.

Course and Relations.—The peroneal artery follows pretty closely the line of the fibula, lying to its inner side on the posterior aspect of the limb. In the upper part of its course it lies on the tibialis posticus, and before long is overlapped by the flexor longus pollicis, in the fibres of which it generally pursues its course to the bottom of the leg.

Position of Subject and Operator.—The leg should be flexed and laid on its inner side. The operator should stand on the outer side of the leg.

Operation.—The operator should make an incision about three inches in extent along the posterior border of the fibula, rather above the middle of that bone. Divide the soleus from its fibular attachment, and lay bare the deep muscular fascia; open it and search for the vessel just behind the posterior border of the fibula. The ligature may be passed from either side, as there is no accompanying nerve.

POPLITEAL ARTERY.

The subject being turned over on its face, the operator should turn his attention to *the popliteal artery.*

Course and Relations.—This vessel, entering the space of the same name through the tendon of the adductor magnus, ends at the lower border of the popliteus. It does not pursue its course parallel with the long axis of the limb, but inclines slightly from within outwards until it ends exactly in the middle line of the popliteal space. Its course is expressed by a line drawn to the centre of the popliteal space, from a point four inches higher up the limb and an inch to the inner side of the middle line. The artery lies on the back of the femur, the posterior ligament of the knee joint, and the popliteus muscle successively; to its outer side, and partially overlapping it, is the popliteal vein, and, still more external, the popliteal nerve.

Position of Operator.—The operator may stand on the outer side of the limb.

Operation.—The wound for exposing the vessel should be nearly four inches long, and should be slightly oblique in its direction from within outwards, terminating midway between the condyles of the femur. Care should be taken in making the first incision not to injure the posterior saphena vein. On dividing the integuments and fascia, the popliteal nerve will generally be seen; it should be drawn to the outer side, and the vessel sought for to its inner side, where it will be found lying deep in the popliteal space with its vein external to it. Separate the artery and vein, and pass the ligature from without inwards.

Collateral Circulation. (See Diagram 14.)—The collateral circulation is carried on by the anastomotica magna, the superior articular, the external circumflex and termination of the profunda on the one hand, anastomosing with the inferior articular and tibial recurrent on the other hand.

CHAPTER V.

OPERATIONS ON THE GENITO-URINARY ORGANS.

Amputation of the Penis—Excision of the Testicle—Tapping the Bladder through the Rectum—Tapping the Bladder above the Pubes—Lithotomy and Lithotrity—The Supra-pubic Operation—Lithotrity—Lateral Operation—Median Operation—Vaginal Lithotomy—Buchanan's Operation.

AMPUTATION OF THE PENIS.

THIS operation differs from all other amputations, in that, while in those it is essential to provide a tegumentary covering for the stump, it is the design of this to leave the corpus spongiosum prominent for the necessities of urination. In performing the operation it is well to bear in mind the retractile nature of the corpora cavernosa, for these, after division, tend to draw with them the corpus spongiosum downwards towards the scrotum, and to embed the orifice of the urethra in the loose integument of that part.

Position of the Operator.—The operator should stand on the left-hand side of the body.

Operation.—The operator, grasping the extremity of the penis in his left hand, should draw the integument towards the glans; he may now with one vertical sweep of a long knife remove the organ, or he may carry the section obliquely through the parts from behind forwards and above downwards, so as to leave the corpus spongiosum

the most prominent of the three bodies on the surface of the stump. Again, he may divide the skin in a circular manner, and, allowing it to retract, may cut the deeper structures on a level with the lower margin of the wound in the integument. It is recommended by some surgeons to complete the operation by attaching the margins of the mucous membrane of the urethra to the cut edge of the common integuments of the part. The urethra, before being sewn to the external skin, should be split into three divisions, to allow of its orifice being spread out.

Arteries Divided.—There are generally several arteries which require ligature in this operation: the two dorsal vessels, which are found beneath the skin of the penis on its upper surface, the two arteries of the corpora cavernosa, which lie deeper, in those bodies from which they derive their name, and the superficial pudic.

EXCISION OF THE TESTICLE.

Position of the Subject.—To remove the testicle, the body should be drawn to the edge of the table and the thighs separated.

Position of the Operator.—The operator should stand between the thighs, facing the abdomen.

Position and Duties of the Assistant.—The assistant should stand facing the operator, on the right-hand side of the body; his duties are to seize the cord before it is divided by the operator, and prevent it being drawn up into the abdomen, and to hold the scrotum aside whilst the testicle is being dissected out.

Operation.—The operator should grasp the hinder

part of the scrotum with his left hand, pinching it up, and thus throwing forward the testicle and tightening the integuments over it and the spermatic cord. Let him now make a nearly vertical incision, commencing at the external abdominal ring, extending downwards to the lower part of the testicle, and laying bare the gland; forcing the latter forward by tightening the grasp of his left hand, with the point of the scalpel the operator should dissect off the coverings of the cord at that point where it leaves the testicle. When completely isolated, this part may be included in a strong ligature, or held by an instrument for the purpose, to prevent the retraction of its upper end. It should now be divided just above the epididymis, its lower end grasped by the operator, and the testicle dissected out from above downwards, while the scrotum is held aside by an assistant.

Arteries Divided.—The superficial pudic artery is divided in this operation in making the first incision, and in the living body generally requires ligature; in the section of the cord the spermatic, deferential, and cremasteric vessels are divided.

TAPPING THE BLADDER THROUGH THE RECTUM.

Anatomy.—Before performing this operation the student will do well to introduce his finger into the rectum and endeavour to make out the important anatomy of its anterior wall.

Immediately within the sphincter his finger will come upon the bulb and membranous portion of the urethra. About one inch and a half from the anus the apex of the prostate may be detected, and if the finger be carried on

one inch further still, the trigone of the bladder will be reached.

The peritoneal pouch, between the bladder and the rectum, will now be about an inch from the point of his finger, *i.e.* one inch from the back of the prostate, or about 3½ inches from the anus. Behind the prostate he should endeavour to feel the vasa deferentia, which may be generally detected as two rounded cords slightly diverging from each other. It is at this spot, namely in the middle line, immediately behind the prostate and between these cords, that the bladder should be punctured (see Diagram 16).

Instruments required.—A long, slightly-curved trochar and canula is all that is necessary. That invented by Mr. Cock serves its purpose admirably.[1]

Position of the Subject and Operator.—The subject may be placed in the ordinary lithotomy position, or, if preferred, on the left side in the obstetric posture.

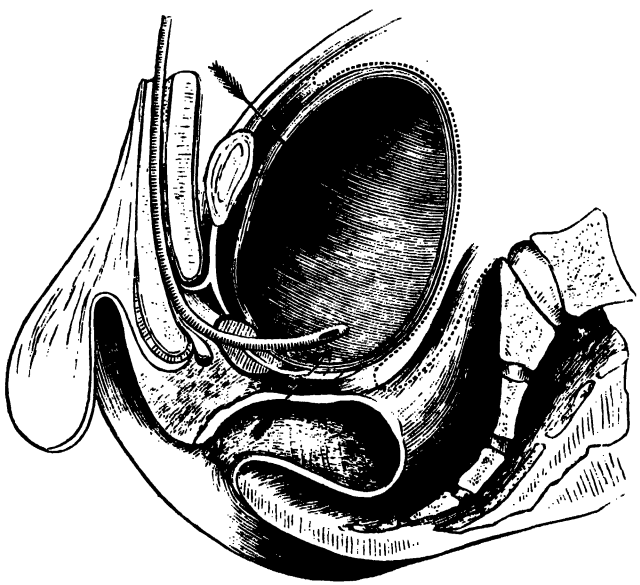
The operator should stand facing the perineum in the former position of the subject, or on the right side if the latter posture is adopted.

Operation.—Having well oiled the fore-finger of his left hand, the operator should introduce it into the rectum, and having made out the trigone of the bladder he should glide the instrument, with the trochar slightly withdrawn into the tube of the canula, along his finger to the spot at which the bladder is to be tapped. The trochar should be now made to protrude from the canula, and thrust into the bladder, and the trochar withdrawn, leaving the

[1] Mr. Davey, of the Westminster Hospital, has also invented a very useful instrument for the purpose.

canula in the cavity of the bladder, where, in the living patient it should be secured by fastening the end of the canula to the margin of the anus. This may be accomplished by means of sutures, or by tying it to the hair around this part.

Fig. 16.



TAPPING THE BLADDER ABOVE THE PUBES.

The bladder should be injected with water before this operation is undertaken.

Anatomy.—A little above the pubes the peritoneum is reflected from the abdominal wall on to the upper part of the bladder, leaving, immediately above that bone, about an inch and a half of the anterior wall of the bladder uncovered by the peritoneum, and only separated from

the abdominal parietes by some loose cellular tissue and fat (see diagram 16).

Operation.—The operator should thrust a long curved trochar and canula backwards and downwards through the linea alba, just above the pubes into the cavity of the bladder, and then withdraw the trochar and secure the canula in the bladder when operating on a living subject.

PERINEAL SECTION.

This operation can hardly be performed with much profit on the dead subject, as the parts are somewhat disturbed by the previous operation of lithotomy.

Position of the Subject.—The subject should be placed in the ordinary position for lithotomy.

Instruments required.—Syme's staff and a straight bistoury.

Position of the Operator.—The operator should sit facing the perineum.

Operation.—Having passed the staff so that its small portion may be situate in the membranous portion of the urethra,[1] the operator thrusts the bistoury through the central line of the perineum, about half an inch in front of the rectum, into the groove on the staff, and divides the urethra for about three-quarters of an inch by cutting from behind forwards in the groove on the staff.

LITHOTOMY AND LITHOTRITY.

The methods of removing a calculus from the urinary bladder necessarily differ in the two sexes.

[1] In the living this portion of the staff should be placed in the stricture, the wider portion being in contact with the anterior entrance to the stricture.

From the male bladder a stone may be removed by lithotrity or lithotomy, which latter operation may be performed in three situations, viz. above the pubes, by the perineum, or through the rectum; from the female a stone may likewise be removed by lithotrity and the supra-pubic operation, or by urethral dilatation, vaginal lithotomy, or the lateral method of Buchanan of Glasgow.

We shall describe the following operations :—

1st. Those applicable to either sex	Lithotrity The Supra-pubic Operation
2nd. Those applicable to the male only . .	Median Lithotomy Lateral „
3rd. Those applicable to the female only . .	Vaginal Lithotomy Buchanan's Operation

We advise the student, should his subject be either male or female, in the first place to practise the steps of the supra-pubic operation as far as the stage of opening the bladder, and having done this to introduce a stone and carefully sew up the incision in the bladder and abdominal walls, and proceed to the performance of the ordinary lateral operation if the subject be a male, or Buchanan's method if a female.

1*st. Operations that may be performed on either Sex.*

HYPOGASTRIC LITHOTOMY.

Having first injected several ounces of water into the bladder, a full-sized staff should be introduced and made to project on the front wall of the abdomen, just above the pubes.

The operator should next make an incision exactly in the middle line through the skin and subcutaneous fasciæ,

commencing immediately above the pubes and continued for about two inches upwards, but not higher, lest the peritoneum be injured (see diagram 16).

The tissues forming the linea alba may next be divided on a director, from below upwards, taking care not to wound the peritoneum should it descend lower than usual on the abdominal wall.

The operator should now carefully make his way through the loose cellular tissue between the abdominal walls and bladder, and, lastly, make an incision into this viscus by cutting through its anterior wall on to the projecting staff.[1] The finger may now be introduced through this opening, which should be then enlarged sufficiently to allow of the easy extraction of the stone. On the dead subject there will, of course, be no stone in the bladder during the performance of this operation.

A stone or a soft piece of chalk should be now introduced, while the edges of the bladder wound are held asunder by forceps, and the incisions sewn up, and one of the following operations performed :—

LITHOTRITY.

As this does not differ essentially in the two sexes we shall let one description suffice.

Three or four ounces of water should be injected into the bladder, a soft piece of chalk, about the size and shape of an acorn, having been previously introduced.

[1] On the living the edges of the wound in the bladder must be secured by blunt hooks during the introduction of the forceps.

Position of the Subject.—The subject should lie on its back, with the pelvis slightly raised on a block.

Position of the Operator.—The operator should stand on the right-hand side of the subject.

Instruments required.—A lithotrite only is required on the dead subject.

Operation.—Having introduced the lithotrite into the bladder, the operator should endeavour to seize the stone. This he may do in one of two ways, viz:—

1st. By Brodie's method.

2nd. By Civiale's method.

Brodie's Method.—By this method, the handle of the lithotrite being raised, the convex part of its curved extremity will be brought into contact with the posterior wall of the bladder. The operator should now open the lithotrite by gently withdrawing with his right hand the sliding, or male, blade to some extent, according to the size of the stone. The fixed, or female, blade, being at the same time firmly held by his left hand, and gently pressed downwards towards the rectum, will thus be below the level of the other parts of the bladder, and the stone will most probably fall into it by its own weight, and will be caught by sliding back the male blade. If the stone does not thus fall between the blades, the handle of the lithotrite may be gently shaken by the left hand of the operator, and it will now, probably, be caught. Should it not be grasped by this means the lithotrite may be closed and turned slightly to either side, and the same manipulations repeated.

Having seized the stone, the blades of the lithotrite should be fixed by pressing up the spring placed on the

handle, and the stone lifted from the floor of the bladder by withdrawing the lithotrite a little. The male blade should be screwed home and the stone crushed.

Civiale's Method.—Civiale's method consists in turning the opened blades of the lithotrite towards the stone and in endeavouring to seize it without touching the walls of the bladder.

As lithotrity is an operation unadapted for performance on the dead subject we shall not enter into further detail concerning it.

2. *Operations that can be practised on the Male Subject only.*

A. THE LATERAL OPERATION.

Instruments required.—The instruments required on the dead body are :—

1. A lithotomy knife; 2. Lithotomy forceps; 3. A staff with the groove on the left side.

Position of the Subject.—The staff having been first introduced, the subject should be tied up with the soles of the feet in the palms of the hands, in the ordinary position for lithotomy. The perineum, thus exposed, should be drawn to the edge of the table and shaved if necessary.

Position of the Operator.—The operator should sit on a low stool facing the perineum.

Position and Duties of the Assistants.—Three assistants are required. One should stand on each side of the body and hold the legs well apart. A third, placed on the left side of the subject, should take charge of the staff and hold the genitals out of the way.

Manner of Holding the Staff.—The staff should be firmly grasped by the assistant with his right hand, and hooked gently up under the pubes, with its handle in a vertical position. It should be steadied by placing the thumb upwards, pressing against the flattened portion of the handle, while the fingers grasp the instrument just below this.

Operation.—It may be well, before commencing, to pause for a minute, and consider what are the various steps in the operation. The operator must first satisfy himself that the staff is fairly in the cavity of the bladder;[1] it must then be entrusted to an assistant, who should hold it as before described, and at the same time keep the scrotum out of the way. The perineum is now to be carefully examined, to ascertain the position of the tuberosities of the ischia, and the relative situation of the staff as it passes beneath the pubic arch.

The operator has to divide the integuments, the superficial and deep perineal fasciæ, to make his way through the loose tissue between the urethra and rectum, to open the former at the junction of its membranous and prostatic portions, and to prolong the wound in the urethra for a short distance onwards towards the bladder. The wound has to be dilated, and the stone extracted.

Incision.—The operator, steadying the parts with the fore-finger and thumb of his left hand, and holding the knife horizontally, like a pen, in his right hand, should make an incision in the perineum from two to three

[1] On the living subject the surgeon should always, previously to operating, strike the stone himself with the *staff*, and get one of the assistants to do the same, so that there may be no possibility of a mistake concerning the presence of the stone, or of the staff being well in the cavity of the bladder.

inches in length, commencing slightly to the left side of the middle line a little below the tendinous centre of the perineum.[1] This incision should be carried downwards, outwards, and to the left to a point just below the anus, but one third nearer to the tuberosity of the ischium than to the verge of the anus.

The knife having penetrated pretty deeply into the fat of the ischio-rectal fossa may be withdrawn, and the fore-finger of the left hand introduced to feel for the staff; if any considerable thickness of parts remain undivided over the staff, the knife may be re-introduced and used to assist the finger in making its way to the membranous portion of the urethra. The staff being plainly felt, the nail of the left fore-finger should be pressed against the groove, and the knife guarded, by laying it on its flat against the palmar surface of the finger, should be made to enter the groove a little in front of the prostate. The handle of the knife should be now slightly depressed and its edge turned downwards and outwards towards the left side. The knife thus protected and lateralized, with its point pressed well into the groove of the staff, should be pushed onwards towards the bladder, so as to divide the prostate to a small extent on its under and left-hand aspect[2]; this wound should be of sufficient size to admit the finger. Having stretched the wound in the prostate with the fore-finger of the left hand to a suffi-

[1] The tendinous centre of the perineum is situate midway between the anterior verge of the anus and the fold of the scrotum, i.e. about one inch and a half in front of the anus. An incision commencing a little below this point will, therefore, be just below the bulb. The subject is supposed to be of adult proportions.

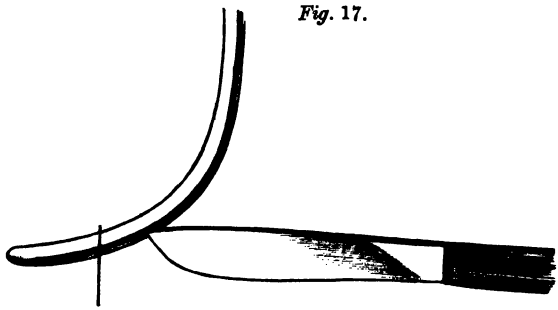
[2] *Left hand of the patient.*

cient extent, the staff should be withdrawn, and the forceps introduced as the finger is taken out of the wound. If there is any urine in the bladder, the stone may be grasped at once, but if the attempt to seize the stone on the first introduction of the forceps prove unsuccessful, the blades being closed, they may be used gently to feel for the stone; the subsequent effort to extract must be gentle and continuous, and should be made in a downward direction.

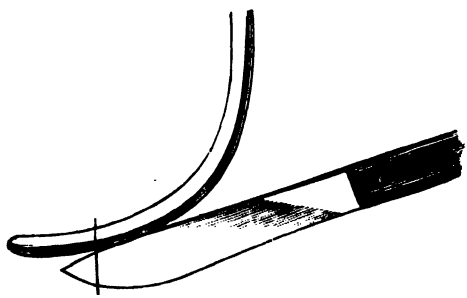
The parts cut through in the several steps of the operation are:—The skin and superficial fascia; the deep layer of the superficial fascia; the transversus perinei muscle, vessels, and nerve; a few branches of the inferior hæmorrhoidal vessels in the ischio-rectal fossa, the superficial perineal vessels and nerves; the anterior fibres of the levator ani, part of the compressor urethræ muscle; and the membranous and prostatic portions of the urethra.

We venture here to remind the operator of some of the more common errors that one is likely to fall into in the performance of this operation, and the best means of guarding against them. On making the first incision care should be taken not to commence it too far forwards, or the bulb and its artery will be endangered, nor should it be prolonged too far backwards, lest the rectum be wounded: again, any considerable deviation outwards will bring the knife in dangerous proximity with the trunk of the pudic artery. In deepening the first incision, the position of the bulb and rectum should be borne in mind, the former at the upper, and the latter at the lower angle of the wound; in incising the prostatic

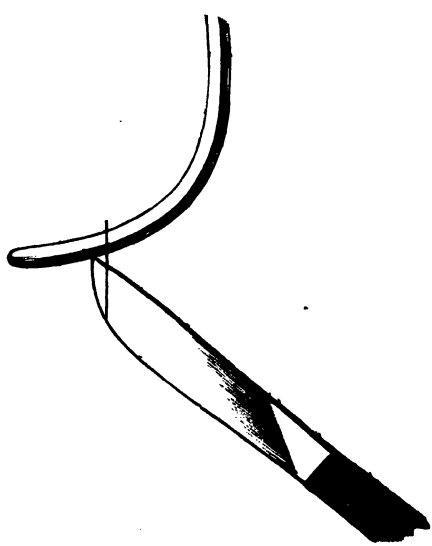
Fig. 17.



Right way of holding knife.



First wrong way of holding knife.



Second wrong way of holding knife.

urethra, the cutting edge of the knife should be directed downward, outwards, and to the left-hand side of the body, and great care should be exercised lest, in prolonging the wound in the urethra, the point of the knife escape from the groove in the staff; this latter is one of the most unfortunate accidents that can happen, as it leads to still greater difficulties. It can best be avoided by holding the knife well pressed into the groove of the staff; but in doing this the handle must not be too much depressed, or the prostate, and, possibly, the capsule of this organ also, will be completely divided. (See diagram, *fig.* 17.) This accident on the living would most probably lead to extravasation of urine. The staff should not be withdrawn until the operator feels certain that his finger is within the cavity of the bladder, and, if possible, in contact with the stone. Lastly, we would strongly recommend the operator to proceed to work quietly, and continue to the termination of the operation without any attempt at brilliancy of execution.

B. THE MEDIAN OPERATION.

Many different proceedings have been adopted for opening the bladder in the median line. We shall confine ourselves to a description of the operation as performed by Mr. Allarton, which we give in the author's own words:—'I introduce a grooved staff in the usual manner and of the usual size, and confide it to an assistant, with directions to keep it perpendicular and hooked up against the pubes; I then introduce the index-finger of my left hand into the rectum, placing its extremity in

contact with the staff as it occupies the prostate, and press it firmly against the staff so as to steady it; then, with a sharp-pointed straight knife, with a tolerably long and rough handle, I pierce the perineum in the middle line about half an inch in front of the anus,[1] or at such a distance as may appear necessary to avoid dividing the fibres of the external sphincter. I carry the knife steadily and firmly on till it strikes the groove of the staff, the deep sphincter lying between the knife and the directing finger, which enables me to judge of the distance as the knife passes along. Having struck the groove of the staff, I move the point of the knife along the groove towards the bladder a few lines and then withdraw it, cutting upwards, so as to leave an external incision of from three quarters of an inch to one and a half inches, according to the presumed size of the stone; the escape of urine indicates the entrance to the urethra. I then introduce a long ball-pointed probe or wire through the external opening into the groove of the staff and slide it into the bladder, to sufficient depth to insure its safe lodgment in that viscus, and withdraw the staff. I then well grease the index-finger of the left hand, and pass it along the probe with a semi-rotatory motion, through the prostate, into the bladder, which procedure is accomplished without difficulty; and when the stone is free it comes in contact with the finger, and if of moderate size passes at once into the wound on withdrawing the finger.' The forceps are introduced and the stone grasped, as in the lateral operation.

[1] The edge of the knife being turned upwards.

3. *Operations that can be performed on the Female Subject only.*

The Lateral Operation, as practised by Dr. Buchanan, of Glasgow.—"The subject being placed in the ordinary position for lithotomy, the operator having first introduced a grooved staff into the bladder and entrusted it to an assistant, should make an incision with a common scalpel on the left side of the vulva, beginning opposite the clitoris, and cutting obliquely across the left labium minus in a line with the ramus of the ischium.

"When the groove in the staff is felt by the finger in the wound the operator should pass a straight bistoury into the groove anterior to the neck of the bladder, and run it along into the vesical mouth. The wound may be enlarged by cutting outwards and downwards towards the left tuber ischii, care being taken not to penetrate the vaginal wall. The finger can now be easily passed into the bladder and the stone extracted."

We strongly recommend this operation, and that of vaginal lithotomy, to the attention of the student, as we are convinced that they are both far superior to dilatation of the urethra when the stone is at all large.

VAGINAL LITHOTOMY.

By vaginal lithotomy we mean the extraction of a stone through an incision into the bladder, through the front wall of the vagina, behind the vesical orifice of the urethra.

Anatomy.—The front wall of the vagina is about four inches in length, and has projecting into it above

the neck of the uterus; below this it is in contact with the lower wall of the bladder, and still more anteriorly with the urethra, which is, as it were, embedded in its substance, and can be felt as a rounded cord through the vaginal wall when the finger is introduced into this canal.

The peritoneum, being reflected from the anterior surface of the uterus about half-way down this organ, consequently does not come into contact with the front wall of the vagina. There are likewise no vessels of importance between the vagina and bladder in the middle line.

Instruments.—A duck-bill, speculum, forceps, probe-pointed scissors, and a long-handled scalpel.

Position of the Subject.—The subject should be placed in the ordinary position for lithotomy, with the pelvis well raised on a block, so as to better expose the anterior wall of the vagina.

Position of the Operator.—The operator should sit facing the perineum.

Position and Duties of the Assistant.—The assistant should be stationed on the right-hand side of the subject. Having introduced a speculum—should endeavour to thoroughly expose the anterior wall of the vagina by drawing the posterior wall downwards with the speculum.

Operation.—The operator should first introduce a small pair of forceps into the bladder through the urethra, and having seized the stone, should hold it so that it may project through the anterior wall of the vagina. He should next make an incision from behind forwards, about

two inches in length, through the vaginal wall, exactly in the mesial line, cutting on the stone. This incision should not encroach upon the urethra in front, and should stop short of the neck of the uterus posteriorly. Ordinary lithotomy forceps should now be introduced into the bladder through the wound, and the stone placed between their blades by the small forceps already grasping it. The smaller forceps being now withdrawn by the urethra, the stone may be extracted by the larger ones through the wound in the vaginal septum.

CHAPTER VI.

OPERATIONS ABOUT THE MOUTH, LARYNX, AND PHARYNX.

Excision of Tongue—Excision of Lower Jaw—Excision of Upper Jaw—Tracheotomy—Laryngotomy—Œsophagotomy.

EXCISION OF THE TONGUE.

THE tongue may be either partially or completely excised.

Partial excision may be accomplished by the knife or écraseur.

By the Knife.—As removal by the knife simply consists in cutting off the anterior portion of the organ, we shall make no further comments upon it, than that we do not advise this method of excision, as it is attended on the living with profuse hæmorrhage often very troublesome to control.

By the Ecraseur.—The operator, seizing the tongue with the artery forceps, passes a thread, by means of a curved needle, through its tip, and then, drawing it forwards by making traction on the thread, he intrusts it to his assistant, who should keep it well drawn out of the mouth. He next carries a strong thread, by means of the same needle, well behind the disease, on the living patient, or as far back as convenient when practising on the dead subject, and, having attached the wire of the écraseur to this thread, he withdraws the thread, leaving the wire in its place. In like manner he passes the wire

of a second écraseur through the tongue at the same spot, and, having well included the diseased portion of the tongue between the two wires, he tightens the écraseurs and begins removing the diseased portion by working the handles of the instruments. A turn of the handle should be made about once every twenty seconds.

2. *Complete Excision.*—The tongue may be completely excised by one of the following methods:—

1. Mr. Syme's.
2. Rignoli's.
3. Nunneley's, of Leeds.
4. Paget's.

We shall describe briefly all four methods, but we advise the student to practise the last-named proceeding only.

Syme's Method.—Mr. Syme divides the lower lip down to the bone, and after drilling a hole through each half of the jaw near the symphysis, so as to allow of the parts being held in apposition after the operation by a silver wire suture, he cuts through the symphysis.

The origin of the mylo-hyoid, genio-hyoid, and genio-hyo-glossus muscles, are now separated from the jaw; and the tongue is drawn forwards and removed by one sweep of the knife; or the écraseur may be made use of instead of the knife at this stage of the operation.

Rignoli's Method.—Rignoli, of Pavia, makes an incision along the lower border of the inferior maxillary bone stretching nearly as far back as the angle on either side. This incision he bisects by a second, reaching from the chin to the hyoid bone.

The flaps thus formed are reflected on either side, and

the soft tissues connecting the tongue to the symphysis divided. The tongue is then drawn out through the wound and removed either by the knife or the écraseur.

Mr. Nunneley's Method.—Mr. Nunneley introduces the wire of the écraseur beneath the chin through the soft tissues forming the floor of the mouth; this he does by means of a curved needle, and, having carried the wire over the base of the tongue, he brings the end of it out at the same opening, thus leaving a loop of the wire round the base of the tongue. The organ is then removed by tightening the écraseur.

Paget's Modification for Complete Removal of the Tongue.—Sir James Paget first clears the mucous membrane from the bone with a scalpel, and then divides the origin of the genio-hyo-glossi muscles close to the symphysis. The tongue being pulled out of the mouth, the wire of the écraseur is then easily passed round the base of the tongue, and the organ can be removed in the usual manner.

The foregoing operations are not usually practised on the dead subject.

REMOVAL OF THE LOWER JAW.

We proceed to describe this operation before treating of excision of the superior maxillary bone, as its performance does not interfere with the subsequent execution of that operation. With care, on the same face both sides of the inferior maxilla may be removed as well as both superior maxillary bones.

It is only necessary to describe the method of removing half this bone: should the whole need removal, it is best

accomplished by cutting the bone in two, and removing each half separately. The head should be slightly raised on a block.

Instruments required.—Scalpels, large bone forceps, lion forceps, a small shallow-backed saw, and forceps for the incisor teeth.

Position of Operator.—The operator should stand on the right-hand side of the body facing the subject.

Operation.—Having extracted one of the central incisor teeth, an incision must be made along the lower border of the jaw, commencing at the symphysis and extending up the ramus as far as the lobule of the ear, but not farther, so as to avoid the division of the facial nerve; the facial artery should be recognised, as, at this stage of the operation on the living body, it has to be tied. The masseter muscle with the soft parts must be reflected upwards from the bone, until the cavity of the mouth is reached; the flap thus formed being held aside by an assistant, the saw is to be applied to the bone at that part where the tooth has been extracted, until a pretty deep groove has been cut; to this apply the cutting bone forceps, and complete its division. The part to be removed should now be grasped at its extremity with the lion forceps and be drawn upwards and outwards, away from the deeper structures, while a narrow-bladed scalpel is inserted beneath the bone and drawn outwards and upwards along the under and inner surface of the body and ramus, keeping close to the bone in its course, so as to avoid the gustatory nerve and submaxillary gland. The internal pterygoid should now be carefully separated from its insertion, forcible traction being made on the jaw so as

to depress the coronoid process, and facilitate the division of the temporal muscle. The dental nerve being now divided at the spot where it enters the dental foramen the articulation should be opened from the front and the jaw dislocated. The knife should now be cautiously carried behind the condyle, and the few remaining connections torn through by forcibly wrenching the jaw, taking care not to wound the internal maxillary artery by twisting the jaw outwards.

An important point to remember in the foregoing operation is to be careful to keep the edge of the knife close against the under surface of the bone, while dividing the deeper parts; and the only difficulty in its performance is the complete division of the insertion of the temporal muscle on the inner surface of the coronoid process, and that of the external pterygoid in front of the condyle of the jaw.

REMOVAL OF THE UPPER JAW.

This operation may be performed on the same side of the face as that from which the lower jaw has just been removed, if not on the opposite side.

Anatomy.—The principal attachments of this bone, which must be divided before it can be removed, are the articulations on its outer and upper angle with the malar bone, its articulation by the ascending or nasal process with the frontal bone, and its junction in the middle line of the hard palate with the bone of the opposite side. These points must be divided with the bone forceps; its remaining connections may be torn through. Besides the instruments necessary for the removal of the lower

jaw, large-cutting bone forceps are required for this operation, and forceps for the upper incisor teeth.

Position of Operator.—The head of the subject being raised on a block, the operator should stand facing the body, on its right-hand side.

Operation.—One of the central incisor teeth should be drawn, and a curved incision made with its convexity downwards, beginning at the angle of the mouth, and extending upwards and outwards to about the centre of the malar bone. Having recognised the position of the facial artery, this flap should be drawn upwards by an assistant, while it is dissected from its deep connections until the lower margin of the orbit is exposed: inwards it should be reflected so as to separate the lateral cartilage of the nose from the bone, and expose the cavity of the nostril and the nasal process of the upper jaw; and externally it must be thrown back as far as the malar bone. The mucous membrane on the floor of the nostrils and roof of the mouth may now be divided longitudinally from behind forwards by an incision, falling just aside of the middle line, and ending at the alveolus occupied by the incisor tooth just extracted. This longitudinal incision should extend backwards as far as the junction of the superior maxillary and palate bones and from this point a transverse incision should be carried outwards down to the bone, as far as the molar teeth along the line of the palato-maxillary suture. The operator, taking in hand the cutting forceps, should place one blade in the nostril and the other in the mouth, and thus divide the hard palate; next, placing one blade in the nostrils against the nasal process of the bone, and the other in the inner

angle of the orbit at its lowest part, he should cut the nasal process; lastly, he should separate the upper jaw from its connection with the malar bone—and this may be effected at one stroke of the forceps, cutting from under the malar bone into the inner angle of the orbit; or, better, by two separate divisions, first cutting upwards, and subsequently backwards into the inner angle of the orbit and spheno-maxillary fissure. The lion forceps being now fixed firmly into the bone, it may be twisted from its remaining attachments, the knife being used to divide the superior maxillary nerve or any of the soft parts that may need its application.

There is another, and perhaps a better, plan of incising the skin of the face for this operation. It was first adopted, we believe, by Sir W. Fergusson. It consists in cutting through the middle line of the upper lip to the margin of the nostril, and continuing the incision close around the alar cartilage, up the side of the nose to the inner angle of the eye, and, if necessary, prolonging it outwards along the inferior margin of the orbit. This method has the advantage of leaving a more sightly cicatrix than the plan formerly adopted.

It often happens on the living body that circumstances admit of the orbital portion of this bone being left undisturbed; this may be done by sawing transversely across the bone below the lower rim of the orbit, from the nostrils to the malar bone.

TRACHEOTOMY.

Anatomy.—The trachea, so far as it concerns us in operative surgery, extends from the lower border of the cricoid cartilage to the first bone of the sternum.

In its passage down the neck it gradually recedes from the surface, and, from being at its commencement comparatively subcutaneous, it lies just above the first bone of the sternum, a full inch beneath the skin.

Though overlapped on either side by the depressors of the os hyoides, yet in the middle line, where it is always opened, it is covered only by the integuments, superficial and deep cervical fasciæ, a layer of membrane uniting the contiguous margins of the sterno-hyoid muscles, and some loose cellular tissue. About half an inch below the cricoid cartilage it is crossed by the isthmus of the thyroid gland, and from this point to the sternum it has the middle thyroid veins in front of it, as they run to join the left innominate. In many bodies there is another large vein in front, immediately beneath the integuments, which takes the place of the anterior jugular.

The operator should also remember that the innominate artery and left innominate vein occasionally cross the trachea higher than usual, and may be found above the first bone of the sternum. A large artery, called the thyroidea ima, arising either from the innominate or directly from the arch of the aorta, may likewise be found in front of the trachea.

The trachea may be opened either above the isthmus of the thyroid gland, or between this and the sternum, though in many cases the isthmus is so insignificant in

size that any part of the tube may be safely exposed. The extent of that part within reach of the surgeon varies much in different bodies, depending upon the length of the neck.

Very little idea can be formed of the difficulties of this operation on the living from its performance on the dead body; still its practice should not be neglected, as one can thereby acquire a familiarity with the appearance and arrangement of the structures covering the air-tube.

Instruments required.—Scalpels, sharp and blunt; forceps, retractors, tracheotomy tubes, blunt and sharp-pointed hooks.

Position of the Subject.—The subject should be placed horizontally on its back, with the neck supported on a block, and its head thrown back so as to expose the neck thoroughly.

Position of the Operator and Assistant.—The operator should stand on the right-hand side of the subject facing the neck.

The assistant should be placed on the opposite side of the subject facing the operator.

Operation. — 1. *Above the Isthmus of the Thyroid Gland.*—Having accurately determined the position of the cricoid cartilage, the operator should make an incision about an inch and a half long, over the trachea in the middle line of the neck, commencing at the lower border of the above-mentioned cartilage. Having divided the skin, subcutaneous and deep fasciæ, the knife should be used more carefully, and the deeper layer of fascia connecting the contiguous edges of the sterno-hyoid muscles divided, taking care in doing this not to wound any large

veins or arteries which may be met with. The isthmus of the thyroid gland will be now exposed, and, should there be found too little room between this and the cricoid cartilage, the former may be drawn down with a blunt hook; or, if this be found impossible without doing unjustifiable violence to the parts, as is sometimes the case, the isthmus may be divided and the bleeding attending this operation arrested by ligature.

The dissection should be now continued in the middle line of the neck until the air-tube is fully exposed. All arterial hæmorrhage on the living patient having been arrested, it may be opened by a longitudinal incision about three-quarters of an inch in extent. This may be accomplished by thrusting in the knife, with its back turned towards the sternum, and cutting through one or two rings in an upward direction. In the living, some surgeons steady the trachea by thrusting in a sharp hook just below the cricoid cartilage before opening it with the knife. The inner tube of the tracheotomy canula having been previously withdrawn from the outer bivalved portion, the latter should be introduced with its convexity upwards, its sides being pressed together by the thumb and fore-finger of the operator's right hand.

During its introduction the point should be first directed backwards and subsequently turned downwards, being guided by the operator's left fore-finger placed in the wound. The inner portion of the tube should now be placed in the outer, and the canula secured in position by tapes. Some surgeons advise, after the first layer of fascia has been divided, the laying aside of the knife

and the exposing of the trachea by tearing the deeper structures by means of two pairs of forceps held in either hand.

2. *Below the Isthmus of the Thyroid Gland.*—Divide the skin over the middle line of the neck for two inches, draw aside any veins that may show themselves, and lay open the cervical fascia and the fascia of the sterno-hyoid muscles. Surrounding the trachea at this point is usually found a layer of loose cellular tissue, which should be torn through, as previously described, and the trachea opened and tube passed as in the preceding operation.

In opening the air-tube at this point, it should be borne in mind, as before stated, that occasionally the innominate artery and left innominate vein ascend high enough in the neck to be exposed to injury.

LARYNGOTOMY.

The larynx may be opened at the crico-thyroid membrane. The extent of this membrane varies much in different individuals. It rarely measures more than half an inch from above downwards; and we have in one or two instances observed the distance between the thyroid and cricoid cartilages to be too small to allow of the passage of an ordinary tube.

The membrane in question is left bare in the mesial line of the neck by the divergence of the crico-thyroid muscles; and this is the spot selected for its perforation. It is covered by the skin and superficial fascia, and has in addition a fascia connecting the crico-thyroid muscles. The crico-thyroid artery, a branch of the

superior thyroid, is found running across the membrane at its upper part.

Instruments required.—A scalpel, forceps, and a laryngotomy trochar and canula, or an ordinary tube, are required for this operation.

Operation.—Make an incision an inch long in the middle line of the neck over the crico-thyroid membrane, divide the subjacent fasciæ, and clear the centre of the membrane. Open the larynx either by a crucial incision through the crico-thyroid membrane with the scalpel, or by perforating it with the laryngeal trochar, and introduce the tube as before described.

ŒSOPHAGOTOMY.

The alimentary tube can be reached at any part of its course in the neck, from the lower border of the thyroid cartilage down to a point within an inch of the upper border of the sternum. The part that is most convenient for the performance of the operation in question is where the pharynx contracts itself and ends in the œsophagus, just below the situation of the cricoid cartilage; here the œsophagus lies behind the air-tube, in front of the spine and between the great vessels and nerves of the neck. The part of its course to which we refer is, fortunately, that in which a mass of unmasticated food or other foreign body is most likely to stick.

Instruments required.—Scalpels, forceps, and retractors.

Position of the Subject and Operator.—The head of the subject should be thrown back, and the chin turned

towards the right side. The operator should stand on the left side of the body.

Operation.—Having first thrust a foreign body into the pharynx, and having made it project at the situation at which it is intended to open the tube, the operator should make an incision parallel to the line of the sterno-mastoid muscle on the left side of the larynx, commencing at the lower border of the thyroid cartilage and extending downwards for three inches; this cut should fall just over the interspace between the great vessels of the neck and the trachea. The platysma and cervical fascia being divided, the interval between the sterno-hyoid and omo-hyoid should be sought, and through this the operator should break his way with the point of the director, searching for the deeper part of the trachea; behind this the œsophagus will be found, and should be opened by a longitudinal incision. The inferior thyroid artery and recurrent nerve should be avoided during the search for the œsophagus in the bottom of the wound. The operation is usually performed on the left side, on the ground that the œsophagus deviates slightly to this side in its course down the neck. Practically, this deviation is scarcely appreciable on the body.

CHAPTER VII.

AMPUTATION OF THE BREAST.

THE main object in this operation is to leave sufficient integuments and soft parts to cover, without stretching, the wound inflicted by the removal of the gland.

Instruments required.—A large scalpel, artery or torsion forceps. A large scalpel is the only instrument required for this operation on the dead body; it should be held as a pen if the breast is small, or it may be grasped more firmly in the second or third position (p. 4) if the breast is large.

Position of Subject and Operator.—The subject should lie on its back, with the shoulders supported on a block. The operator should stand on the same side of the body as that of the breast to be removed, the corresponding arm of the subject being carried out from the side, so as to put the pectoralis major on the stretch.

Operation.—The operator should make two semi-elliptical incisions, having their long axes parallel with the fibres of the pectoralis muscle, and including between them the nipple and a sufficiency of skin to allow of the removal of the gland through the wound. The advantages of having the incisions in this direction are that it enables the surgeon to extend the wound into the axilla, should any large glands require removal from

that region, and that after cicatrisation it allows of freer movement of the arm. These incisions should meet one another beyond the axillary and sternal borders of the breast respectively. For the right breast the upper incision should be first made, commencing from the axilla; it should extend pretty deeply into the subcutaneous fat; it should not cut quite vertically through the skin, but rather in an upward direction, so as to pass over the convex surface of the breast without injuring the glandular structure. The lower incision should next be made from the sternum towards the axilla, and this also should be adapted somewhat to the convexity of the breast.

Many operators on the living subject make the lower incision first, so that the parts may not be obscured by the blood from the upper when this is first formed. While the assistant grasps the gland and draws it upwards, the operator should seize the skin at the lower edge of the wound and dissect it off the breast until the lower border of the gland comes into view; lifting up this, and dissecting between it and the pectoral muscle, he must *completely* undermine the gland. Taking the breast into his own hand, and drawing it downwards while the assistant raises the upper edge of the wound, the operator should dissect away the coverings from the upper part of the gland until he reaches its upper boundary, when the separation of the breast will be complete.

Arteries divided.—Perforating arteries from the internal mammary; the long and short thoracic branches of the axillary.

CHAPTER VIII.

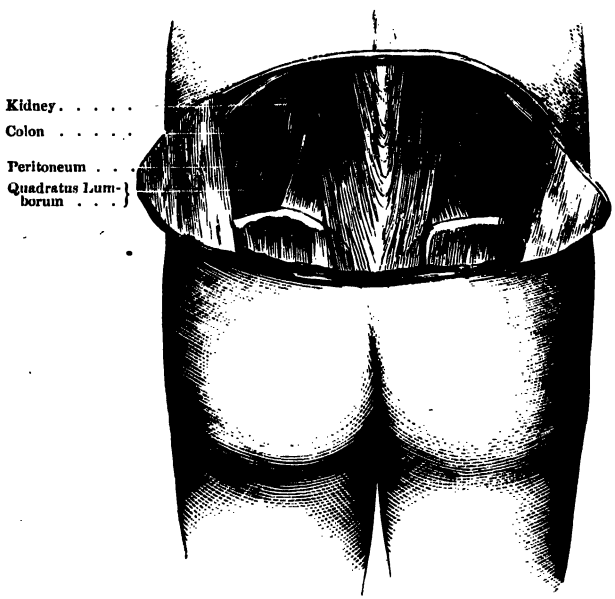
COLOTOMY.

THE large intestine has been opened in various situations. We shall confine ourselves to a description of the operation of colotomy as performed in the right and left lumbar regions.

Anatomy.—The colon, commencing in the cæcum in the right iliac fossa, first ascends in front of, and a little external to, the quadratus lumborum, then in front of the right kidney to the liver, where it makes a bend and crosses the abdominal cavity to the spleen, from whence it descends in front of the left kidney, and in front of, and slightly external to, the left quadratus to the left iliac fossa, where it terminates in the sigmoid flexure. The ascending and descending portions of the colon are usually uncovered by peritoneum, and only attached to the kidney and fascia transversalis by some loose cellular tissue and fat. But the student should remember that the ascending colon, and more rarely the descending colon, are occasionally completely surrounded by peritoneum. When distended, the gut projects external to the margin of the quadratus, and its peritoneal covering may be stretched until a considerable portion of the posterior surface of the bowel is left uncovered by peritoneum (see diagram 18).

The bowel may be known by the arrangement of the muscular fibres forming its coats and the direction of its blood-vessels. The portion of intestine within reach when operating in the lumbar regions is limited above by the lower border of the kidney, and below by the crest of the ilium; at this point the gut lies upon the

Fig. 18.



aponeurosis of the transversalis muscle, partly to the outer side of the quadratus lumborum, and behind the peritoneal sac and mass of the small intestines. More or less loose fat separates the bowel from the fascia transversalis.

The exact position of the outer border of the quadratus lumborum muscle and with it the colon, according to Mr.

Allingham, was in fifty dissections half an inch posterior to the centre of the crest of the ilium.

Position of the Subject.—The subject should lie on its face, the loins being made to project by placing several blocks beneath the abdomen.

Position of the Operator and Assistant.—The operator should stand on the left-hand side of the body. The assistant should face the operator on the opposite side of the body.

Instruments required.—Scalpels, artery and common forceps, curved needle in handle, ligature silk, retractors, and a director.

1. COLOTOMY IN THE LEFT LOIN, COMMONLY CALLED AMUSSAT'S OPERATION.

An oblique incision should be made midway between the last rib and the crest of the ilium, beginning at the external border of the erector spinæ just below the last rib, and continued downwards and outwards for about three inches towards the crest of the ilium. The skin and superficial fascia being divided, the latissimus dorsi, and perhaps a small portion of the external oblique muscle, will come into view. These must next be divided, along with the posterior layer of the lumbar aponeurosis on a director, when the edge of the erector spinæ will be exposed. The aponeurosis of the transversalis and internal oblique being next cut through on a director the outer border of the quadratus will be seen, and is the guide on the dead subject to the gut. On the living subject the distended bowel will most probably project at the wound; but on the dead, search must be made with the point of

the director in the loose fat and cellular tissue immediately external to the quadratus, and the bowel, having been found, must be drawn slightly into the wound and secured by sutures, and then opened by a crucial incision and fastened by the sutures to the integuments.

2. OPERATION IN RIGHT LOIN.

This may be performed in the same manner as the former operation, and does not require a separate description.

CHAPTER IX.

AMPUTATIONS.

General Remarks—Amputation of Upper Extremity—Various Methods—Instruments—Assistant—Amputation of the Phalanges of the Fingers by Disarticulation—Anatomy of Phalangeal Articulations—Disarticulation of the Distal Phalanx of the Fingers or Thumb by a single Palmar Flap—Removal of the Fingers at their Second Joints—Amputations of the Phalanges of the Fingers by Double Flaps—Disarticulation of the First, Second, and Third Fingers at their Metacarpal Joints—Disarticulation of the Little Finger at its Metacarpal Joint—Disarticulation of the Fingers *en masse* at their Metacarpal Joints—Amputation through the Third and Fourth Metacarpal Bones—Amputation of the Thumb at its Articulation with the Trapezium—Circular Method—Flap Method—Amputation of the Hand at the Carpo-Metacarpal Articulation, leaving the Thumb and its long Muscles intact—Amputation of the Hand at the Wrist-joint: (1) By a Palmar Flap, (2) by Double Flaps, (3) by an External Flap, (4) by the Circular Method—Amputation through the Fore-arm—Anatomy: (*a*) the Circular Method, (*b*) the Flap Operation, (*c*) Integumental Flaps and Circular Division of the Muscles, (*d*) Mr. Teale's Operation—Amputation of the Arm: (*a*) the Circular Method, (*b*) the Double Flap Operation by Transfixion, (*c*) the Operation by Integumental Flaps and Circular Division of Muscles, (*d*) Mr. Teale's Method—Amputation at the Shoulder Joint: (1) by Upper and Lower Flaps, (2) by Anterior and Posterior Flaps.

GENERAL REMARKS ON AMPUTATIONS.

AMPUTATIONS are generally classed as those of continuity, or amputations proper, and those of contiguity, or disarticulations. The object in view in all methods of amputation is the same—namely, after the removal of the part, to secure a suitable and sufficient covering for the end of the bone, to avoid adhesion between the latter and the cicatrix of the integument; to divide the large nerves

and blood-vessels transversely, and to leave their cut ends in a part of the stump little exposed to pressure. Stumps are either formed of integuments alone,[1] or of muscular tissue and integument together; where the parts admit of it, sufficient muscle is detached to form a cushion around the end of the bone, and enough integument is reflected to cover the whole. The ingenuity of operators, and the varying necessities of different parts of the body, have given rise to four principal methods of amputation: (1) the circular; (2) the flap; (3) a combination of the two preceding operations; and (4) the oval method.

(1.) *The circular method* consists in the formation of a circular incision of the integuments in the entire circumference of a limb; the division of the muscles in the same manner, though higher up the limb, and in the section of the bone at a point still nearer the body. It has its advantages in a comparatively small external wound and a transverse division of the large blood-vessels of the part; on the other hand, the resulting cicatrix is liable to be opposite and adherent to the extremity of the bone, and the operation requires more care and skill in its execution than the flap method.

(2.) *The flap amputation* consists in removing a limb by double flaps, of which the one is generally anterior, the other posterior, or by forming a single anterior or a single posterior flap. These flaps include all the soft parts of the limb; they may be made by transfixion where the position of the bones in the limb will admit of it, and in this case they are cut from the centre of the

[1] By integuments we mean both skin and subcutaneous tissue.

part towards the circumference. When the bones do not occupy a central position in a limb, one of the flaps is generally formed by cutting from the circumference to the centre. Modifications of the flap operation have been introduced by Messrs. Teale, Carden, and Spence, to these we shall subsequently refer more at length. The flap operation is quickly and easily performed, and generally gives satisfactory results; but in the thick part of a muscular limb the size of the external wound is somewhat excessive, and in certain parts there is a risk of splitting up the large vessels instead of dividing them transversely.

(3.) There exists a mode of amputating by a combination of the two methods first alluded to; it consists in forming double flaps of integument, and subsequently dividing the muscles down to the bone as in the circular amputation. It is strongly recommended by many surgeons, and deservedly so, for this plan of dividing the integuments facilitates their reflection: while the circular division of the muscles ensures a completely transverse section of the vessels; thus it combines many of the advantages of both the circular and the flap operation.

(4.) *The oval incision* is principally used for the removal of the fingers and toes at their various articulations, and occasionally for amputation at the shoulder joint. It is effected by dividing all the soft parts surrounding the bone in the direction indicated by its name.

Mr. Teale calls his operation '*amputation by a long and a short rectangular flap.*'

The long flap, which is anterior or antero-external, is quadrangular in shape, its length and breadth being each

equal to half the circumference of the limb. It includes all the soft parts down to the bone on the anterior aspect of the part, and should not contain any important nerve or blood-vessel. The short flap is posterior, or postero-internal; it is one-fourth the length of the anterior, and its breadth is equal to half the circumference of the limb. It includes all the soft parts down to the bone on the posterior aspect of the limb, and *should* contain the large nerves and blood-vessels of the part. Both flaps are flat at their extremities and of the same thickness throughout, where the arrangement of the soft parts about the bone will permit. Mr. Teale claims for this plan of operation (1) a freedom from tension in the stump; (2) a soft covering for the ends of the bones, free from large vessels and nerves; and (3) a dependent position of the wound, favouring the escape of its secretions.

The incisions that have been made in ligaturing the arteries should be sewn up, and the same body used for the practice of the amputations.

AMPUTATIONS OF THE UPPER EXTREMITY.

Instruments required for the Amputations of the Upper Extremity generally:—1. An amputating knife, about seven inches long in the blade and pointed at its extremity. 2. Two or three narrow scalpels of different lengths. 3. A catlin. 4. A strong-backed narrow knife, with a blade five inches in length, for amputations about the carpus. 5. A pair of bone nippers. 6. Amputating saw. 7. Artery and torsion forceps. 8. Ligatures and sutures. 9. A tourniquet, when operating on the living subject.

AMPUTATION OF THE PHALANGES OF THE FINGERS BY DISARTICULATION.

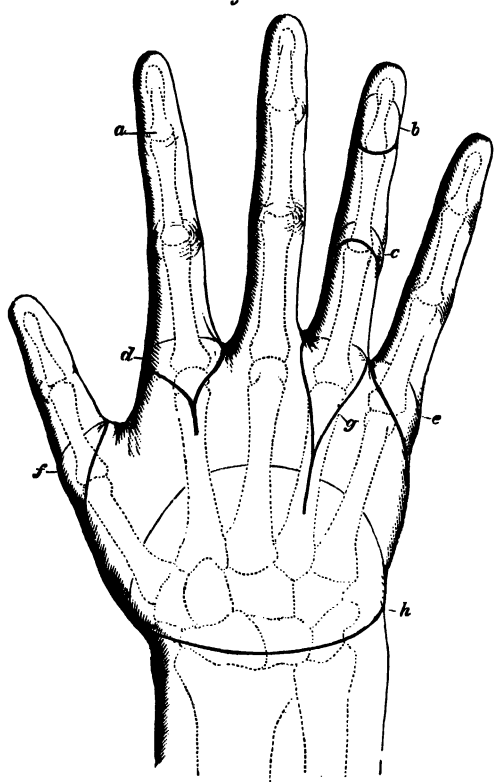
Anatomy.—Before commencing these operations, it will be well to take a general view of the skeleton of the hand, and to entertain some considerations as to the exact positions of the phalangeal joints, and the shape of the articular extremities of the phalanges.

Situation of the Articulations.—Let the operator close his hand and inspect the back of it, comparing it with the bones in the accompanying woodcut. He will observe that the prominences of all the knuckles—we mean those of all three rows—belong to the proximal bones of the respective articulations; that is, that the first row of knuckles is formed by the heads of the metacarpal bones; the second row, by the extremities of the first phalanges; and the third, by those of the second phalanges. Thus it follows that the line of articulation in each case is just *beyond* the corresponding knuckle. Having noticed the situation of the articulations, we would recommend the operator to observe their precise shape; and for this we would refer him to *fig.* 19, where he will find the line of the two more distant phalangeal joints to be concave from side to side, with the concavity directed towards the ends of the fingers. He may also notice that the line of articulation runs parallel to and is the same shape as the inferior margin of the nail where it first appears from the matrix. A semilunar incision in this direction, and in front of the corresponding knuckle, will therefore lay open any of these phalangeal joints in their entire width.

The metacarpal joints of the phalanges are curved in

the opposite direction, that is, their concavity points towards the wrist; the line of their articulation lies just in front of the first row of knuckles, and fully half an inch behind the clefts of the fingers, as these are seen from the palm.

Fig. 19.



Operations.—There are many methods of amputating the phalanges of the fingers, and while some are much more easy of execution than others, it is advisable to practise all; for on the living body we rarely have a choice of plan for operating, but must rather adapt our

method to the necessities of the case and the condition of the soft parts around the bones. The most common proceeding adopted for removing either of the more distal phalanges is by disarticulation, and if by this means the covering for the remaining bone is insufficient, to complete the operation by removing its head with the bone forceps.

On the living patient it is not advisable to amputate the fingers at their second joints, as this proceeding would leave the first phalanx not only useless but also in the way, as the first phalanx is unprovided with an extensor tendon.

DISARTICULATION OF THE DISTAL PHALANGES OF THE FINGERS OR THUMB BY A SINGLE PALMAR FLAP.

Instruments required.—Small scalpels, artery or torsion forceps, bone nippers.

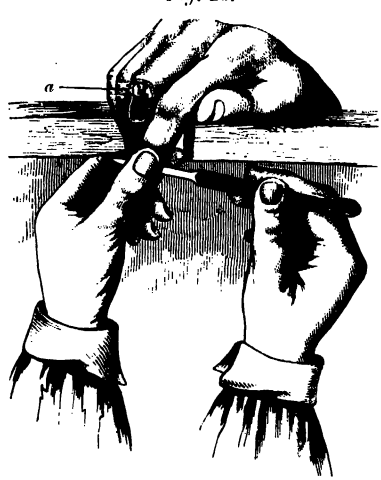
Position of Operator and Hand.—The operator being prepared with a small scalpel, which should be sharp-pointed and narrow, should stand facing the dorsum of the hand with the fingers pointing towards him; let him grasp the last phalanx between the forefinger and thumb of the left hand (*fig.* 20), the thumb being placed uppermost.

Position of Assistant.—The assistant facing the operator should support the hand and hold the other fingers apart.

Operation, First Method.—The scalpel, held as a pen, with its cutting edge turned towards the operator, must now be thrust through the soft parts immediately beneath the shaft of the phalanx, just anterior to the bony tubercle (*fig.* 19*a*), that may be felt on its under side: this is situ-

ate just in front of the joint, and marks the spot where the shaft of the phalanx expands into the articular extremity. A flap should now be formed from the under surface of the finger about two thirds the length of the last phalanx. Lastly, connect the opposite angles of the flap by a curved incision made on the back of the articulation in such a direction as will open the joint in its entire width (*fig.* 19*b*); divide the lateral ligaments, at the same time bending the joint, and the operation will be complete.

Fig. 20.



It will be found that the convexity of the flap will just adapt itself to the concavity of the incision on the back of the finger. Fig. 20*a* represents the appearance of the wound after the performance of this operation.

Arteries requiring a Ligature or Torsion.—The two digital arteries, the cut ends of which will be found in the palmar flap, will require a ligature or twisting.

Operation, Second Method.—As before, the operator

should grasp the phalanx to be removed between his finger and thumb, and, forcibly bending it, let him cut into the back of the joint in its whole extent, divide the lateral ligaments, and, passing the knife beneath the bone, complete the operation by cutting a flap of sufficient size from the palmar surface of the finger; the wound in this case should be precisely the same shape as in the preceding operation.

REMOVAL OF FINGERS AT THEIR SECOND JOINTS.

On the dead body the same operations may be performed for the removal of the fingers at their second joints as those described for the removal of the distal phalanges, and the directions that we have given above will apply throughout; but on the living, as already stated, it is not advisable to disarticulate here.[1]

AMPUTATION OF THE PHALANGES OF THE FINGERS BY DOUBLE FLAPS.

The hand being placed in a position of pronation, the operator stands as in the preceding operations; he should transfix the soft parts immediately under the shaft of the phalanx, just in front of the joint at which he wishes to disarticulate, and thus cut a short flap from the palmar side of the finger. A semilunar flap of the same dimensions, being traced out over the dorsum of the joint, should be reflected, the joint opened from behind, and the bone

[1] It often happens in practice that the integuments on the palmar side of the finger are insufficient of themselves to form a covering for the head of the remaining bone; in these cases either the head of the proximal phalanx may be removed with the forceps, or a small flap must be traced out and reflected from over the back of the joint.

removed. *Fig.* 19*c* shows the shape and position of the flaps for this operation.

DISARTICULATION OF THE FIRST, SECOND, AND THIRD FINGERS AT THEIR METACARPAL JOINTS.

Instruments required.—A large scalpel, artery or torsion forceps, bone nippers.

Position of Operator and Hand.—The operator should stand facing the subject, grasping the finger he is about to amputate.

Position of Assistant.—The assistant, standing with his back turned towards the subject, should separate the contiguous fingers.

Operation.—The hand being pronated let an incision be commenced on the back of the metacarpal bone, about half an inch behind its head; this must be carried along the line of the extensor tendon for half an inch, and then diverge to the operator's right-hand side, and run obliquely up to the angle of the cleft between the fingers, pass across the palmar surface of the first phalanx, at the transverse mark which is found at its base, and, returning to the back of the hand, should fall into the first incision just over the prominence of the knuckle (*fig.* 19*d*). This cut should extend down to the bones in its whole extent, and if possible should divide the extensor tendon of the finger as it lies on the head of the metacarpal bone; the incision may be a continuous one, or more easily it is formed by making two separate cuts, each commencing on the back of the metacarpal bone and joining on the palmar surface of the first phalanx. The soft parts must be dissected from the posterior part of the joint, the lateral

ligaments divided, while the operator puts them on the stretch, and the articulation opened by a semilunar incision with its convexity directed towards the ends of the fingers; the remaining ligamentous connections of the bone being severed, the operation will be complete. In practice, should there be insufficient integument on the finger to cover the head of the metacarpal bone, the same operation may be performed, and the head of that bone removed with the cutting forceps, applied so as to divide the bone obliquely.

In operating on the living, this latter proceeding should be adopted when a sightly hand is preferred to a more useful one. But when the hand is required for manual labour the head of the bone should if possible, be preserved as it gives greater breadth and strength to the member, the transverse ligament of the metacarpus being thus left intact.

DISARTICULATION OF THE LITTLE FINGER AT ITS METACARPAL JOINT.

For this, the same operation may be put in practice, except that the angle of the incision should fall over the ulnar side of the corresponding metacarpal bone (*fig.* 19*e*).

DISARTICULATION OF THE FINGERS *EN MASSE* AT THEIR METACARPAL JOINTS.[1]

Instruments required.—1. An amputating-knife, about five inches long in the blade. 2. Artery or torsion forceps. 3. Ligatures. 4. Sutures.

[1] The operation is here described as it should be performed on the left hand. It can rarely be necessary on the living body.

Position of Operator, &c.—The operator should stand facing the body and should grasp the fingers with his left hand, his thumb being in front.

The assistant's duty is to support the hand at the wrist.

Operation.—Having thus grasped the fingers, the operator should turn up the palm of the hand as is represented in *fig.* 23, p. 152, and trace a convex flap, commencing and ending on the distal extremities of the metacarpal bones of the little and index fingers respectively, and extending towards the fingers as far as the transverse line seen on the palmar aspect at their roots. Turning the fingers in the opposite direction, so as to bend the knuckles and expose the back of the hand, let him make an incision commencing and ending at the extremities of the second and fifth metacarpal bones, and extending over the knuckles as far as the fork of the fingers, as seen on their dorsal aspect, thus forming a semilunar flap with its convexity turned towards the fingers and reaching just beyond the heads of the metacarpal bones (*fig.* 21, p. 148). Having reflected this, and opened all their joints on the dorsal aspect, let the operator completely divide the capsular ligaments, and pass the blade of the knife behind the heads of the phalanges he is about to remove; and by cutting towards the fingers he will bring the knife out in the palm at the extremity of the flap which he first traced.

Arteries requiring a Ligature.—The dorsalis indicis, the radialis indicis, the three digital, and three or four dorsal interosseous arteries.

AMPUTATION THROUGH THE THIRD AND FOURTH METACARPAL BONES.

This operation, though demanded in many cases of injury, is often employed in preference to the removal of the fingers at their metacarpal joints, in those cases where the appearance of the hand is a more important consideration than its strength.

Position of Operator, &c.—The position of the operator and assistant should be the same as in amputation of a finger at its metacarpal joint: a long narrow scalpel should be used.

Operation.—An incision, such as is represented in *fig.* 19*g*, being made so that its angle is on the dorsum of the metacarpal bone, midway between its articular extremities, the integuments should be dissected from the shaft and head, proceeding from behind forwards, until the palmar surface of the bone is nearly cleared; the knife should now be thrust under the bone, and made to free its anterior surface from any remaining connections. This accomplished, the shaft of the bone should be divided obliquely with the bone forceps, so as not to leave an abrupt extremity. The foregoing operation has an advantage over the one more commonly employed, in not leaving behind it any cicatrix in the palm, and in injuring no blood-vessels of any size. Its disadvantages are the decrease in the breadth and strength of the hand.

AMPUTATION THROUGH THE SECOND AND FIFTH METACARPAL BONES.

These bones may be removed with greater facility than the two last-mentioned, and the same operation may be used, except that the incisions must commence and end on the radial side of the second, and on the ulnar side of the fifth metacarpal bone. In using the forceps it is here especially necessary to divide the bone obliquely, and thus avoid an unsightly prominence on the side of the palm. No artery of any consequence need be wounded in any of the preceding operations; though care must be taken, in separating the second metacarpal bone from its connections, to avoid injuring the arteria radialis indicis, anywhere but at the point where it *must* be divided, namely, opposite the metacarpo-phalangeal articulation.

AMPUTATION OF THE THUMB AT ITS METACARPO-PHALANGEAL ARTICULATION.

Anatomy.—It may save subsequent trouble, and much facilitate the process of disarticulation, if the operator will turn to page 148, *fig.* 21, and glance at the skeleton of the hand. He will notice that the line of this articulation is much more nearly transverse than that of the same joint in the other fingers; it is situated just in front of the prominence of the knuckle, and for practical purposes may be considered to run straight across the thumb from side to side.

Instruments required.—A scalpel, and artery forceps.

Position of the Operator.—The operator should stand facing the patient, grasping the bone to be removed

with the first finger and thumb of his left hand, his own thumb being uppermost.

Position of Assistant.—The assistant should support the wrist, and separate the fingers from the bone to be removed.

Operation.—Make an incision as represented in *fig. 21b*, with its angle on the subcutaneous surface of the metacarpal bone half an inch behind the head, and passing in front of the thumb well in advance of the sesamoid bones. Dissect away the soft parts from the back and outer side of the joint, and open it on its posterior aspect, twisting the thumb hither and thither to facilitate the division of its ligaments. In separating the soft parts from the front of the phalanx, care should be taken lest the point of the knife be entangled in the sesamoid bones, for covering which a larger provision of soft parts must be made than was necessary in the corresponding operation on the other fingers.

Arteries requiring a Ligature.—The dorsalis pollicis and arteria magna pollicis.

AMPUTATION OF THE THUMB AT ITS ARTICULATION WITH THE TRAPEZIUM.

Anatomy.—It will be well to examine this articulation before attempting to remove the bone. The articular surface of the trapezium is saddle-shaped, and so, indeed, is the metacarpal bone of the thumb, though in an opposite direction, and thus it is by no means easy to insinuate the point of the knife between their opposed surfaces; the exact position of the joint may, however, be ascertained by passing the fore-finger down the dorsal

surface of the corresponding metacarpal bone towards the wrist, until the tubercle is felt at the base of the bone which gives insertion to the extensor ossis metacarpi pollicis; immediately behind this point of bone lies the articulation in question.

Position of Operator and Hand.—The operator should grasp the thumb, and stand facing the dorsum of the hand, which should be in a position between pronation and supination.

Duties of Assistant.—The assistant should hold the fingers aside.

Operation.—1. *Circular Method.*—The point of a narrow knife must be inserted midway between the tubercle of bone above alluded to and the styloid process of the radius, and an incision be carried from this spot obliquely along the dorsum of the metacarpal bone to the ulnar side of the base of the first phalanx of the thumb,[1] around the palmar surface of which it must pass transversely and be carried down the radial side of the metacarpal bone, to the point from which it started. The soft parts should be dissected from the back and sides of the bone until the knife can be passed under its shaft, along the palmar surface of which it should be drawn until it cuts its way out at the transverse part of the first incision, on the palmar surface of the first phalanx. The articulation of the metacarpal bone with the trapezium may now be opened, and the ligaments divided while the bone is twisted here and there, to put them on the stretch. In performing this operation, some difficulty will be ex-

[1] In operating on the right side of the body, the incision would, of course, be made in the opposite direction.

perienced in carrying the knife along the palmar surface of the metacarpal bone without either getting the blade locked between the sesamoid bones and the head of the metacarpal bone, or wounding the skin over the prominence of these bones; to avoid this, the knife should be held with a light hand, and its edge be turned to allow of its passing over the top of these bones, which, of course, are removed in the operation.

Arteries requiring a Ligature.—The dorsalis pollicis and arteria magna pollicis.[1]

2. *Flap Operation.*—The mode of performing this operation varies somewhat according to the side of the body on which it is proposed to operate.

(*a.*) *Right Side.*—When operating on this side the surgeon should introduce the point of the knife into the web of skin between the first and second metacarpal bone, and transfix the ball of the thumb, causing the point of the knife to emerge on the palmar aspect of the carpo-metacarpal joint. He should next cut outwards, forming a palmar flap from the tissues forming the ball of the thumb, taking care whilst doing so to keep the blade of his knife close to the bone, and he should endeavour, on the one hand, to avoid locking the knife between the sesamoid bones and the head of the metacarpal bone, and, on the other hand, wounding the skin over the bones.

The knife should now be drawn obliquely across the back of the metacarpal bone from one extremity of the

[1] Care should be taken not to injure the arteries of the index finger. By keeping close to the bone the radial artery where it dips into the palm may be avoided. Should it be cut, both ends must be tied.

flap to the other, the carpo-metacarpal joint opened, and the operation completed as in former method.

(*b.*) *Left Side.*—The point of the knife should be introduced into the palmar aspect of the carpo-metacarpal joint, and an incision be made across the back of the thumb to the web between it and the index finger; the point should then be thrust down through the tissues forming the ball of the thumb, and made to emerge at the spot where the incision was commenced. A flap should then be formed by cutting outwards, the same precautions being taken as on the right side, and the operation completed as before.

Arteries requiring a Ligature.—The dorsalis pollicis, the arteria magna pollicis, and the radial, and arteries of index finger if divided.

AMPUTATION OF THE HAND AT THE CARPO-METACARPAL ARTICULATION, LEAVING THE THUMB AND ITS LONG MUSCLES INTACT.

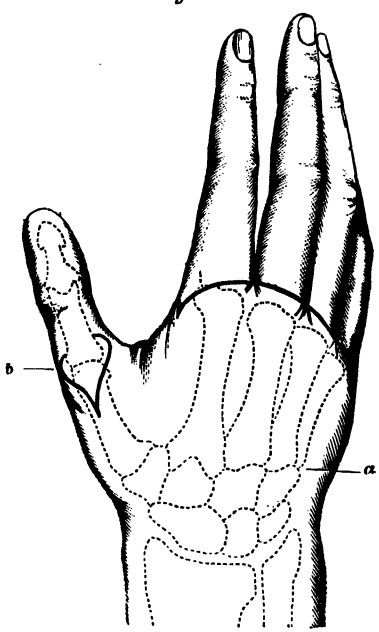
This operation has been most successfully adopted as a substitute for amputation of the whole hand in gun accidents and lacerations by machinery, where, as often happens, the thumb is not involved in the general injury to the parts.[1]

Anatomy.—The operator should glance at the articulations he is about to open; it is marked *a* in *fig.* 21; it is formed by the four inner metacarpal bones and the second row of carpal bones. He will observe on the dorsal surface that the three metacarpal bones on the

[1] See 'Medical Times and Gazette,' Oct. 30, 1858, for an account of this operation on the living body.

ulnar side form, with the os magnum and unciform bones, a pretty regular series of joints, slightly curved, with the convexity towards the fingers; while the articulation between the head of the second metacarpal bone on the one hand, and the trapezium, trapezoid, and os magnum on the other, is much more irregular, nor is this irre-

Fig. 21.

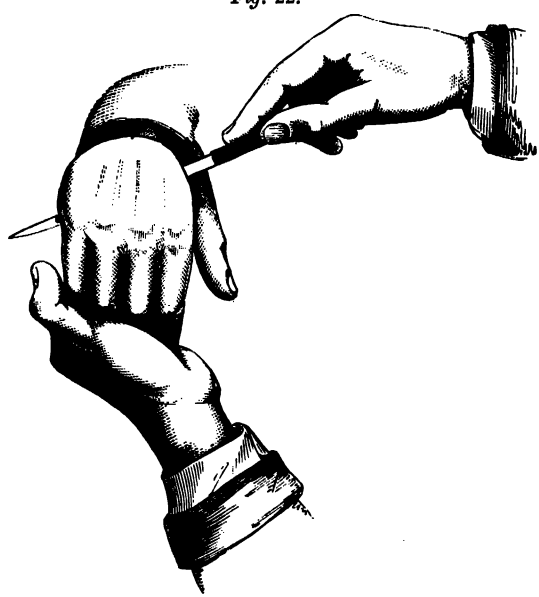


gularity exactly uniform in all bodies.[1] That part of the articulation now in question may be roughly compared in its outline to the letter W, the open part of the letter being directed towards the fingers. The general direction of the series of joints is pretty accurately ascertained, in

[1] In ten articulated skeletons we have examined there are no two exactly similar in this particular. We have described that outline of articulation which appears most prevalent.

the living or dead body, by gliding the fore-finger and thumb of the left hand down the sides of the fifth and second metacarpal bones respectively, towards the wrist, until arrested on either side by a prominent tubercle at the base of each bone. A line drawn across the wrist, from a point immediately behind one of these tubercles,

Fig. 22.



to a similar point behind the other, indicates sufficiently accurately the line of the articulations.

Instruments required.—1. A sharp-pointed, strong, and narrow knife, such as is used for operations on the tarsus. 2. Artery forceps.

Position of Operator.—The operator should stand looking towards the fore-arm.

Position of Assistant.—The assistant should face the operator, and support the wrist.

Operation.—Placing his fore-finger and thumb upon the carpal extremities of the fifth and second metacarpal bones, let the operator thrust the knife through the palm from side to side, as near the shafts of the metacarpal as possible, its points of entrance and exit being just in front of one and the other of the aforesaid tubercles; in this manner a flap can be cut from the palm of the hand, about two or three inches in length (*fig.* 22). An incision should now be made across the back of the wrist, joining the angles of the flap just formed and anterior to the line of the carpo metacarpal articulation. The operator, grasping the hand, and strongly flexing the wrist, should commence by opening the articulations on the ulnar side, dividing the dorsal ligaments with the point of his knife; this he will succeed in effecting until arrested by the first prominence at the base of the second metacarpal bone, around *this* he must turn, cutting with the point of his knife; and so again around the second projection of the same bone, until he has opened the articulation in its entire width. This once effected, he has only to complete the separation of the bones, and pass the knife behind them into the palm, and the operation is concluded.

Arteries divided.—The radial and ulnar arteries will be divided in this operation, in that part of their course where they extend into the palm of the hand; their cut ends should be sought in the palmar flap. The dorsal interosseous and dorsalis indicis arteries will also be divided, and will be found in the posterior flap.

AMPUTATION OF THE HAND AT THE WRIST JOINT.

The hand may be removed at the wrist-joint by several different methods. We shall describe the following:—

1. By a palmar flap.
2. By double flaps.
3. By an external flap.
4. By the circular method.

Anatomy.—The articulation formed between the radius and fibro-cartilage on the one hand, and the scaphoid, semilunar, and cuneiform bones on the other, is curved in its direction from side to side, having the convexity of the curve directed towards the fore-arm (*fig.* 21). Its position can easily be ascertained by feeling for the styloid processes of the radius and ulna, between which points of the bone the line of the articulation extends in the direction above indicated.

Instruments required.—1. A sharp-pointed, strong, and narrow knife, such as is used on the tarsus. 2. Artery or torsion forceps. 3. Bone nippers.

Position of Operator and Assistant.—The operator should stand facing the subject; the assistant, stationed opposite the surgeon, should support the wrist.

First Operation by a Palmar Flap.—The operator having ascertained the exact position of the styloid processes of the radius and ulna, should grasp the hand as represented in the adjoining woodcut (*fig.* 23), and trace a semilunar flap from the palm, commencing (for the right hand) at the apex of the styloid process of the radius, and terminating at the same point on the ulna: this cut should reach to the bones in its whole extent. The hand should

now be forcibly flexed to facilitate the division of the dorsal ligaments, and an incision should be made across the back of the wrist from one styloid process to the other, connecting the angles of the flap,[1] the soft parts divided and the wrist-joint opened. The lateral ligament to the operator's left-hand side being *first* divided with the point of the knife, the opposite one may be subsequently

Fig. 23.

disposed of; the carpal bones being separated from their ligamentous connections, the heel of the knife should be laid beneath them and be carried with a sawing movement away from the wrist, under the metacarpus, until it cuts its way out at the extremity of the flap that has been traced in the palm. Whilst cutting the palmar flap the operator

[1] *Fig.* 10 *h*, page 135.

should endeavour to avoid catching the blade of the knife against the prominences formed by the projection of the pisiform and hook of the unciform bones into the palm. This he will best do by holding the knife with a light hand during this part of the operation. The convexity of the flap formed in this method will be found to accommodate itself to the slight concavity of the incision on the back of the wrist; while the general adaptation of the parts will be completed by the removal of the styloid processes of the radius and ulna with the bone forceps.

Situation of Arteries divided.—The radial and ulnar arteries will both be divided in the foregoing operation, and their divided ends will be found at the angles of the palmar flap.

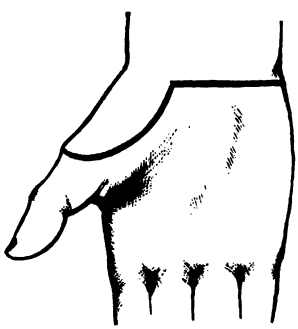
Second Operation, by double flaps.—This operation may be performed in the same manner as the preceding, excepting that the anterior flap cut from the palm must be of smaller dimensions; while one of the same size as this must be cut from the back of the wrist and reflected, the operation being completed as in the last-described method.

Third Operation.—Dubrueil's operation by external flap. (See Diagram, *fig.* 24.)—We have described this operation as given by Mr. Bell: 'Commencing just below the level of the articulation, while the hand is pronated, the surgeon makes a convex incision, beginning at the junction of the outer and middle thirds of the arm behind, reaching at its summit the middle of the dorsal surface of the first metacarpal bone, and terminating in front just below the palmar surface of the joint, again

at the junction of the outer and middle thirds of the breadth of the arm. This flap being raised, the wrist is disarticulated, beginning at the radial side. A circular incision finishes the cutting of the skin.' [1]

Fourth Operation.—The Circular Method.—The skin having been drawn back by an assistant, a circular sweep of the knife is made through the integuments about an inch below the styloid processes of the radius and ulnar. The remaining soft parts being next divided over the line of the joint by another circular sweep of the knife,

Fig. 24.



Dubrueil's Amputation at Wrist-joint.

the articulation is opened and the operation completed, as described in the former methods. We venture to recommend the amputation by a single flap, as it gives a firmer and better-nourished covering for the bones than that obtained by the other operations.

AMPUTATIONS THROUGH THE FORE-ARM.

Anatomy.—Before describing the various methods of amputating the fore-arm, we beg to draw the student's

[1] See *Manual of Operative Surgery*, by Joseph Bell, page 55.

attention to a few points in its anatomy. He will perceive that the bones are well covered in front—in their upper two-thirds by muscular, and in their lower third by tendinous structures; whilst behind they are comparatively superficial, the posterior border of the ulna being subcutaneous throughout its entire length.

The insertion of the pronator teres also into the middle of the radius should be remembered, as it is important in the living subject to leave the insertion of this muscle intact, so that the stump may enjoy the power of pronation. The varying position of the two bones to each other during pronation and supination should be also noted, as in transfixion operations the knife is apt to be thrust between them if their relative position is not attended to before commencing the operation.

Operations.—The following amputations may be practised on the fore-arm:—(*a*) The circular operation. (*b*) The flap operation. (*c*) The integumental flaps and circular division of muscles. (*d*) Mr. Teale's operation.

Choice of Operation.—For amputation through the middle third all four operations are applicable. For the upper and lower thirds the circular division of muscles and skin flaps is the best operation.

On the dead body we strongly recommend the student to amputate through the lower third, as this leaves a longer stump, and so facilitates the subsequent excision of the elbow-joint.

(*a*) THE CIRCULAR METHOD.

1. *Instruments required.*—1. Small amputating knife, about six inches long in the blade. 2. Amputating saw.

3. Artery or torsion forceps. 4. Bone nippers. 5. Scissors.

2. *Position of Surgeon.*—He should stand on the outer side of the limb when operating on the right side, and on the inner when operating on the left.

3. *Position and Duties of Assistant.*—The assistant should stand on the opposite side of the fore-arm to the surgeon, and should surround the part to be removed with his hands, and retract the skin forcibly.

4. *Position of Limb.*—The arm should be extended from the side of the body, and placed in a position midway between pronation and supination.

Operation.—Grasping the knife in his fist with its edge turned upwards, and placing the right foot slightly in advance, let the operator stoop down and pass the knife beneath, then above and thus around the limb, dropping its point until it is as nearly vertical as possible, its back being turned towards him and its heel resting against that part of the arm nearest to himself. From this point let him commence a circular incision of the integument alone, raising his body to the erect position as he does so, and making his knife retrace its steps until the skin in the whole circumference of the limb is divided. The integument being retracted should be dissected back and turned over on itself, until about two inches or more have been reflected. Let the operator divide the muscles close to the reflected integument, in the same manner as the skin and subcutaneous tissue, the assistant still continuing to retract the parts. Thrusting the knife through the interosseous membrane, and having cleared the bones for the application of the saw as high as possible, the

saw should be laid across the bones, with its heel resting on either one of them, and should first be *drawn towards* the operator while it is pressed pretty firmly against the bones. This will make such a notch as will prevent it subsequently slipping from the part to which it was first applied.

Main Arteries to be Secured.—The radial and ulnar arteries will be found in the anterior part of the stump, in front of the bones from which they respectively derive their names; the anterior and posterior interosseous vessels may be sought for, the former in close connection with the front of the interosseous membrane; the latter between the deep and superficial layers of muscles in the posterior part of stump.

(*b*) DOUBLE-FLAP AMPUTATION OF THE FORE-ARM BY TRANSFIXION.

This operation is best adapted for amputation through the middle third of the fore-arm, as higher up it is difficult to form a posterior flap by this method, and lower down the structures, being chiefly tendinous, form bad flaps. Before undertaking this operation it may be well again to notice the abundance of soft parts on the front of the fore-arm, and the comparatively bare condition of the bones posteriorly.

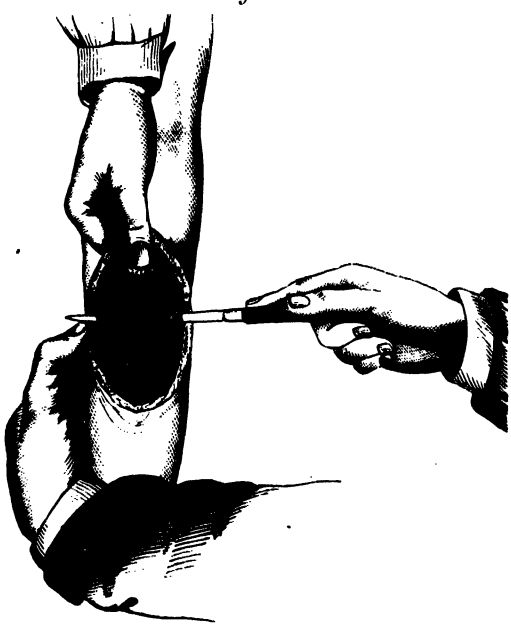
1. *Position of Operator.*—The operator should stand outside the limb, if it be that of the right side, and inside that of the left.

2. *Position of Assistant.*—The assistant should be placed opposite the operator, on the other side of the fore-arm.

3. *Position of Limb.*—The fore-arm should be supported horizontally, away from the body, and supine, as in this latter position the bones are more nearly parallel and in the same horizontal plane with each other.

The soft parts over the front of the limb being grasped and slightly upraised by the operator's left hand, let him transfix the limb from side to side immediately in front of

Fig. 25.



the bones, entering the knife at the subcutaneous margin of the nearer bone, and coming out at the corresponding spot on the opposite side of the fore-arm. Now, cutting downwards towards the wrist, a flap should be formed with a rounded border about three inches in length; this may be held up, but not retracted, by the assistant. Seiz-

ing the soft parts on the back of the fore-arm, let the operator draw them away from the bones and again transfix the limb, immediately behind the bones, the points of entrance and exit of the knife being respectively the nearer and more distant angle of his first incision; in this manner a posterior flap may be formed, which should be rather longer than the anterior. In performing the second transfixion of the limb, it is often difficult to avoid wounding the skin on the distal side of the fore-arm, and to insure its safety it is better to hold down its cut edge with the thumb during the passage of the knife, in the manner represented in the preceding woodcut (*fig.* 25). The soft parts being retracted by the assistant, the knife should be passed around and thrust between the bones both in front and behind, just at the angle of junction of the flaps, at which point the saw should be applied. It is the custom with some operators to recommend that the bones should be divided while in a position midway between pronation and supination, to insure their being left more nearly the same length; there is no objection to this proceeding.

Position of the Chief Vessels.—The divided ends of the radial and ulnar arteries will be found near the extremity of the anterior flaps, opposite their respective bones; the anterior interosseous artery in front, and in intimate relationship with the interosseous membrane; the posterior interosseous vessel between the deep and superficial layer of muscles on the surface of the posterior flap.

(*c*) AMPUTATION BY INTEGUMENTAL FLAPS AND A CIRCULAR DIVISION OF THE MUSCLES.

This operation can be practised on any part of the fore-arm. We strongly recommend it to the attention of the student.

Position of Operator.—The operator should stand outside the limb, if it be that of the right side, and inside that of the left.

Position of Assistant.—The assistant should be placed opposite the operator on the other side of the fore-arm.

Position of Limb.—The fore-arm should be supported horizontally, away from the body, and supine, as in the latter position the bones are parallel and in the same horizontal plane with each other.

Operation.—The operator, having first marked the position of the bones of the fore-arm by the fore-finger and thumb of his left hand, should enter the point of the knife at the spot marked by the fore-finger, and cut a semi-oval flap from the front of the fore-arm, composed of integument only, by carrying the knife along the more distant bone for about three inches, then across the front of the fore-arm, and upwards, along the nearer bone to the place marked by his thumb, which should be opposite the point where he entered the knife. This flap, about three inches in length, should occupy exactly half the circumference of the limb. The fore-arm being slightly bent, a similar flap should be cut and reflected from its posterior surface, commencing and ending at the same points as the anterior; the parts being retracted by the assistant, the muscles may be divided in a circular

manner, close to the base of the flaps, and the operation completed as in other amputations of the fore-arm.

(*d*) AMPUTATION OF THE FORE-ARM BY MR. TEALE'S METHOD.

General directions for performing this operation will be found at page 132. The arm being in the prone position, the operator, standing on the right-hand side of the limb,[1] must trace with a short amputating knife or long scalpel, the lateral incisions of the anterior long flap, along the subcutaneous margins of the radius and ulna respectively, dividing the integuments alone. The transverse incision of the same flap may be made by one sweep of the knife, dividing everything down to the bones; all the soft parts in front of these and the interosseous membrane being reflected upwards, the posterior or short flap may be cut in the same way, and being reflected as high as the commencement of the lateral incisions of the long flap, the bones may be sawn. For the appearance of the flaps, and the manner of bringing the parts together after the operation, we refer the operator to *fig.* 40, and *fig.* 41, page 197.

AMPUTATION AT ELBOW-JOINT.

We shall not describe this operation, as its advantages are very questionable on the living subject, and on the dead it is better to perform a resection of the joint.

[1] The patient's right-hand side, *i.e.* outside the right arm, inside the left.

AMPUTATION OF ARM.

Amputation through the Upper Arm may be effected (*a*) by the circular operation; (*b*) by double flaps; (*c*) by integumental flaps and circular division of the muscles; (*d*) by Mr. Teale's operation.

Choice of Operation.—When operating on the living subject this will depend very much on the available integument for covering the stump, and in cases of injury on the condition of the bones, skin, blood-vessels, &c.

(*a*) THE CIRCULAR OPERATION.

Instruments required.—1. An ordinary amputating knife. 2. A saw. 3. Artery or torsion forceps. 4. Bone nippers.

Position of Operator.—The operator should take his place outside the limb he is about to remove.

Position and Duties of Assistant.—The assistant, placed at the shoulder of the subject, should encircle the arm with both hands just below the point at which it is to come off, and should retract the integuments to their utmost.

Operation.—The operator, bending both knees, should stoop down and pass his knife around the limb from its under side, and, laying the heel of the blade on the side of the arm nearest to him, should make a circular sweep around the limb, at the same time straightening his own body, and rising to the erect position. This cut should divide the integuments down to the muscles, which must be bared of their covering, to the extent of two or three inches, by dissecting off the skin and subcutaneous tissue;

the assistant meantime turning back the parts while he retracts them. The muscles and all the remaining soft parts down to the bone should now be divided by a circular sweep of the knife, effected in the same manner as the incision of the integuments, the edge of the knife being laid close against the reflected integument. Let the assistant again grasp the muscles and integuments *en masse*, and retract them; the stump will now assume a conical form, and the operator should again sweep his knife around the bone; dividing this muscular cone about its centre, and applying the saw at the same spot, the operation will be complete.[1]

Arteries divided.—The brachial, the superior profunda, and the inferior profunda.

The brachial will be found on the inner side of the stump, the superior profunda on its posterior aspect with the muscular spiral nerve.

The inferior profunda on the inner side with the ulna nerve.

(The superior profunda often divides into two branches high up in the arm; in this case two vessels, one on either side of the muscular spiral nerve, will require a ligature.)

(*b*) AMPUTATION BY DOUBLE FLAPS BY TRANSFIXION.

In the amputation by double flaps the arm should be rotated outwards, the assistant and operator being placed as in the preceding method.

Operation.—Having with the left hand grasped and

[1] In sawing the bone, the operator should grasp it with his left hand close to the point of section; in this way only will he effectually steady it.

raised the soft parts in front of the humerus, let the operator transfix them, the point of his knife grazing the anterior surface of the bone in its passage through the limb, and passing in front of the brachial vessels; a semilunar flap should be formed about three inches in length, as the knife cuts its way out. The operator should now grasp the soft parts on the posterior aspect of the limb, draw them away from the bone, and transfix them, cutting a posterior flap about the same size and shape as the anterior; sweeping the edge of the knife around the bone to clear it from any remaining connections, the saw should be applied as high up as possible, while the assistant retracts both flaps.

Position of Arteries divided.—The brachial artery should be looked for near the inner angle of junction between the anterior and posterior flap.

The superior profunda, after a short course, divides into two branches, and these will be found on either side of the musculo-spiral nerve in the posterior flaps.

(*c*) AMPUTATION BY INTEGUMENTAL FLAPS AND CIRCULAR DIVISION OF MUSCLES.

1. *Instruments required.*—1. Short amputating knife. 2. Saw. 3. Artery forceps.

2. *Position of Operator.*—The operator should take his place outside the limb of the right side, inside that of the left, the arm being carried out from the side.

3. *Position of Assistant.*—The assistant should stand opposite the operator.

4. *Operation.*—Commencing on the side of the limb farthest from him, the operator should trace out in the

skin and subcutaneous tissue a flap with its convexity downwards, and again, passing his hand under the limb, he should connect the opposite angles of the first incision by tracing a flap of the same size and shape on the posterior surface of the limb; these being retracted by the assistant, and reflected from their deep attachments to the fullest extent, the muscles should be divided at the base of the flaps, as in the circular operation, and the bone sawn through as high up as possible.

5. *Arteries divided.*—As in the previous operation.

(*d*) MR. TEALE'S METHOD.

For a description of Mr. Teale's method of amputating, we refer the reader to the general description of his plan of operating, at page 132, and to *fig.* 40, and *fig.* 41, page 197. In the upper arm the anterior flap should be made rather external in position, and care should be taken to include the brachial vessels in the posterior or short flap.

AMPUTATION OF THE ARM AT THE SHOULDER-JOINT.

The plans adopted for disarticulating the humerus at this joint are very numerous, though many only differ from each other in inessential particulars. We shall only describe (*a*) *the operation by an upper and a lower flap*; and (*b*) *that by an anterior and posterior flap.*

(*a*) AMPUTATION BY UPPER AND LOWER FLAP.

Instruments required.—1. Amputating knife of mode-

rate dimensions. 2. Artery or torsion forceps. 3. Bone nippers. 4. Saw. 5. Scalpels.

Position of Body.—(*a*) The body, raised by two or three blocks placed beneath the shoulders, should be brought towards the edge of the table.

Position of Operator and Assistant.—The operator should stand outside the limb, and the assistant behind the shoulder. In the living the subclavian artery should be compressed by a third assistant, a fourth manipulating the arm.

Operation.—The operator, grasping the deltoid in his left hand, and raising it, should thrust his knife beneath it, transfixing the limb just below the acromion, and on its upper and outer aspect; the knife should graze the neck of the humerus, and in cutting its way out below should form a flap with a rounded border, about four inches in length; this the assistant raises and retracts. The head of the bone being now exposed, the knife should be laid on the upper aspect of the anatomical neck, and the muscles inserted into the greater tuberosity divided, while the bone is rotated inwards; the joint being opened on its upper and outer aspect, the subscapularis should be divided, the knife passed behind the neck of the bone, and with one sweep be made to cut its way out in the axilla, forming an inferior flap similar to the first. The preceding operation is modified by some surgeons, in that the anterior flap is cut and reflected, instead of being formed by transfixion.

Arteries divided.—The axillary, the circumflex, the subscapular, the thoracica-humeria, and other small branches.

(*b*) DISARTICULATION BY ANTERIOR AND POSTERIOR FLAPS.

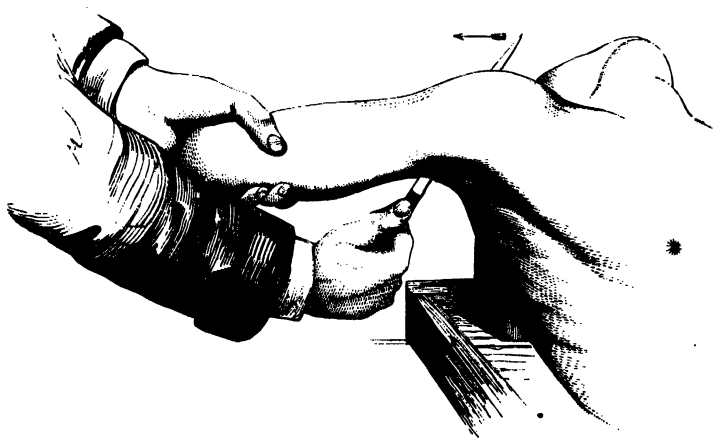
The subject, being placed on its back, should be brought to the edge of the table and one or two blocks placed under its shoulders.

Position of Operator.—The operator should stand outside the limb near the elbow, facing the body.

Position and Duties of the Assistant.—The assistant should be placed behind the shoulder. An assistant in the living should compress the subclavian artery.

Operation.—The operator should grasp the shaft of

Fig. 26.

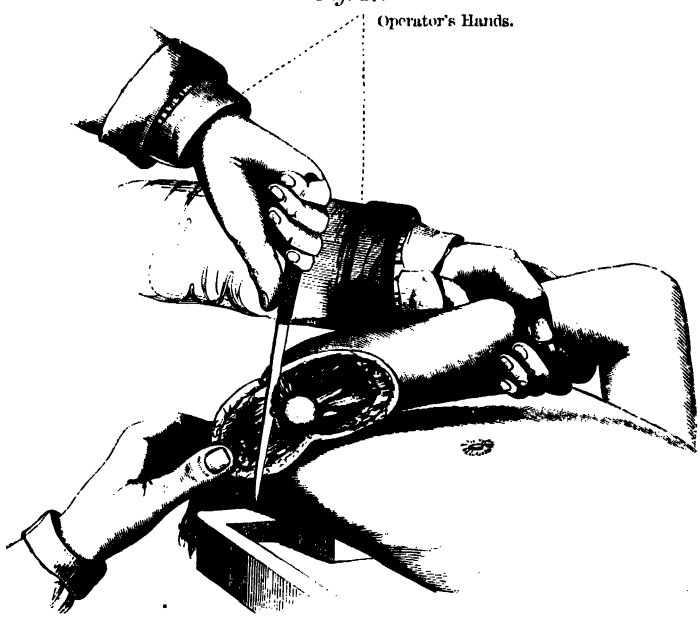


The arrow represents the direction in which the flap should be cut.

the humerus low down, draw the arm out from the side, and at the same time throw the head of the bone forwards; he should insert the knife with its edge turned towards him, just in front of the posterior fold of the axilla, and, thrusting it upwards, close *behind* the neck of the humerus, should bring out its point as near the acromion as possible; the accompanying woodcut (*fig.* 26)

shows the knife in its proper position, and the manner in which the humerus should be held. A flap should thus be cut from the posterior aspect of the limb, about four inches long, and oval at its extremity; this the assistant should grasp and keep well retracted. The arm should now be thrown forwards across the chest (*fig.* 27), and

Fig. 27.



the heel of the knife applied to the head of the bone to divide the three muscles of the greater tuberosity; this will thoroughly open the joint on its posterior aspect, and will enable the operator to complete the division of the capsular ligament, to pass the knife from behind forwards, between the head of the bone and the glenoid cavity, and to divide the tendon of the subscapularis. Having now passed the knife round the head of the humerus, so that

its blade rests against the front of the neck of the bone, the arm should be placed in the position shown in *fig.* 28, and the operation completed by forming a flap—such as is there represented by a curved line. The axillary artery will be found in this, the anterior flap, near its extremity,

Fig. 28.

Disarticulation by an Oval Incision.

and it is, as it should be in all cases, nearly the last thing divided in this method of disarticulation.

Before proceeding to the amputations of the lower extremity it is advisable to perform the amputation of the breast, if the sex of the subject admits of the operation being practised with any advantage.

CHAPTER X.

AMPUTATIONS OF THE LOWER EXTREMITY.

General Remarks on the Skeleton of the Foot, and Position of its various Articulations—General directions for Amputations about the Foot—Amputation of Phalanges of Toes—Ditto *en masse*—Amputation of Great Toe at Tarso-metatarsal Joint—Lisfranc's Amputation—Chopart's—Syme's—Operation of M. Roux—Pirogoff's Amputation—Ordinary Method—Dr. Eben. Watson's Method—Lignerolle's Sub-astragaloid Amputation—Hancock's Modification—Laborie's Operation—Amputation of Leg—Anatomy—General directions for Amputating Leg—Operations: (1) Circular Method, (2) Double Flap Operation, (3) Integumental Flaps and Circular Division of Muscles, (4) Teale's Method, (5) by a Long Anterior Flap—Amputation through the Knee-joint—General directions: (1) by a Single Anterior Flap, (2) by a Posterior Flap, (3) by Double Skin Flaps and Circular Division of Muscles, (4) by Brinton's Modification of the above, (5) by Lateral Skin Flaps—Amputation of the Thigh—General directions: (1) Gritti's Method, (2) Carden's, (3) Spence's, (4) Vermale's Operation, (5) the Circular Method, (6) Transfixion, (7) Integumental Flaps and Circular Division of Muscles, (8) Teale's Method—Amputation at Hip-joint.

GENERAL REMARKS ON THE SKELETON OF THE FOOT.

FOR the successful performance of the amputations about the tarsus a knowledge of the outline and exact position of its various articulations is so essentially necessary, that we make no apology for here introducing a few remarks on what may be called the external anatomy of the part, and for appending a sketch of the foot with an outline tracing of its bones. By attending to a few simple rules, the position of the various joints of the tarsus may be exactly ascertained, at any rate when they have not previously been the seat of disease.

As was the case in the hand, the two distal phalangeal

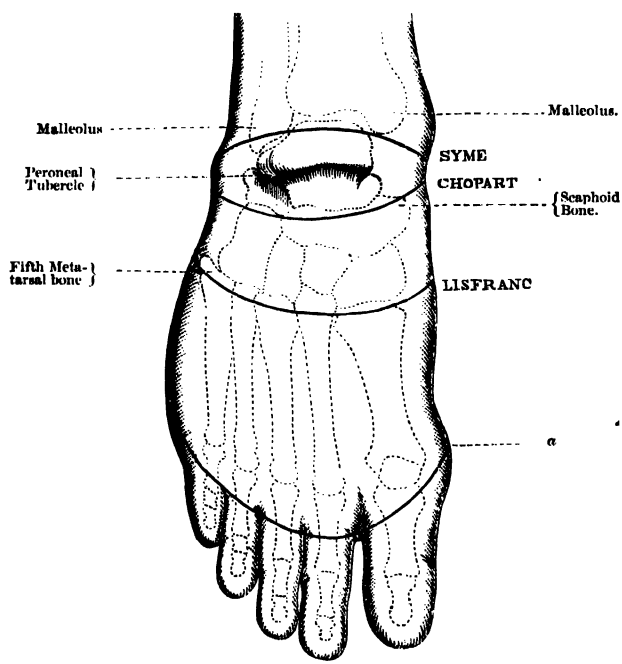
joints of all the toes, with the exception of the first joint of the great toe, are concave from side to side, the concavity being directed towards the ends of the toes, and they are all situated about two lines in front of the corresponding knuckles; the prominence of the knuckle belonging in every case to the nearer of the two bones entering into its formation. The first, or metatarsal articulation of the phalanges of *all* the toes, is concave in its outline from side to side, with its concavity turned towards the tarsus; it lies just in front of the heads of the corresponding metatarsal bones, which latter can be plainly distinguished in any foot.

To ascertain the situation of the tarsal articulations, the operator, pulling the right foot over the edge of the table, and facing the body (turning his attention to the inner side of the foot), should place the fore-finger of his right hand on the inner malleolus, and draw the point of the finger down the inner side of the foot. His attention will first be arrested by the tubercle of the scaphoid bone (*fig.* 29), which here forms a marked prominence, exceedingly useful as a guide, firstly to the articulation between it and the astragalus, opened in Chopart's amputation; and secondly, to its joint with the internal cuneiform bone; the latter of these articulations is situated half an inch in front of the prominence, the former lies a quarter of an inch behind it. Tracing onwards along the inner border of the foot, the projection of the proximal end of the first metatarsal bone may perhaps be distinguished, indicating the situation of the joint between that bone and the inner cuneiform, opened in performing Lisfranc's operation. But a more

sure guide to the situation of this joint is afforded, by considering that it lies an inch and a half in front of the tubercle of the scaphoid bone (*fig.* 29), the latter point being easy of recognition.

Turning now to the other side of the foot, let the operator place the fore-finger of the left hand on the outer malleolus, and trace along the outer border of the

Fig. 29.



tarsus; here he will meet with two prominences, both deserving of attention: the first, a small, but sharply-defined point of bone on the os calcis, about an inch below the malleolus, and generally called the peroneal tubercle (*fig.* 29); from an inch to an inch and a half

farther on, he will encounter a well-marked bony prominence, constituting the proximal end of the metatarsal bone of the little toe (*fig.* 29). The articulation between the calcis and cuboid is situated about half an inch in front of the peroneal tubercle, or it may be said to be midway between that point and the prominence of the fifth metatarsal bone.

The joint between the cuboid and fifth metatarsal bone lies immediately behind the projecting extremity of the latter.

GENERAL DIRECTIONS FOR AMPUTATIONS ABOUT THE FOOT.

Instruments required.—A strong, narrow knife, about five inches long in the blade, for Lisfranc's and Chopart's operation; a short, strong knife about three inches in the blade, for Syme's; scalpels, narrow and broad, for toes; bone forceps; saw; artery and torsion forceps.

Position of the Foot.—The foot should be drawn well over the end of the table, and the leg supported at a convenient height on a block.

Position of the Operator.—The operator should stand facing the foot.

Position and Duties of the Assistant.—The assistant should be placed facing the operator. His duty is to support the foot with his hands, or to secure it firmly on the block.

AMPUTATION OF THE PHALANGES OF THE TOES.

A small and very narrow-bladed scalpel should be procured for these operations, which may be executed precisely in the same manner as the corresponding am-

putations on the hand. (See page 135, *fig.* 19.) The phalanges may be removed by a single palmar flap, or by double flaps.

The toes may also be removed at their metatarsal joints by the same-shaped incisions, and in the same manner, as was recommended for the corresponding articulations of the hand (page 137). In amputating the great toe at its metatarsal joint, the operator should observe the prominence of the head of its metatarsal bone, and in the incision of the soft parts should provide accordingly for its sufficient covering.

AMPUTATION OF THE TOES *EN MASSE* AT THEIR METATARSAL JOINTS.[1]

The operator should grasp the extremities of all the toes with his left hand, his thumb being against their plantar surface; having extended the toes, he should make a curved incision from left to right, with its convexity directed forwards, across the sole of the foot, commencing on the right foot over the metatarsal joint of the little toe, and extending to the corresponding joint of the great toe on the opposite side of the foot. This cut should reach as far as the angles between the toes, and should fall on the transverse marks in the skin which separate the toes from the sole of the foot. The position of the left hand should now be changed, and the extremities of the toes be grasped, and strongly flexed; the thumb of the operator being now on their dorsal surface. Another curved incision should be made on the dorsum of the foot, joining the extremities of the first, and falling

[1] This is an operation which can scarcely be required on the living body under any circumstances.

across the forks of all the toes (*fig.* 29*a*). The flap thus traced out may be reflected for a short distance, until the metatarsal articulations are exposed; these being opened, and the capsular ligaments completely divided, the blade of the knife should be passed behind the heads of all the phalanges, and, by a slight sawing movement, should be made to cut its way close along the plantar aspect of their shafts, until it appears in the sole at the extremity of the first incision.

Arteries divided.—The digital, the cut ends of which will be found in the plantar flap, and the dorsal interosseous, which are situate on the posterior flap.

AMPUTATION OF THE GREAT TOE AT ITS TARSO-METATARSAL JOINT.

We shall describe two methods of performing this operation.

1. The flap method.
2. The oval incision.

First Method.—The operator, grasping the big toe with his left hand, should enter the point of the knife on the dorsum of the foot over the proximal extremity of the first metatarsal bone, and carry it forward to its distal extremity, then across the inner side of the toe to the plantar aspect of the foot, and backwards to the part opposite where the flap was commenced. The flap thus formed on the inner aspect of the foot being reflected, the knife should be thrust between the first and second metatarsal bones, and made to cut its way out in front between the corresponding toes (*fig.* 30). The insertion of the peroneus longus into the base of the first metatarsal bone should be now divided, taking care to keep the knife close to the

bone, so as to avoid wounding the communicating branch of the dorsalis pedis with the external plantar artery. The remaining soft parts being divided, disarticulation may be accomplished by a few touches with the point of the knife, the bone being twisted hither and thither to

Fig. 30.

Amputation of Great Toe.

facilitate the division of the ligaments. Some operators divide the shaft of the metatarsal bone with the bone nippers through its upper third, leaving the proximal end of the bone *in situ*. This proceeding opens no joint and avoids disturbing the attachment of the peroneus longus, and the risk of cutting the arteries in the angle of the first interosseous space.

Arteries divided.—The first digital artery, the dorsalis pollicis, and probably the external plantar and communi-

cating branch from the dorsalis pedis. Should these latter be divided, two arteries will require ligature in the angle of the first interosseous space.

Second Method.—The operator should make an incision through the skin and soft structure down to the bone, commencing about half an inch behind the tarso-metatarsal joint on its inner aspect, and continue it to the middle of the shaft of the metatarsal bone. He should

Fig. 31.

Amputation of Great Toe.

then make it diverge to the web between the first and second toe, and carry it round the palmar surface of the big toe at its digital fold and back to the spot where the incision diverged (*fig.* 31). The soft parts must now be separated by keeping the knife close to the bone, and disarticulation completed as before.

LISFRANC'S AMPUTATION.[1]

This consists in the removal of part of the foot, at the articulation between the tarsus and metatarsus.

[1] Often improperly called Hey's operation.

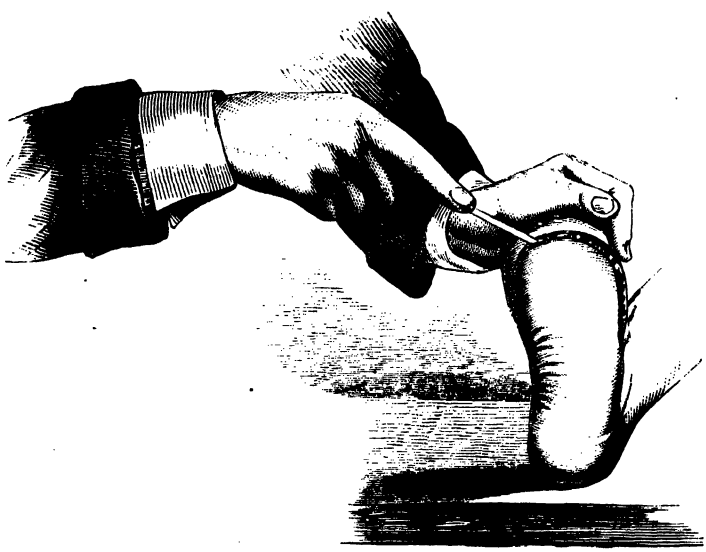
Anatomy.—The operator should glance at the line of articulations he is about to open (*fig.* 29); he will perceive that, with the exception of that belonging to the second metatarsal bone, they are arranged in a pretty regular curve across the dorsum of the foot; while the proximal end of the bone in question dips down towards the tarsus, and is wedged in between the first and third cuneiform bones; again, the first and second metatarsal bones are connected by strong plantar ligaments to the internal cuneiform bone; and lastly, the tendon of the peroneus longus is attached to the base of the metatarsal bone of the great toe; these connections, which must all be divided in this operation, form the principal difficulty in its execution.

Operation.—The operator, taking a knife about four inches long in the blade, should grasp the sole of the foot in the palm of his left hand, the extremities of his thumb and fore-finger being placed just behind the tarsal ends of the metatarsal bones of the little and great toes respectively.[1] The former of these being prominent, its situation may be easily ascertained on the outer side of the foot, while the latter is found about an inch in advance of the prominence of the scaphoid on the inner side. These two points, marked by the finger and thumb, should be connected across the dorsum of the foot, half an inch in advance of the articulations about to be opened, by a slightly-curved incision, having its convexity turned towards the toes (*fig.* 29, page 172). The extremities of this first cut must now be joined by an incision running along the sides of the metatarsal bones of the great and

[1] This refers to the right foot.

little toes, and crossing the sole in a curved manner, just at the ball of the toes, as represented in the adjoining woodcut (*fig.* 32). This flap, traced on the sole, should be longer on its inner than on its outer side, and it should be cut deeply, down to the bones. The foot being now firmly grasped in the left hand, and the dorsal ligaments put on the stretch, they may be divided over the line of the tarso-metatarsal articulations, and the latter opened.

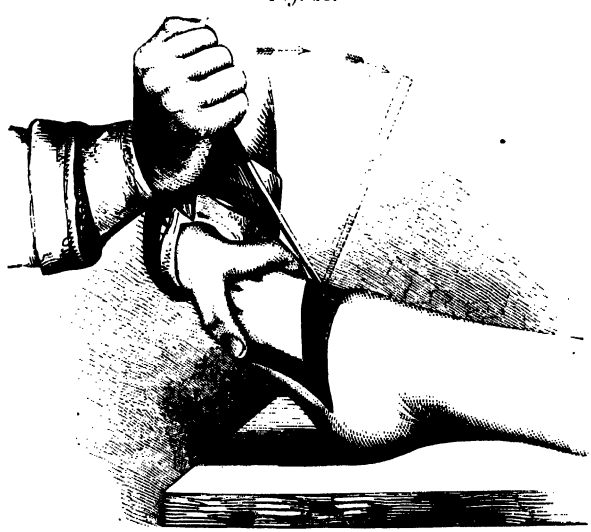
Fig. 32.



The knife should now be inserted between the shafts of the first and second metatarsal bones, its point being directed towards the tuberosity of the os calcis, and its edge looking upwards; it should be grasped in the fist, and should be made to move in a direction which we trust may be expressed by the accompanying woodcut (*fig.* 33); at the same time the left hand of the operator should

bear downwards upon the end of the foot. The object of this proceeding is to divide the ligaments at the base of the second metatarsal bone, and set its articular extremity free; the division of these ligaments is easily ascertained by the resistance to the left hand suddenly ceasing, and by the wide separation of the tarsus from the metatarsus. All the ligamentous connections of the bones being divided, the blade of the knife should be passed behind them into

Fig. 33.



the sole, and, being carried with a sawing movement close along the under surface of the metatarsus (*fig.* 34), be made to cut its way out into the sole, at the extremity of the flap that has been previously traced.[1]

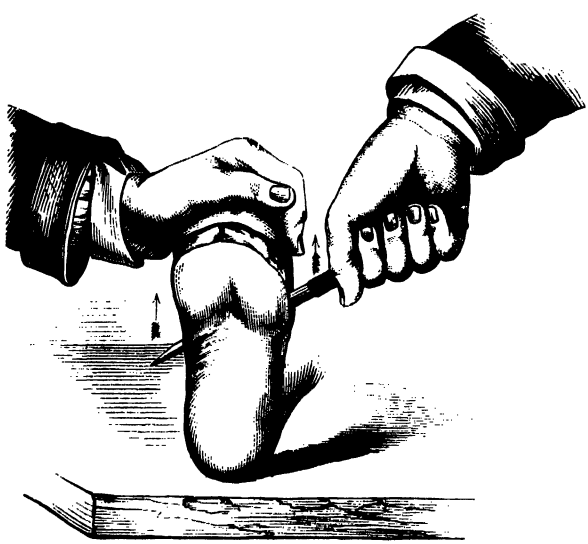
Arteries divided.—The dorsalis pedis, the internal and external plantar, and the digital arteries.

[1] Hey's amputation is performed in precisely the same manner, except that the metatarsal bones are sawn through just below their proximal ends, instead of being disarticulated.

AMPUTATION THROUGH THE TARSUS, OR CHOPART'S OPERATION.

Chopart's operation is the partial amputation of the foot at the articulation between the calcis and astragalus on the one side, and the cuboid and scaphoid bones on the other (*fig.* 29); the principal covering for the stump being

Fig. 34.



taken from the sole. We shall describe the operation as it is performed on the right foot.

Operation.—The operator, grasping the sole of the foot in the palm of his left hand, should feel for the prominence of the scaphoid bone on the inner side, and having placed the end of his fore-finger upon this, should next ascertain the position of the peroneal tubercle[1] on the outer side, and marking its exact situation with the thumb

[1] It is found about an inch below and in advance of the outer malleolus.

of the same hand, let him make a curved incision across the front of the tarsus from a point an inch in front of the peroneal tubercle to the prominence of the scaphoid. He should then connect the extremities of this incision by tracing out a flap from the sole in the manner represented in *fig.* 32; this flap, being curved at its extremity, and reaching just short of the balls of the toes, should, as in the preceding operation, be longer on its inner side than on its outer side. The dorsal ligaments of the tarsus, put on the stretch by bearing with the left hand upon the toes, and using the heel as a fulcrum, should first be divided over the calcaneo-cuboid articulation, which is found half an inch in front of the peroneal tubercle, and subsequently over the articulation between the astragalus and scaphoid; these two joints being opened, the ligamentous connections of the bones should be entirely divided, and the blade of the knife passed to the under surface of the bones, and made, with a slight sawing movement, to cut its way out at the extremity of the plantar flap, in the manner exhibited in *fig.* 34.

Arteries divided.—The dorsalis pedis, the internal and external plantar, and the digital arteries.

AMPUTATION THROUGH THE ANKLE-JOINT OR SYME'S AMPUTATION.

Syme's Amputation (*fig.* 29) consists in the removal of the foot at the ankle-joint, cutting off the malleoli with a thin slice of the articular surface of the tibia, and retaining the integuments of the heel as a covering for the bones. The chief difficulty experienced in this operation is the separation of the os calcis from its posterior

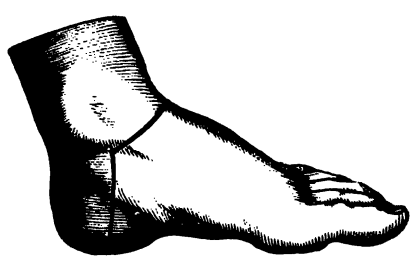
and lateral connections, without injury to the integuments behind, or to the posterior tibial artery on the inner side.

Instruments required.—A strong knife about three inches long in the blade, artery or torsion forceps, saw, bone nippers, scissors.

Position of Operator.—The operator should stand facing the foot.

Position of Assistant.—The assistant, facing the operator, should support the leg; the heel should rest on the edge of the table, the foot being at a right angle

Fig. 35.



Amputation at Ankle-joint.

to the leg. On the living he may at the same time control the tibial arteries with his thumb and fore-finger.

Operation.—Since this operation was first introduced into practice by Mr. Syme, many minor modifications have been proposed and practised. We shall content ourselves with giving the original operation in Mr. Syme's own words, and in describing the modification as performed by Professor Pirrie, of Aberdeen, and what we venture to think a still better method.

Mr. Syme's original Operation.—'The foot being placed at a right angle to the leg, a line drawn from

the centre of one malleolus to that of the other directly across the sole of the foot will show the proper extent of the posterior flap; the knife should be entered close up to the fibular malleolus, and carried to a point on the same level of the opposite side, which will be a little below the tibial malleolus; the anterior incision should join the two points just mentioned at an angle of 45° to the sole of the foot and long axis of the leg. In dissecting the posterior flap, the operator should place the fingers of his left hand upon the heel, while the thumb rests upon the edge of the integuments, and then cut between the nail of the thumb and the tuberosity of the os calcis, so as to avoid lacerating the soft parts, which he at the same time gently, but steadily, presses back, until he exposes and divides the tendo Achillis. The foot should be disarticulated before the malleolar projections are removed, which it is always proper to do, and which may be most easily effected by passing the knife round the exposed extremities of the bones, and then sawing off a slice of the tibia connecting the two processes.'

Pirrie's Modification.—This merely consists in sawing through the bones of the leg just above their articular surface without disarticulating the foot; the rest of the operation is performed in exactly the same manner as described by the late Mr. Syme.

Another Method.—As we consider this the best way of performing the operation we have described it somewhat fully.

The operator should make an incision from the tip of the external malleolus to a little below the posterior

border of the internal malleolus, across the under surface of the heel, in the direction shown in the preceding diagram (*fig.* 35). This incision should extend down to the os calcis in its whole extent. The ankle-joint should now be opened by a cut, connecting the extremities of the first incision, and running from malleolus to malleolus, across the front of the articulation. The foot being firmly extended, the joint should be fully opened, by dividing the lateral ligaments, and the os calcis be separated from its posterior and lateral connections by dissecting from above, down its posterior surface, the point of the knife being used, and this being kept close against the bone.

In separating the integuments from their connections, the operator should be careful not to score them crossways, as by doing this their vascular supply is interfered with, and the flap rendered liable to slough. Having freed the calcis from the tendo Achillis and the parts about the outer side of the heel, the operator should separate the soft parts from the inner ankle with great care, so that the posterior tibial artery may not be wounded in this part of the operation.

In operating on young subjects the epiphysis of the os calcis is usually left in the posterior flap, and may there remain.

The malleoli should now be cleared for the saw by drawing the knife firmly round them just above the articular surface of the tibia, and a thin slice of the tibia with the two malleoli sawn off. The tendons about the ankle should now, if necessary, be shortened with the scissors, and the arteries secured.

Arteries divided.—The anterior tibial, which will be

found on the front of the tibia, and the external and internal plantar arteries, which are situate at the extremity of the inner side of the plantar flap.

Mr. Syme advised an incision to be made in the bottom of the heel flap to prevent the collection of discharges. If the plantar incision be carried well back towards the point of the heel there is no need of this outlet in the posterior flap.

Roux's Amputation of the foot is effected at the ankle-joint, the integuments on the inner and under side of the heel being saved as a covering for the stump. The operator, standing at the side of the foot, commences an incision at the apex of the outer malleolus, and carries it half across the front of the ankle-joint, from whence it should run inwards in an oblique direction over the astragalo-scaphoid articulation, then pass in a curved manner downwards and backwards to the mesial line of the sole of the foot, and, running along the under surface of the heel, must ascend the posterior aspect of that part, and terminate at the outer malleolus, where it commenced. The ankle-joint should be opened on its upper and outer aspect, the calcis dissected from its connections (*fig.* 36), the malleoli and a slice from the articular surface of the tibia removed, and the operation will be complete. The shape of the flap may, perhaps, be gathered from the appearance presented by a foot upon which the operation has been performed. This is shown in *fig.* 37.

PIROGOFF'S OPERATION.

This is a modification of Mr. Syme's operation. It differs from it in that, instead of completely removing

the os calcis, in this operation the posterior part of that bone is sawn through obliquely and left in the heel, and the latter is retained as the covering for the ends of the bones of the leg; it is more easily performed than Mr.

Fig. 36.

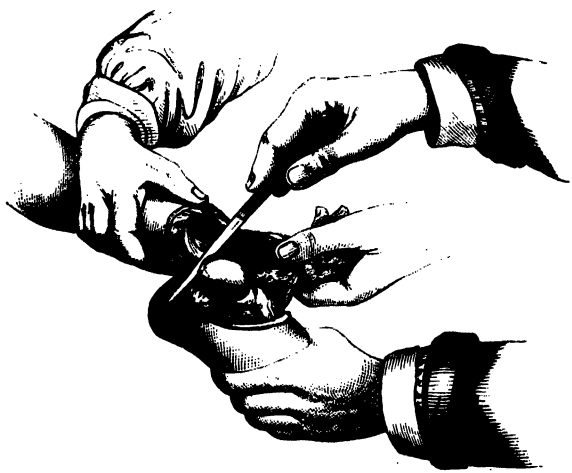


Fig. 37.

Syme's operation, avoiding as it does the dissection of the soft parts from the posterior surface of the os calcis.

The operator, turning the foot upwards, makes an incision down to the bone, straight across the sole, from the apex of one malleolus to the apex of that of the opposite side. Extending the foot, he now joins the extremities of this incision by another, stretching across the front of

the ankle-joint. Having opened the articulation, with the point of the knife he divides the lateral attachments of the astralagus until it so far comes out of the ankle-joint as to allow the os calcis to come into view behind it; with the foot in the same position, the saw should be placed behind the astragalus, and the os calcis divided vertically[1] downwards. The remaining connections of this bone being separated with the knife, and the ends of the tibia and fibula removed, the operation is complete. When the lower flap is brought up, the os calcis will be found to be cut obliquely, so as to come into more accurate apposition with the bones of the leg by its sawn surface.

An Improved Method of Performing Pirogoff's Amputation, by Dr. Eben. Watson.—This operation is performed in the following manner. The operator stands on the right-hand side of the limb, and, turning up the sole by flexing the foot, he makes an incision down to the bone from the tip of one malleolus to the other, across the under surface of the heel; into this wound the saw is introduced, and the posterior part of the os calcis sawn off behind the astralagus, the section being carried in a direction upwards and inclining backwards. The heel is now retracted by an assistant, the knife applied between the sawn surfaces of bone, and made to cut its way upwards for a short distance behind the ankle-joint (*fig.* 38). The operator now joins the extremities of his first incision by cutting straight from malleolus to malleolus across the front of the ankle, dividing all the tendons and soft parts down to the tibia; these being retracted, and the

[1] In this position of the foot the section should be vertical.

bones of the leg cleared at their lowest part, their articular surfaces, with the malleoli, should be sawn off. This section should only include a thin shell of bone, and should be carried nearly at right angles to the long axis

Fig. 38.

of the bones, though with a slight inclination *upwards*[1] (*fig.* 39).

The foregoing operation is more easy of execution than the ordinary method of performing Pirogoff's amputation; and, among other advantages which it possesses, we may allude to the exact adaptation of the parts to each other when brought together after the operation, and to the greater ease with which it is performed on the living

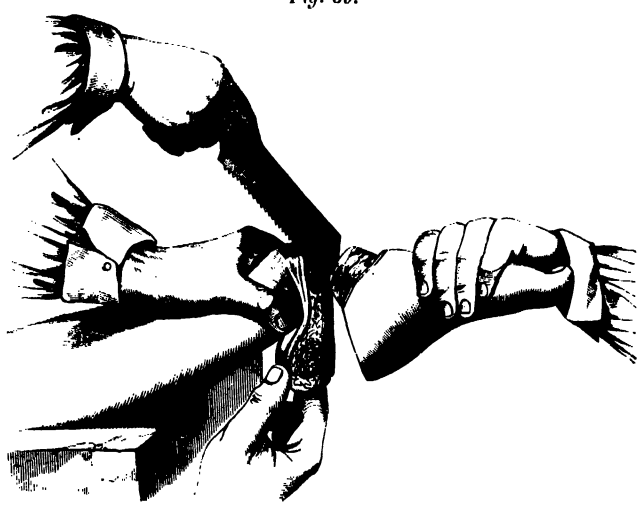
[1] In this particular we have ventured to differ from Dr. Watson's recommendations, as given in the *Lancet*, June 11, 1859. He there recommends that the bones of the leg be sawn 'from before, backwards and *downwards*.'

body when the foot is too mutilated to allow of its being firmly grasped.

As Lignerolle's, or the sub-astragaloid, operation, Hancock's modification and Laborie's operations are seldom practised, we shall only briefly allude to them.

Lignerolle's Sub-astragaloid Operation.—This consists in removing all the bone of the foot with the exception

Fig. 39.



of the astragalus. It is performed by making a heel flap, as in Syme's operation, and a short dorsal flap, in opening the joint between the scaphoid and astragalus, and disarticulating between the latter bone and the os calcis.

Hancock's Operation.—This is a modification of the above. Mr. Hancock saws off part of the os calcis, as in Pirogoff's operation, removes the under surface of the astragalus, and brings the two sawn surfaces together.

Laborie's Operation.—This operation is somewhat

like Chopart's, only M. Laborie retains the scaphoid in addition to the os calcis and astragalus.

Several other operations on the tarsus have been described, but, as they are seldom or never performed in this country, we have not thought it necessary to allude to them.

AMPUTATION THROUGH THE LEG.

Anatomy.—Before commencing any of the following operations, it may be well to observe the conformation of the leg in respect to the position of its bones and the relation that these bear to one another. The great preponderance of soft parts on the posterior aspect of the limb cannot fail to attract attention; and the relative position of its bones being examined, they will be found not to lie in the same horizontal plane, but rather the one somewhat posterior to the other, the fibula being hindermost. The remembrance of these points will, in the performance of the flap operation, facilitate the formation of flaps bearing a proportionate size to each other, and will render impossible either the thrusting of the knife between the bones, or the empalement of the more distal bone with the point—accidents which occasionally occur even on the living body.

Different Methods of Operating.—It was formerly the custom, on the living body, to amputate immediately below the knee in all cases where the patient would be obliged to wear a common wooden pin, and rest his weight on the bent knee, the long stump under these circumstances being found very inconvenient. This spot was called by the older surgeons the *seat of election.* Since the introduction of the short socket pin, ampu-

tation through the lower extremity is performed as low as possible, as every additional inch removed increases considerably the risks of the operation.

On the dead body the leg may be amputated through its upper, middle, or lower thirds.

The following are some of the principal methods and modifications which have been devised for amputating in these situations.

1. The circular method.
2. The double flap operation.
3. Integumental flaps and circular division of muscles.
4. The oval method.
5. Mr. Teale's operation.
6. Mr. Lee's operation by a long posterior flap.
7. The lateral flap operation.
8. The long anterior flap method.

We shall describe the circular, the double flap, the circular muscle and skin flaps combined, Mr. Teale's operation, and the long anterior flap operation. We advise the student to amputate low down, as this leaves a long stump, which will be found useful for steadying the leg during excision of the knee-joint.

GENERAL DIRECTIONS FOR AMPUTATING THE LEG.

Instruments required.—Amputating knife, about six inches long in the blade, saw, artery or torsion forceps, bone nippers, scissors, scalpels.

Position of the Limb.—The limb should be drawn over the edge of the table and supported by an assistant, the opposite leg being secured, well out of the operator's way, to the leg of the table.

Position of Operator.—The operator should stand on the right-hand side of the leg to be amputated—*i.e.* outside the limb when operating on the right leg; between the legs when amputating the left leg.

Position and Duties of Assistants.—One assistant, facing the operator on the opposite side of the leg, should in the circular operation retract the soft parts just above the part to be amputated, and in the other operations take charge of the flaps as soon as cut by the operator. Another assistant should support the part to be removed. On the living, a third assistant should control the circulation through the limb.

1. THE CIRCULAR METHOD.

This may be performed at any part of the leg, but it is usually preferred in amputations high up the limb, in which the patient eventually supports the weight of the body on the bended knee, and not on the extremity of the stump; indeed, the covering and protection afforded to the ends of the bones by this operation are scarcely sufficient to support the weight of the body.

The soft parts being retracted by the assistant, the operator should sweep the knife around the limb so as to divide the integument in its entire circumference; this, being retracted by the assistant and dissected back for three or four inches, must be turned over on itself like the cuff of a coat. The muscles should be divided in a circular manner as high up as possible, and the knife passed around and between the bones in front and behind, and the saw applied so that in dividing the bones the section of the fibula be completed, though not commenced,

before that of the tibia. After amputating through the upper third of the leg at the seat of election, the sharp, projecting edge of the tibia should be sawn off obliquely, as this, if allowed to remain, is apt to cause injurious pressure on the anterior flap of skin covering it.

This sharp edge is conveniently removed by first applying the saw obliquely a little above where it is intended to divide the bone, and then, withdrawing it, to reapply it to the bone at right angles a little lower down.

The head of the fibula should in all cases be left when amputating high up, as the articulation between it and the tibia occasionally enters into the formation of the knee-joint.

Arteries divided.—The anterior tibial, the posterior tibial, and the peroneal arteries will have been divided; and if the amputation has been performed in the upper third of the leg, some little difficulty may be experienced in recognising the end of the anterior tibial, which, at this situation is involved in the fibres of the interosseous membrane.

2. DOUBLE-FLAP OPERATION.

This operation, though applicable to any part of the limb, is generally preferred for amputation through the lower two thirds. The anterior flap in this part of the body is formed by cutting, and not by transfixion. The operator should place the thumb and fore-finger of his left hand on the posterior margins of the tibia and fibula respectively, and from one to the other should make a semilunar incision, with its convexity towards the foot, thus tracing a flap on the anterior and outer aspect of the limb about four inches long, and being at its base half the circum-

ference of the leg in width. This incision may be made to extend pretty deeply, so as to include as much as possible of the subjacent muscles; the whole being reflected to the full extent, the soft parts at the back of the limb may be transfixed, the point of the knife entering at the termination and coming out at the commencement of the first incision, thus passing behind both bones. This proceeding may be facilitated by adopting the plan recommended in amputation of the fore-arm, and represented in *fig.* 25. A posterior flap of the same shape, though somewhat longer than the anterior, being cut, the knife should be passed around and between the bones at the angle of junction of the flaps, and the saw applied as in the preceding method.

Arteries divided.—If this amputation be practised in the middle third of the leg, the anterior tibial artery will be found in front of the interosseous membrane; the posterior tibial a short distance behind that structure on the tibialis posticus muscle, and the peroneal under the sawn edge of the fibula in the substance of the flexor longus pollicis.

3. AMPUTATION BY INTEGUMENTAL FLAPS AND CIRCULAR DIVISION OF THE MUSCLES.

This method may be made use of with great advantage in any part of the leg. The operator, marking the posterior borders of the tibia and fibula with the fore-finger and thumb of the left hand, traces and subsequently reflects a semilunar flap formed of integuments, extending across the anterior and outer aspect of the limb from the posterior margin of one bone to that of the other, and reaching downwards for about four inches. Next he forms and

reflects a posterior flap by connecting the extremities of his first incision. At the base of these flaps, the posterior of which should be the longer, the muscles are to be divided in a circular manner, and, being retracted as far as possible, the knife may be applied between the bones, and the latter sawn in such a way that the section of the fibula is completed before that of the tibia. In the upper third the spine of the tibia may be sawn off as before.

Arteries divided.—As before stated in last operation.

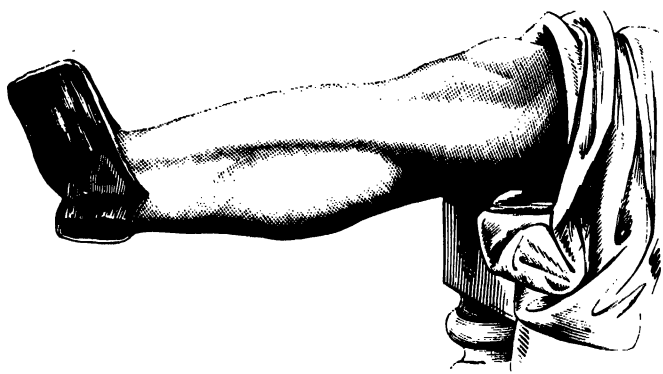
4. AMPUTATION BY RECTANGULAR FLAPS.

Mr. Teale recommends this operation in either the middle or upper thirds of the leg; and in all cases he advises that the flaps be carefully measured and traced upon the limb before operating.[1] The operator, standing on the right-hand side of the leg, should trace out with his knife the lateral boundaries of the anterior flap. This should be quadrangular, the width of half the circumference of the limb, and the same length; its lateral incisions should run along the posterior margins of the tibia and fibula respectively, and should divide the integuments alone. These incisions being connected at their lower extremities by a transverse cut dividing everything down to the interosseous membrane, the long flap should be dissected upwards, with all the structures in front of the bones and interosseous ligament. The posterior flap, one-fourth the length of the anterior, should be made by a direct cut *through everything down to the bones*, and separated as high as the point where it is intended that the bones should be sawn. To aid our description, we refer to

[1] For the general rules for performing this operation, see page 133.

fig. 40, copied from Mr. Teale's book. The wound is brought together as in all cases where this method has been employed; namely, the upper flap is doubled on itself, and thus folded over the ends of the bones, its extremity

Fig. 40.



Appearance of the wound after Mr. Teale's operation (from Mr. Teale's pamphlet).

being fixed by suture to the extremity of the short flap, and its reflected portion connected to its unreflected portion in a similar manner (*fig.* 41).

Fig. 41.

Manner of bringing the wound together after Mr. Teale's operation.

5. BY A LONG ANTERIOR FLAP.

A long anterior flap, half the circumference of the leg, and well rounded at its ends, is cut from the front of the leg. This flap should include the soft structures occupying the interval between the tibia and fibula, and should be about four inches long. This is now retracted, and the soft parts on the posterior aspect divided by a circular sweep of the knife, the bones cleared, and the saw applied in the usual way.

Arteries divided.—The anterior tibial should be contained in the long flap. The posterior tibial and the peroneal will be found on the posterior part of the stump.

This differs from Mr. Teale's operation, in the anterior flap being shorter, in the absence of a posterior flap, and *in the division of the bones lower in the leg than by* ethod.

AMPUTATION THROUGH THE KNEE-JOINT.

Many different methods of amputating through the knee-joint have been devised, some of much value, but others of doubtful utility. We shall describe the following methods of operating, viz. :

(1) By a single anterior skin flap.

(2) By a posterior flap.

(3) By double skin flaps and circular division of the deep structures.

(4) By Brinton's modific

(5) By lateral skin

We advise the student

the last of these methods.

GENERAL DIRECTION.

Position of the Subject.—The subject being placed on its back, the leg should be drawn over the edge of the table, and supported by an assistant sitting in front of it.

Instruments required.—Amputating knife; artery and torsion forceps; scissors; scalpels.

Position of Operator.—The operator should stand on the right-hand side of the leg to be removed.

Position of the Assistants.—One assistant should stand facing the operator, on the opposite side of the limb. Another should support the leg.

SINGLE ANTERIOR FLAP.

The operator should trace out on the front of the leg a flap with a rounded extremity six or seven inches long, and extending laterally from one hamstring to the opposite; this incision should begin at the posterior part of one condyle of the femur, and terminate at the corresponding spot on the other side of the limb.[1] An incision should now be made through the integuments alone straight across the back of the knee-joint, connecting the extremities of the first; the operator, having reflected the anterior flap so as to expose fully the front of the knee-joint, must open the articulation on its anterior aspect while the limb is flexed, and, dividing the ligaments, should cut straight through the joint, bringing the knife out at the posterior incision. The patella may be left, or surface of the femur may be re-

Some surgeons advise the division of the quadriceps extensor tendon above the patella, to prevent this bone being drawn up by the above-mentioned muscle.

Arteries divided.—The popliteal, the superior articular, the sural, and anastomotica magna. The popliteal artery will be found at the back of the femur, between the condyles, and nearer to the bone than its companion vein, from which it can only be distinguished by its position.

SINGLE POSTERIOR FLAP.

This is effected by making a slightly-curved incision across the front of the joint from condyle to condyle, and reaching below the patella. Having raised the integuments over the joint, it should be opened in front and its ligaments divided. The knife should now be passed through the articulation behind the head of the tibia, and a posterior flap be cut from the calf six or seven inches long, and as broad as possible at its extremity, as it has to adapt itself to the condyles of the femur; this will complete the operation.

It is questionable whether this operation should be performed on the living, as the posterior flap is apt to slough.

DOUBLE SKIN FLAPS AND CIRCULAR DIVISION OF THE DEEP STRUCTURES.

This operation is performed by cutting, from without inwards, an anterior and a posterior skin flap, and dividing the deep parts and ligaments by one sweep of the knife. The anterior flap should be slightly the longer. *The patella should not be taken away*; Mr. Bryant states, indeed, that in two amputations he performed at this

articulation he did not even see this bone during the performance of the operation.

DR. BRINTON'S MODIFICATION BY DOUBLE SKIN FLAPS.

Dr. Brinton makes two skin flaps and cuts through the coronary ligaments, thus leaving the semilunar cartilages attached to the femur.

LATERAL SKIN FLAPS.

In this operation two skin flaps, about four inches in length and slightly rounded at the corners, are formed from the lateral aspects of the upper parts of the leg; the muscles are divided in a circular manner, and the lateral connections of the patella left undisturbed, thereby preventing its being drawn up by the contraction of the quadriceps extensor muscle. The anterior angle of junction of the flaps should be opposite the lower border of the patella, the posterior angle in the centre of the ham.

These flaps should be very wide and formed so as to preserve all the integuments of the upper part of the leg; this can best be done by tracing the second flap so that the line of its incision falls into that of the first flap two inches below the lower border of the patella.

AMPUTATION OF THE THIGH.

The thigh may be amputated through any part of its length. On the living subject amputation should be performed as low down as possible, as every inch of bone removed increases considerably the risk of the operation.

We shall describe the following methods of amputating:—

1. Gritti's operation.

2. Mr. Carden's operation, through the lower third by a long anterior integumental flap.

3. Mr. Spence's amputation through the lower third.

4. Lateral flap method, 'Vermale's operation.'

5. The circular method.

6. The double flap operation by transfixion.

7. The integumental flaps with circular division of the muscles.

8. Mr. Teale's operation.

We shall not attempt to discuss the merits and demerits of these different operations, as they are fully treated of in the systematic works on surgery, but shall content ourselves with referring to any special advantages claimed for each whilst describing it.

On the dead body we advise the student to perform Mr. Carden's operation, and should he determine to amputate higher up the thigh also we strongly recommend the circular division of the muscles with skin flaps to his consideration.

The objection on the dead body to amputating high up the thigh is that the stump left is too short for the satisfactory performance of amputation at the hip-joint.

GENERAL DIRECTIONS FOR AMPUTATING THE THIGH.

Intruments required.—Amputating knife about eight inches long in the blade, amputating saw, artery and torsion forceps, bone nippers.

Position of the Subject.—The body being placed on its back, the nates should be drawn to the edge of the table, and the limb to be amputated supported horizontally.

Position of the Operator.—The operator should stand on the right-hand side of the limb he is about to remove in performing transfixion operations, and in cutting flaps from without inwards; but in the circular operation he may find it more convenient in amputating the left thigh to stand on its outer side.

Position and Duties of the Assistants.—One assistant should support the limb to be removed; a second, on the living patient, should control the femoral artery as it passes over the brim of the pelvis, either with his fingers or the tourniquet; a third, placed opposite the operator, should take charge of the flaps and retract them whilst the bone is being cleared for the saw. After the limb is removed he should assist the operator to secure the main vessels.

1. AMPUTATION JUST ABOVE THE CONDYLES WITH AN ANTERIOR FLAP, IN WHICH THE PATELLA IS PRESERVED, ITS SURFACE BEING SAWN AND APPLIED TO THE CUT SURFACE OF THE FEMUR.—'GRITTI'S, SUPRA-CONDYLOID AMPUTATION.'[1]

This operation has been practised successfully by Messrs. Pollock, W. Stokes, Jessop, and Teale, of Leeds, and others. It is performed as follows:—

A semilunar incision is made in front of the knee, beginning at the upper end of the fibula, and terminating at a point exactly corresponding on the inner side of the joint. It should pass a little below the patella, and only including the skin. Two parallel incisions are now made from the extremities of the transverse one extending as high as the upper border of the patella, and down to the

[1] *Annali Universali*, July 1857.

bone. The anterior flap is now dissected up and the joint opened; the cartilaginous surface of the patella sawn off the tissues behind transfixed, and a posterior flap formed by cutting from the bone to the inferior extremities of the lateral incisions.

The bone should be sawn across at the superior angle of the flaps.

Rizzoli has introduced a slight modification in not sawing off a slice of the patella and in laying open the *cul de sac* below the quadriceps.

Marcacci does not disarticulate.

Mr. Pollock has invented forceps for cutting off a slice from the under surface of the patella.

2. MR. CARDEN'S AMPUTATION THROUGH THE LOWER END OF THE FEMUR BY A SINGLE SKIN FLAP.[1]

'This operation,' says Mr. Carden, 'consists in reflecting a rounded or semioval flap of skin and fat from the front of the joint (*fig.* 42), dividing everything else straight down to the bone, and sawing the bone slightly above the plane of the muscles, thus forming a flat-faced stump with a bonnet of integument to fall over it.'

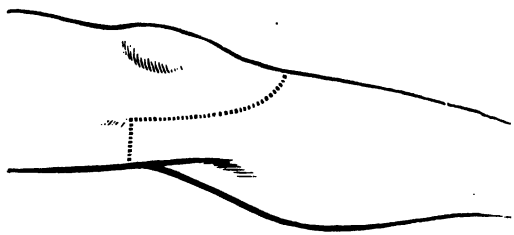
The operation is performed in two ways.

'The operator, standing on the right side of the leg, seizes it between his left fore-finger and thumb at the spot selected for the base of the flap, and enters the point of the knife close to his finger, bringing it round through skin and fat below the patella to the spot pressed by his thumb; then turning the edge downwards at a right angle with the line of the limb, he passes it through to

[1] *British Medical Journal*, vol. i. p. 416, 1864.

the spot where it first entered, cutting outwards through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down

Fig. 42.

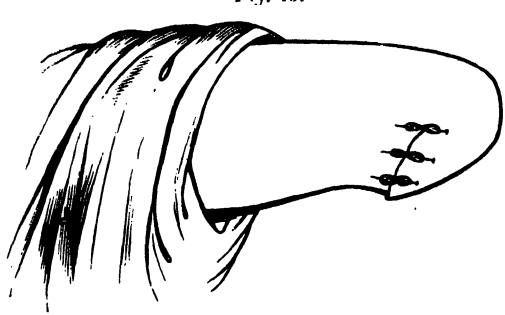


Line of Incisions. (After Mr. Carden.)

to the bone; the muscles are then slightly cleared upwards, and the saw is applied.'

'Or, the limb being held as before, the hand and knife may be brought round under the limb, as in the circular operation, and the blade entered near the thumb

Fig. 43.



Flap covering Stump. (After Mr. Carden.)[1]

and drawn round to the opposite side, when the ham may be cut across by turning the edge of the knife upwards; and the operation completed as before.'

[1] *British Medical Journal*, 1864, vol. ii.

'Or the flap may be reflected first, and the knee-joint examined, particularly if the operator be undetermined between resection and amputation. In amputating through the condyles the patella is drawn down by flexing the knee to a right angle before dividing the soft parts in front of the bone.'

Arteries divided.—The popliteal artery and its articular branches. Mr. Carden advises a slight separation of the artery from the vein, as he believes the beat of the artery, in the living, by preventing closure of the vein, predisposes to secondary hæmorrhage from the latter vessel.

The advantages of this operation are thus stated by Mr. Carden:—

'1. The facility afforded for amputating either through the knee or any part of the lower end of the femur, thus avoiding the shock of higher amputation, and the risk of exfoliation, pyæmia, etc., attendant on sawing through the cylinder of the bone. 2. The simplicity of the whole proceeding, and small extent of wound. 3. The favourable position of the flap for dressing and the escape of the discharge. 4. The painlessness and quietude of the stump, the principal nerves being divided high up and drawn out of reach of pressure or exposure. 5. The fitness of the stump to stand or walk upon, the bearing being broad, and the skin employed being accustomed to bear the weight of the body in kneeling. 6. The cicatrix being drawn clear of the point of the bone, and out of the reach of pressure.'

We strongly advise the student to practise this operation on the dead subject.

3. MR. SPENCE'S AMPUTATION THROUGH THE LOWER THIRD BY A LONG ANTERIOR FLAP.

This operation, which is a modification of one introduced by Mr. O'Halloran of Limerick in 1765, is described by Mr. Spence as 'simply cutting a large, slightly-rounded flap from the anterior aspect of the thigh, consisting of integuments alone; dividing the soft parts posteriorly by a circular sweep of the knife, so that when the bone is sawn through, the anterior flap may fall upon and adjust itself to the section of the limb.'

The posterior flap is made by sweeping the knife round the limb and cutting all the tissue down to the bone. The thigh should now be somewhat raised towards the pelvis, the soft parts retracted, and the bone cleared for the saw about two inches higher up than the base of the flap. The bone is thus left deeply buried in the soft parts. The great vessels will be found in the posterior and inner part of the stump.

4. LATERAL FLAPS OR 'VERMALE'S OPERATION.'

This operation is advocated by some surgeons for amputations through the lower third of the thigh. If lateral flaps are made when operating through the upper or middle thirds, the bone is apt to project into the upper angle of the wound. We do not advise its performance in any situation.

Arteries divided.—The femoral artery will be found in the inner flap; the termination of the profunda will also be seen on the surface of the inner flap, but nearer the bone.

5. THE CIRCULAR OPERATION.

The circular operation may be performed in any part of the thigh, and as its execution is the same in all its details, whether it be effected in the lower or upper third, we shall describe the operation once for all. The operator, standing on the outside of the limb, his assistant being on the same side and somewhat behind him, the limb should be drawn over the edge of the table, and supported in a horizontal position. Let the assistant retract the integuments above the part selected for amputation, and this he may best do by encircling the limb with both hands. The heel of the knife being laid on the side of the limb nearest to the operator, the integuments should be divided with one circular sweep of the knife if possible,[1] so as to free them from their connection with the muscles and deep fascia. While the assistant still forcibly retracts, let the operator pass the knife again and again around the limb, each time dividing fresh bridles of connective tissue between the integuments and the muscles, until sufficient integument has been obtained for covering the stump. The assistant should now take a fresh grasp of the limb, and, keeping the integuments well out of the way of the knife, the operator must divide all the remaining tissues down to the bone in the same manner that the skin was divided: if the soft parts be still firmly retracted, the stump will now assume a somewhat conical shape, owing to the more superficial muscles retracting to a greater extent than those more closely connected with the bone; these should be again divided,

[1] The manner of effecting this is described in detail at page 156.

by passing the knife around the femur about an inch from the extremity of this muscular cone, and the saw applied as high up as possible. In using the saw, the operator should grasp the bone close to the point of section, with his left hand, that he may thus the more effectually steady it. If this operation has been performed in the lower third of the thigh, the large vessels will be found near to the bone on its inner side.

6. AMPUTATION OF THE THIGH BY DOUBLE FLAPS.

In this operation the flaps are formed, the one from the anterior and outer aspects of the limb, the other from its posterior and inner side. The soft parts in front and to the outer side of the bone being grasped and raised by the left hand, a sharp-pointed amputating knife should be introduced on the outer side of the limb, rather nearer its posterior than its anterior aspect, and, being pushed onwards over the front of the bone, should emerge at a corresponding point on the opposite side; the parts held in the left hand may now be suffered to drop a little, while an anterior flap is cut about five or six inches in length, decreasing in thickness towards its extremity, which must be curved, and not left too thin at the edge. The assistant should gently raise this flap, while the operator passes the knife behind the bone, between it and the remaining undivided parts, and cuts a posterior flap the same shape as the anterior, but an inch or two longer: by drawing the soft parts downwards away from the bone, the transfixion of the limb on its posterior aspect will be much facilitated; both flaps being now retracted, the heel

of the knife may be passed around the bone at their point of divergence and the saw applied. In transfixing the thigh in its lower half, the knife, if possible, should pass in front of the femoral vessels; while in the upper half of the thigh the main artery will necessarily be situated in the anterior flap: the operator, in amputating above the middle of the thigh, should guard against transfixing these important structures.

Arteries divided.—The femoral, the profunda, the external circumflex, and muscular branches.

7. AMPUTATION BY DOUBLE FLAPS OF THE INTEGUMENT AND CIRCULAR DIVISION OF THE MUSCLES.

The operator must trace on the anterior surface of the thigh a semilunar flap, the width of half the circumference of the limb at its base and about five inches long; this, being formed of integuments alone, should be reflected and a posterior flap of the same shape and dimensions should be made, by connecting the extremities of the first incision; both being retracted, the muscles may be divided, and the operation completed as in the circular method of amputation. The performance of this operation is facilitated by making lateral skin flaps.

8. AMPUTATION BY A LONG AND SHORT RECTANGULAR FLAP.

For the general directions for performing this operation we refer the operator to page 132; in performing it on the lower two thirds of the thigh, the operator should stand on the outside of the limb, and should trace

one of the lateral incisions of the long flap, just anterior to the line of the femoral vessels, while the other should be on the outer aspect of the thigh, half the circumference of the limb distant; these incisions should include the integuments alone, the transverse cut connecting their extremities may be made by a single sweep of the knife, dividing all the soft parts down to the femur; the flap is completed by reflecting the fleshy structure, from below upwards, close to the bone. The posterior short flap, containing the large vessels and nerves, should be made by dividing all the soft parts on the posterior aspect of the limb, and separating them from the bone as far upwards as the point where this is to be sawn. The flaps are brought together in the manner shown in *fig.* 41, and described at page 197.

AMPUTATION OF THE THIGH AT THE HIP-JOINT.

The lower limb may be removed at its pelvic articulation in several ways; the chief difference in these methods consists, however, in the formation of a covering for the wound, from one or the other aspect of the limb. We venture to think that the operation by an anterior flap, where practicable, is the most suitable operation, and to this we shall more particularly allude.

Instruments required.—A knife about twelve inches long in the blade, artery and torsion forceps, and Lister's abdominal tourniquet, when operating on the living.

Position of the Subject.—The subject should be drawn to the edge of the table so that the tuberosities of the ischia may rest well over its edge: the limb to be ampu-

tated is taken charge of by an assistant, and the other limb secured out of the way to the leg of the table.

Position of the Operator.—The operator should stand outside the limb when operating on the left side, but between the legs when operating on the right side.[1]

Position and Duties of the Assistants.—Three assistants are necessary. One, facing the operator, should grasp the thigh just above the knee with his left hand, and the slightly-flexed leg with his right hand. His duties are first to flex the thigh and rotate it inwards, then, after the anterior flap has been cut, to rotate the thigh outwards, abduct and forcibly extend, so that the head of the bone may be forced out of its socket as the operator divides the ligaments in front of the joint. As soon as the head of the bone is dislocated forwards he should adduct and draw the thigh away from the body, to facilitate the passage of the knife behind the neck and great trochanter of the femur. The second assistant, stationed behind the operator when the left thigh is being amputated, but facing him on the opposite side of the limb when the right is about to be removed, should follow the knife with his hands thrust into the wound, and so secure the vessels on the anterior flap, even before they are divided. The third assistant should, on the living, have charge of the abdominal tourniquet.

Operation.—The formation of the anterior flap, and the spot at which the knife should be entered, will differ according to the side on which the operation is performed. When operating on the *left side* the knife should be inserted midway between the anterior superior spine

[1] Some surgeons stand outside the limb in both cases.

of the ilium and the top of the great trochanter, and thrust downwards and inwards parallel with the fold of the groin, in front of the head of the thigh-bone, but behind the great vessels, and should emerge on the inner side of the limb, two inches below the ramus of the pubes, and as near the tuberosity of the ischium as possible. In effecting this it is advisable for the operator to lay his left hand over the front of the joint, to ascertain when the point of the knife has reached the capsule of the hip-joint, which, if possible, should be opened on its anterior aspect, whilst thus transfixing. Having passed the head of the bone, the point of the knife may be considerably depressed, so that fully half the soft parts of the limb may be included in the anterior flap, which should be cut about eight or ten inches in length, and rounded at its extremity. When operating on the *right side* the point of the knife should be inserted two inches below the descending ramus of the pubes, and as near the tuberosity of the ischium as possible, and, crossing in front of the head of the thigh-bone, as on the left side, should be made to emerge about midway between the anterior superior spine of the ilium and the top of the great trochanter.

The anterior flap should be then cut, as on the left side.

The remaining steps of the operation are the same on both sides.

During the formation of the anterior flap the limb should be slightly flexed on the abdomen, adducted and rotated inwards, and the assistant in charge of the flap should thrust his fingers into the wound, and, following

the knife, should grasp the vessels even before they are divided.

This flap being retracted with some force, and the limb extended and rotated outwards, so as to put the capsule on the stretch, the operator should boldly draw his knife across the front of the joint as if about to cut off the head of the bone. The capsule being thus freely opened, the ligamentum teres must be divided, and the head of the bone dislocated forwards by the assistant.

The limb being now slightly flexed, adducted, and drawn forcibly from the body, the external rotator muscles should be separated from the bone, and its head being quite free from all attachments, the operator may at once pass the knife behind it, and, cutting vertically downwards through the remaining soft parts, remove the limb. It is the practice of some surgeons, after having completely freed the head of the bone, to pass the knife behind the limb, and cut straight across its posterior aspect from the inner to the outer angle of the wound, and from its cutaneous to its deeper surface.

During the passage of the knife behind the bone the assistant should be careful not to abduct in the slightest degree, as by so doing he would cause the operator to lock his knife between the head of the bone and the great trochanter, thus seriously delaying the operation.

In the foregoing operation there is no posterior flap; the wound will therefore be on the most dependent aspect of the limb, tending much to its cleanliness, and in the living body to the comfort of the patient. This operation may be modified by making an anterior and posterior flap

of equal dimensions, or by forming a short anterior with a long posterior flap.

Arteries divided.—The vessels divided in this proceeding are both numerous and large; those that demand the greatest attention are the superficial and deep femoral, the obturator, and sciatic. In the living body the arrest of hæmorrhage from the femoral trunk, as before stated, is the duty of an assistant, who should continue to hold it until the vessels in the posterior part of the stump are secured, the femoral and profunda being tied last of all.

The position of the cut ends of the arteries is as follows:—

The femoral, at the end of the anterior flap; the profunda on the surface of the flap further back than the femoral; the ischiatic, with the nerve of same name, on the posterior part of stump; the circumflex and obturator close to the acetabulum.

AMPUTATION OF THE THIGH AT THE HIP-JOINT BY LATERAL FLAPS.

As this operation is advised by many surgeons in preference to the former, we have thought it advisable to describe it. For our own part, we advise the anterior flap operation.

Mr. Bryant thus describes this operation:—

'The surgeon should make an external skin flap by means of a semi-circular incision, starting from the tuberosity of the ischium downwards and outwards, one hand's-breadth below the great trochanter, and then upwards and forwards to the centre of the groin on the outer side of the femoral vessels; this is reflected and the joint

opened, and disarticulation completed, the limb being forcibly adducted to facilitate this step. Transfixion is then performed by inserting the knife in the anterior wound, passing it close to the neck of the femur, and bringing it out near the tuberosity of the ischium, where the external incision was commenced, and then cutting out through the soft parts on the inner side of the limb.'

CHAPTER XI.

RESECTION OF ENTIRE BONES AND JOINTS.

Resection of Joints and entire Bones—Instruments—Phalanges of the Fingers—Phalangeal Joints: (1) by Lateral Incisions, (2) by a Dorsal Flap—Metacarpal Bone of the Thumb—Metacarpal Bone of Little Finger—Wrist-joint: (1) by Lateral Incisions, (2) Mr. Butcher's Method, (3) Lister's Method—Carpal End of the Ulna—Elbow-joint: (1) Langenbeck's Operation, (2) Maunder's Modification, (3) M. Ollier's Method, (4) Liston's Method, (5) H-shaped Incision—Shoulder-joint: (1) by a Semilunar Flap, (2) by a Longitudinal Incision, (3) Stromeyer's Method, (4) M. Ollier's Subperiosteal Method—Resections of the Lower Extremity—Metatarsal Bone of Great Toe—Excision of Os Calcis—Ankle-joint: (1) First Method, (2) Mr. Hancock's Method, (3) Buchanan's Modification of above—Knee-joint—Hip-joint.

It is usual to practise the resection of entire bones upon the dead body, though the performance of these operations in many cases gives but a faint idea of their execution on the living. It is not so with resections of joints; for in the case of these, considerable facility of execution may be acquired by practice on the dead body, a facility which it is important to possess for their successful performance on the living.

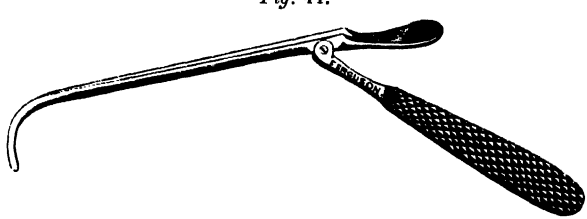
Resection in most cases aims at the complete destruction of an articular cavity, and the bringing together of two fresh cut surfaces of bone. This can be accomplished in the majority of the articulations of the body, though there are some where the anatomical disposition of the parts does not admit of the complete removal of the whole articular surface.

Instruments required.—Two or three strong scalpels of different sizes; an amputating saw, with a moveable back; a Butcher saw; a metacarpal saw; a director[1] (such as is represented at *fig.* 44); a pair of cutting bone forceps; lion forceps, for grasping bones; artery and torsion forceps.

RESECTION OF THE PHALANGEAL BONES OF THE FINGERS.

These bones may be removed in their entire length, by making two lateral incisions, rather nearer the dorsal than the palmar aspect of the finger, or on either side the

Fig. 44.



bone to be removed. These cuts should extend at either end just beyond the phalanx. The flexor and extensor tendon being dissected from their sheaths, the lateral ligaments at one articular end of the bone should be divided, while they are put on the stretch by bending the finger laterally: this extremity of the bone being cleared from its connections, it should be grasped, and the remaining attachments divided.

[1] This director is used for passing under bones that are to be sawn; it is passed around the bone, and the handle is then used to turn it with its groove upwards. It is especially useful in the neighbourhood of tendons.

RESECTION OF THE PHALANGEAL JOINTS OF THE FINGERS.

This may be effected in two ways: 1st, by making two lateral incisions, one on either side of the articulation; 2nd, by a semilunar flap, made over the dorsal aspect of the joint. The former method leaves both the extensor and flexor tendon uninjured, the latter divides the extensors.

1. Make an incision parallel with the long axis of the finger on either side of the joint, and dissect the tendons and soft parts from the articular extremities of the bones, keeping the point of the knife close to the bones to ensure the safety of the tendons: put the lateral ligaments on the stretch, and divide them while the joint is flexed laterally—the ends of the phalanges can now be extruded from the wound, and they may be removed with the bone forceps or a saw.

2. A semilunar flap, with its convexity directed towards the ends of the fingers, should be cut over the back of the joint, and all the soft parts dissected off. Bend the joint as much as possible and open it on its posterior aspect, clearing the ends of the bones from their connections; remove their articular surfaces as in the preceding operation.

RESECTION OF THE METACARPAL BONE OF THE THUMB.

Having procured a strong and narrow scalpel, make an incision on the dorsal aspect of the metacarpal bone of the thumb, commencing midway between the styloid

process of the radius and the articulation of the thumb with the trapezium, and extending along the palmar border of the extensor primi internodii up to, or rather beyond, the base of the first phalanx. Carefully dissect away the soft parts from the shaft of the bone, until it is sufficiently isolated to be grasped with the finger and thumb of the left hand. Put the bone in a position of extreme flexion, and divide the extensor ossis metacarpi at its insertion into the base of the bone; disarticulate the latter from its connection with the trapezium, and, grasping this end of the bone, pull it out of the joint and pass the knife behind it, separating the soft parts on its anterior or palmar aspect; and, finally, divide its attachments to the first phalanx, twisting the bone hither and thither to facilitate this process.

The fifth metacarpal bone may be resected in a similar manner by an incision made along its ulnar border.

These operations are seldom required on the living subject except for necrosis, and in this case the bone would probably be found lying loose in the cavity of the new bone.

RESECTION OF THE WRIST-JOINT.

Formerly excision of the wrist consisted merely in the removal of the lower ends of the radius and ulna, or in the laying open of any sinuses which might exist, and the gouging out of any diseased bone which might be found. At the present day we understand by excision of the wrist the removal of the lower extremities of the radius and ulna, the bones of the carpus, and the bases of all the metacarpal bones.

We shall briefly call attention to two of the former operations, and more fully describe the method of complete excision as practised by Mr. Lister.

The principal methods of performing the older operations are two: 1stly, by lateral longitudinal incisions running along the subcutaneous margins of the radius and ulna respectively, leaving all the tendons uninjured; 2ndly, Mr. Butcher's method, in which the extensor tendons of the thumb are left intact.

(1.) This is effected by making two lateral incisions, one on either side the joint, along the subcutaneous borders of the radius and ulna respectively; commencing half an inch in advance of each styloid process, and extending up the fore-arm for three inches or more. The soft parts should first be carefully dissected from the ulna until the director can be passed around the bone and its groove turned upwards; this being effected the bone may be sawn upon the director about an inch above the wrist, the lower fragment grasped with the forceps and disarticulated with the point of the knife. The radius should now be freed from the tendons which surround it, by dissecting chiefly from its outer to its inner border; the director being passed around it to keep these aside, the bone may be sawn off and separated, as in the case of the ulna.

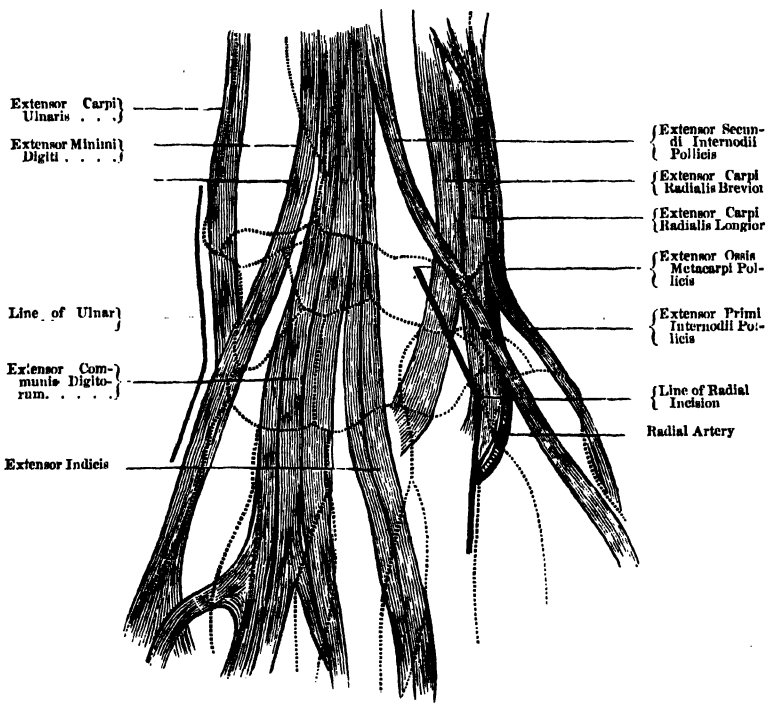
(2.) *Mr. Butcher's modification* consists in making a semilunar flap with its convexity towards the hand over the back of the joint: the incision should commence just to the ulnar side of the tendon of the extensor secundi internodii, and terminate on the subcutaneous border of the ulna, an inch higher up the fore-arm than the point where it commenced. All the extensor tendons of the

fingers are divided and reflected, while those of the thumb are dissected from their grooves and drawn to the radial side; the joint is opened from behind, and the ends of the bones disarticulated and sawn off.

MR. LISTER'S OPERATION.

The following is an extract from Mr. Lister's descrip-

Fig. 45.



Line of Incisions in Lister's Operation of Excision of the Wrist. (After Lister.)

tion of this operation in the 'Lancet.' The operation consists in the removal of the whole carpus, the articular ends of the radius and ulna, and the proximal ends of the metacarpal bones

'The radial incision is made in the direction indicated by the thick line (45 in the diagram of the anatomy of the back of the hand). It is planned so as to avoid the radial artery and the extensor secundi internodii pollicis and the indicator. The incision should commence above at the middle of the dorsal aspect of the radius on a level with the styloid process, this being as close to the angle where the tendons of the indicator and the secundi internodii diverge as it is safe to go. Thence it is directed towards the inner side of the metacarpal phalangeal articulation of the thumb running parallel in this course to the extensor secundi internodii; but on reaching the line of the radial border of the second metacarpal bone it is carried downwards longitudinally for half the length of bone, the radial artery being thus avoided, as it lies somewhat further to the outer side of the hand. The soft parts at the radial side of the incision are next detached from the bone with the knife guided by the thumb-nail so as to divide the tendon of the extensor carpi radialis longior and brevior at their insertions into the bases of the first and metacarpal bones. These tendons, together with that of the secundi internodii, should be raised from the bones, the radial artery being pushed with the soft parts somewhat towards the radial side. The trapezium is now separated from the rest of the carpus with the bone nippers, and preserved until the rest of the carpus has been taken away. The soft parts with the tendons on the ulna side of this incision are now dissected up to some extent. The ulnar incision is next made by entering the knife at least two inches above the end of the ulna on its subcutaneous margin between the tendons of the extensor

and flexor carpi ulnaris, and is carried downwards between these tendons in a straight line as far as the middle of the fifth metacarpal bone on its palmar aspect. The dorsal lip of this incision is then raised, and the tendon of the extensor carpi ulnaris is cut at its insertion into the fifth metacarpal bone and is dissected up from its groove in the ulna. The extensors of the fingers are then separated and raised from the carpus without division, and the dorsal and internal lateral ligament of the wrist-joint divided. The anterior surface of the ulna is now cleared by keeping close to the bone so as to avoid the artery and nerve. The articulation of the pisiform is now opened, and the flexor tendons are separated from the carpus, the tendon of the flexor carpi ulnaris being raised with the pisiform bone. While this is being done the knife is arrested by the process of the unciform bone, which is clipped through at its base with the bone pliers. The anterior ligaments are now divided and the carpus removed by the sequestrum forceps; any remaining connections being divided by light touches of the knife. The ends of the ulna and radius and the heads of the metacarpal bones are now removed by causing them alternately to project at the lateral wounds, the nippers being used for the metacarpal bones, and the saw for the radius and ulna.'

The trapezium is now dissected out, to avoid cutting the flexor carpi radialis, which runs in the groove on its palmar aspect, the knife being kept close to the bone to avoid wounding the radial artery; the thumb being then pushed up by an assistant, its articular surface is cleared and removed.

Lastly, the articular surface of the pisiform is removed, the rest of the bone being left, as it gives insertion to the flexor carpi ulnaris and attachment to the annular ligament. The hook of the unciform is also allowed to remain on the living if sound and healthy.

RESECTION OF THE CARPAL EXTREMITY OF THE ULNA.

The ulna may be resected by a longitudinal incision made along its subcutaneous border, the bone being separated as in resection of the wrist-joint; in detaching its lower end the styloid process may be sawn off, and in this way the integrity of the wrist-joint will be preserved.

RESECTION OF THE ELBOW-JOINT.

The variety of incisions adopted for the resection of this joint is very great, though they all have for their object the adequate exposure of the joint, without undue division of the soft parts or injury to the ulnar nerve. This nerve lies on the inner and posterior side of the articulation, deep between the inner condyle of the humerus and the olecranon process of the ulna.

The methods of resecting this joint most in use at the present day are:—1. Langenbeck's, by a single longitudinal incision. 2. Mr. Maunder's modification of the above. 3. M. Ollier's method. 4. Liston's method. 5. By the H-shaped incision used by Mr. Syme.

Position of the Subject.—The subject should be placed on its back and slightly inclined to the opposite side to that on which the resection is about to be performed.

Position of the Operator.—The operator should stand on the outer side of the limb facing the subject when

operating on the right side, but with his back turned towards the subject when operating on the left.

Position and Duties of the Assistant.—The assistant, facing the operator on the opposite side of the body, should hold the limb in a slightly-flexed position, with the olecranon uppermost. After the condyles have been freed by the operator, he should strongly flex the joint.

BY A SINGLE LONGITUDINAL INCISION OVER THE BACK OF THE JOINT—LANGENBECK'S OPERATION.

Langenbeck's Operation is effected by a single longitudinal cut, at the back of the joint, running down the ridge on the ulna, and extending upwards for three or four inches. This cut should extend down to the bones in its whole length. The joint should be now opened by cutting into it above the olecranon. A blunt hook, or the finger, should be placed within the joint, and the soft parts with the ulnar nerve drawn over the inner condyle while they are separated from the bones with a knife. The external condyle should be next cleaned in like manner. The lateral ligaments being now divided, the joint should be strongly flexed by the assistant, and the ends of the bones turned out of the wound and completely freed from their connections. The articular surfaces of the bones should be separately sawn off, commencing with the ulna. If possible, the coronoid process of this bone and the tubercle of the radius should be preserved, thereby securing the integrity of the biceps and brachialis anticus muscles.

MODIFICATION SUGGESTED BY MR. MAUNDER.

Mr. Maunder, after dividing the triceps longitudinally in his first incision over the back of the joint, clears the inner condyle and then separates the external portion of the triceps with the anconeus muscle, with which it is continuous from the external condyle in one piece.

M. OLLIER'S SUBPERIOSTEAL RESECTION.

M. Ollier, after making a longitudinal incision down to the bones, separates the periosteum from them, together with the soft parts, by means of blunt and sharp raspatories, and completes the operation as in the former methods.

LISTON'S METHOD.

This consists in making a cut shaped H, the long limb of which is commenced about two inches above the olecranon, and is continued downwards, for three inches or more, along the ridge at the back of the ulna, or between this and the ulnar nerve. This cut should extend down to the bone in its whole length. The transverse incision is now made across the radio-humeral articulation and back of the elbow-joint, joining the first at its centre, and opening the elbow-joint. The remaining steps of the operation are the same as in the former method.

MR. SYME'S METHOD.

The H*-shaped division* of the soft parts is made at the back of the joint, the transverse part of the incision crossing the joint just above the olecranon, and the longitudinal cuts falling over the radius and ulna respectively. This is the easiest method of performing the operation,

though, perhaps, the extent of the wound is greater than need be. This is now hardly ever practised.

RESECTION OF THE SHOULDER-JOINT.

Anatomy.—The head of the humerus, in addition to its ligamentous connections, has in front of it, lying in a groove, the long tendon of the biceps, and is attached on its upper and outer aspect to the supra-spinatus, infra-spinatus, and teres minor muscles; while on its inner and under side is inserted the subscapularis muscle.

Closely encircling the neck of the bone in front is the anterior circumflex artery, and behind it is the posterior circumflex artery with the corresponding nerve. The upper and outer aspect of the joint is completely enveloped by the fleshy fibres of the deltoid.

Position of the Subject.—The shoulder of the subject should be raised on a block and drawn well to the side of the table.

Position of the Operator.—The operator should stand facing the subject on the same side of the body as that on which he is about to operate.

Position and Duties of Assistants.—One assistant should be stationed at the head of the subject facing the operator, another should hold the arm and rotate it first inwards to facilitate the division of the muscles inserted into the outer tuberosity, and then outwards, whilst the subscapularis is being divided.

Operations.—We shall describe the following methods of excising this joint:—

1. The old method of forming a semilunar flap from the deltoid muscle.

2. By a single longitudinal incision.
3. Stromeyer's operation.
4. The subperiosteal method of M. Ollier.

First Method.—In the *first method* a short semilunar flap, including all the subjacent soft parts, is either cut or transfixed by grasping the deltoid and raising it. The base of this flap should correspond with the acromion, its convex border be directed towards the elbow, and it should be situated on the upper and outer side of the joint. The assistant should raise this flap to the full extent, while the operator, having divided the long tendon of the biceps, grasps the arm near the elbow with his left hand, and rotates the head of the bone forcibly inwards; this will expose the three tendons inserted into the greater tuberosity, which are best divided by laying the heel of the knife on the head of the bone, and cutting from within outwards, over the upper side of the joint. Now rotate the bone in the opposite direction, and divide the tendon of the subscapularis, at the same time completing the division of the capsule of the joint. Pass the director round the neck of the bone to protect the soft parts, and saw off the head.

Second Method.—The plan which generally goes by the name of Langenbeck's operation is that which he made use of during the Schleswig-Holstein war. Its object is to save the long tendon of the biceps, and to avoid the transverse division of the fibres of the deltoid.

A longitudinal incision is made, commencing at the most prominent point of the acromion, and extending downwards for four or five inches. This should fall just over the bicipital groove, and should divide all the struc-

tures down to the bone; the tendon of the biceps being disengaged from its groove, and, together with the edges of the wound, being held aside by the assistant, the operation may be completed as in the last-described method, though it will be found that its execution is more difficult.

Third Method.—Stromeyer makes use of a semicircular incision, commencing at the posterior edge of the acromion, and extending downwards and outwards for three inches or more, having its concavity directed forwards. The joint is thus freely opened on its upper and posterior aspect, the tendon of the biceps can be preserved, as in the preceding operation, and a dependent aperture is left for the secretions of the wound.

The Subperiosteal Method of M. Ollier.—A longitudinal incision is made through the anterior part of the deltoid down to the bone, and all the soft parts, including the periosteum, detached by means of blunt and sharp raspatories. The head of the humerus is then pushed out of the wound and sawn off as low as denuded of periosteum. M. Ollier advises the incision to be well over the anterior part of the deltoid, so as to preserve the greater part of the muscle, in connection with the circumflex nerve by which it is supplied.

Arteries divided.—The posterior circumflex and some other small vessels.

RESECTION OF THE METATARSAL BONE OF THE GREAT TOE.

A slightly-curved incision should be made, commencing on the inside of the first joint of the great toe, running along the back of the metatarsal bone, and terminating

on the inside of the articulation between that bone and the internal cuneiform. The soft parts being dissected from the back of the bone so as to clear its shaft, this should be grasped with the lion forceps and its ligamentous connections with the tarsus first divided; the bone being raised, the knife is to be passed beneath it, and the plantar connections of its shaft divided; and lastly, its articulation with the first phalanx being destroyed, the operation will be complete. This operation can rarely be necessary on the living body.

EXCISION OF THE OS CALCIS.

This operation is thus described by Mr. Holmes in his 'System of Surgery':—

'An incision is commenced at the inner edge of the tendo Achillis and drawn horizontally forwards along the outer side of the foot, somewhat in front of the calcaneo-cuboid joint. This incision should go down at once upon the bone, so that the tendon may be felt to snap as the incision is commenced. It should be as nearly as possible on a level with the upper border of the os calcis, a part which the surgeon can determine if the dorsum of the foot is in a natural state by feeling the pit in which the extensor brevis digitorum arises. Another incision is now to be drawn vertically across the foot, commencing near the anterior end of the former incision and terminating at the outer border of the inner concave surface of the os calcis, so as to avoid the posterior tibial vessels. This flap being thrown back and the bone denuded, the calcaneo-cuboid, and afterwards the calcaneo-astragaloid joints should be opened. The bone is now to be grasped

by the lion forceps and separated from its remaining ligamentous connection by the free use of the knife. The inner side should be now carefully cleared of soft parts, and the bones will come away.'

Mr. Hancock recommends the exposure of the os calcis by a flap from the heel as in Syme's operation.

This bone has also been resected subperiosteally by M. Ollier. As it is extremely difficult on the dead subject we shall not describe it.

We shall not describe excision of the astragalus, as on the dead subject it spoils the foot for any other operation.

RESECTION OF THE ANKLE-JOINT.

The conditions that demand resection of this articulation on the living body would produce such alterations, either in the soft parts about or in the mutual relation of its bones to each other, that an operation performed on the dead body could bear but little resemblance to that required on the living. For those who may wish to perform the operation on the dead subject, we will describe two methods by which it can be accomplished, and which, in certain cases of gunshot wounds of the articulation, might be usefully employed on the living.

First Method.—Mr. Hancock's Operation.—The following is Mr. Hancock's method as described by Mr. Barwell:—'The foot is first laid on its inside, and an incision is made over the lower three inches of the posterior edge of the fibula. When it has reached the lower end of the malleolus it forms an angle, and runs downwards and forwards to within half an inch of the base of the outer metatarsal

bone. The angular flap is reflected forwards, the fibula about two inches above the malleolus is sufficiently cleared of soft parts to allow the cutting forceps to be placed over it, and the bone is then nipped in two and carefully dissected out, leaving the peroneus longus and brevis uncut. The foot is now to be turned over. A similar incision is made on the inner side over the tibia, the cut in the foot terminating over the projection of the inner cuneiform bone. The flap is to be turned back, and the sheath of the flexor longus and posterior tibial tendons exposed; the knife being kept close to the bone, avoiding the artery and nerve. The internal lateral ligament is then to be carefully severed close to the bone, and now the foot is turned outwards, and the astragalus and tibia will present at the inner wound. A narrow-bladed saw put in between the tendons into the inner wound projects at the outer. The lower end of the tibia and then the top of the astragalus may be sawn off in a proper direction. The only vessel that may require tying is one of the lower branches of the peroneal artery.'

Second Method.—Dr. Buchanan's Modification.—This differs from Mr. Hancock's operation inasmuch as a single incision is made on the outer aspect of the foot instead of two—one on either side. It is more difficult to perform than Mr. Hancock's.

EXCISION OF THE KNEE-JOINT.

Anatomy.—Before describing this operation we beg to remind the student of the following points in its anatomy :—

1. That the popliteal artery is in intimate relation-

ship with the posterior surface of the femur and the posterior ligament, being only separated from them by some loose fat and cellular tissue.

2. That the popliteal artery is separated from the tibia by the popliteus muscle and the expansion from the semi-membranous.

3. That the articular branches of the popliteal ramify over the joint and are divided during the operation, so that should the main artery be injured immediate amputation would have to be performed, as the collateral supply is already cut off; and gangrene would inevitably follow if the leg were allowed to remain.

Position of the Operator.—The operator should stand on the right-hand side of the limb, *i.e.* outside the right knee and inside the left.

Position and Duties of the Assistant.—The assistant, facing the operator and firmly grasping the thigh with one hand and the leg with the other, should, during the first step of the operation, hold the joint slightly flexed, but whilst the joint is being opened and the bone cleared he should strongly flex the knee and force the femur well out of the wound.

Operation.—The operator should trace out with a scalpel a semilunar flap, commencing opposite the posterior part of the condyle most distant from himself, crossing the front of the joint below the patella, and terminating over the posterior part of the other condyle of the femur. This flap, consisting of integuments alone, should be dissected up from the front of the joint, which latter must now be fully opened by cutting through the tendon of the quadriceps above the patella in front and well at

the sides of the condyles, so as to divide the lateral ligaments, the assistant at the same time strongly flexing the limb. As he does so, the operator should sever all remaining ligamentous connections between the bones, being especially careful during the division of the posterior ligament.

On the dead body the crucial ligaments will also require division; on the living they will generally be found disorganised.

The operator should now pass the knife around the lower end of the femur just at that part where he wishes to apply the saw, keeping its edge well directed towards the bone, and, guarding the popliteal artery with the finger. He should now remove with the saw a portion of the bone, cutting from its anterior towards its posterior surface, and taking care that the section be at right-angles to the long axis of the shaft. Any connection that this portion of bone may still retain after the application of the saw should be divided carefully with the scalpel.

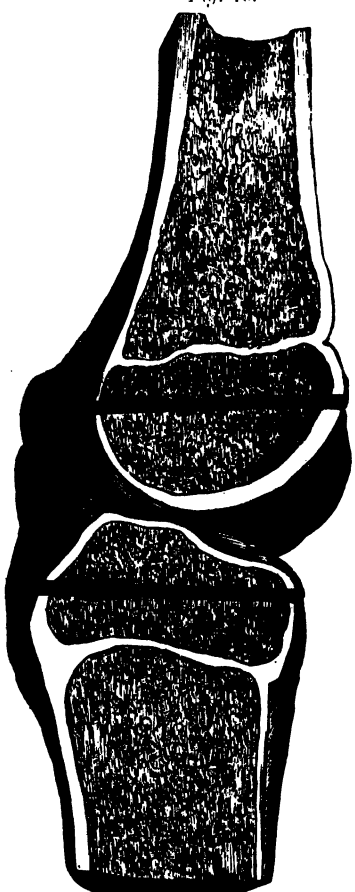
The section of the femur being complete, the knife must be passed round the head of the tibia, dividing all the fibrous structures down to the bone just below the articular surface. The operator, grasping the patella to steady the tibia, should remove a thin slice of the latter with the saw, being very careful, as he gets to the posterior surface of the section, lest he injure the popliteal artery, which lies close behind the bone.

The whole of the cartilaginous surface of the femur should not be removed when operating on young subjects, as by so doing the epiphysial line would be encroached upon, and much shortening result. The exact point at

which the saw should be applied is well shown in the following diagram taken from Mr. Holmes's 'System of Surgery.'

A thin shell of bone being excised in the same

Fig. 46.



The Epiphyses at the Knee-joint. (From Holmes's 'Surgery.')
The dark lines indicate the situations at which the saw should be applied.

manner and with the same precautions from the extremity of the tibia, the operation will be complete. The

whole of the cartilaginous surface of the tibia may be removed, as the line of the epiphysis is below this surface. Some strongly advise that the patella be preserved. It is usually removed.

Arteries divided.—The articular, the tibial recurrent, and anastomotica magna arteries.

RESECTION OF THE HIP-JOINT.

The operation which passes by this name consists in the removal of the head of the femur. It may be well to practise it on the dead body, though on the living the head of the bone is in most cases dislocated by disease, or in any case the ligaments are ulcerated, previous to being subjected to operation. The ordinary instruments for resection are sufficient for this proceeding.

The body being turned over towards the opposite side, and the thigh slightly flexed, the operator should place himself by the side of the joint he is about to excise, and make a curved incision on the outer side of the joint, embracing in its concavity and passing close behind the most prominent part of the great trochanter. This incision should be from four to five inches in length, and should commence between the anterior superior spine of the ilium and the top of the trochanter major. The glutei and the external rotator muscles being divided, the capsule may be opened from behind, while the limb is forcibly flexed and adducted by an assistant; this will bring the ligamentum teres within reach, which, when cut, will allow of the dislocation of the head of the bone. The director being passed around its neck, the head may be removed with the saw, and the operation will be complete.

There are various methods of dividing the soft parts over this joint; but whatever plan be pursued, it must be put in practice over the posterior and outer part of the articulation, and the incision, of whatever form, should fall between the trochanter and the great sciatic nerve.

CHAPTER XII.

OPERATION OF TREPHINING THE SKULL.

In applying the trephine to the cranium on the dead body, a precaution should be adopted which cannot always be followed on the living—namely, that of selecting a spot for its application out of the course of the trunk of the middle meningeal artery, and clear of the longitudinal or lateral sinuses; as a general rule, the immediate neighbourhood of the sutures and the air sinuses in the frontal bone should be avoided.

Instruments required.—For trephining the skull a scalpel, a small probe, and an elevator are required in addition to the trephine itself.

Operation.—A spot having been selected, and the skull fractured at this situation by a blow with a hammer, the scalp, including the pericranium, should be cleanly reflected from the bone over the parts, either by a semilunar, crucial, or Λ-shaped incision; the operator, standing well above the part, should project and fix the central pin of the trephine about a line beyond its serrated edge, and apply the instrument to the bone, with the pin on the margin of the sound bone, the crown of the instrument overhanging the depressed portion of bone. By an alternating semirotatory movement, he should cut a groove of sufficient depth to obviate the chance of its

slipping aside. The pin may be now removed and the rotatory movement of the instrument continued until the diploe is reached; this may be ascertained by the more easy movement of the trephine, the grating sensation communicated to the hand, and by the bone-dust being now of a red colour; to the deeper part the trephine should be employed more carefully until the inner table is nearly cut through; when, from time to time, the flat end of a probe or a pointed piece of quill may be introduced into the groove, to ascertain if the dura mater be exposed at any spot. Owing to the spheroidal form of the skull, this is almost sure to take place at one part of the circumference of the groove before another, as it is impossible to make the instrument cut to an equal depth in its whole circumference. If the bone is ascertained to be perforated at one spot, the trephine should be inclined towards the opposite side, until the included portion be almost wholly separated, when its complete removal can be effected by using the elevator.

The depressed portion of bone can now be raised or removed altogether if it be completely detached, and search made for fragments of bone beneath the edges of the opening in the skull.

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