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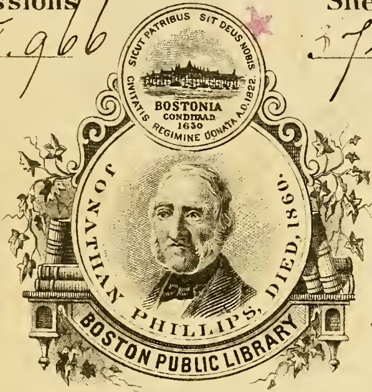

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A TEXT BOOK

OF

OPERATIVE SURGERY

AND

SURGICAL ANATOMY.

BY

PROFESSOR CLAUDE BERNARD,

AND

CH. HUETTE (DE MONTARGIS).

ILLUSTRATED BY 88 PLATES DRAWN FROM NATURE, AND ENGRAVED ON STEEL

TRANSLATED FROM THE FRENCH, AND EDITED BY

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LONDON: BAILLIÈRE, TINDALL, AND COX,

Publishers to Charing Cross Hospital,

20, KING WILLIAM STREET, STRAND, W.C.

[PARIS: BAILLIÈRE. MADRID: C. BAILLY-BAILLIÈRE.]

1878.

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PREFACE.

The present work needs but little introduction. The names of the authors are a sufficient guarantee of its excellence.

The artistic finish of the plates can hardly be surpassed; and as no such series has yet been published in England, the Editor believes that these alone will make the work welcome.

The text is a close rendering of the original, with the exception of some omissions and additions deemed necessary by the Editor.

6, Wimpole Street, W.,

October, 1876.

for the sake of a figure, and a sufficient explanation has therefore been made in each case.

A full description of the many improvements in operative surgery which have been introduced since the publication of the French work has been added, and where more than one operation may be performed with the same object in view, special reference has been made to those operations in vogue in this country and on the continent at the present day.

ARTHUR TREHERN NORTON.

6, Wimpole Street,
May 1*st*, 1878.

LIST OF PLATES.

Pl. 1


Fig 1


Fig 3.


Fig. 4.


Fig 2.


Fig. 5.


Fig. 6.

OPERATIVE SURGERY.

PLATE I.

METHODS OF HOLDING THE BISTOURY.

There may be said to be three principal methods of holding the bistoury, each of which may be subdivided into two varieties.

First Position (Figs. 1 and 2), *Firmness and Strength.*—The handle of the bistoury is held like a table knife, with the edge of the knife turned downwards, and the index finger extended upon the back of the blade (Fig. 1); or with the edge turned upwards, and the index finger placed on the side of the blade close to its junction with the handle (Fig. 2).

Second Position (Figs. 3 and 4), *Lightness and Precision.*—The bistoury is held like a pen, with the edge turned downwards (Fig. 3), or upwards (Fig. 4).

Third Position (Figs. 5 and 6), *Nicety and Precaution.*—The bistoury is held like the bow of a violin, with the handle of the instrument held forwards, the blade backwards, and the cutting edge upwards (Fig. 5), or else with the handle backwards, the blade forwards, and the edge downwards (Fig. 6).

INCISIONS.

Incisions in the skin are made with the object of laying bare or of removing some deeper part.

They should be made sufficiently large, or the operation is rendered tedious and difficult.

Incision are *simple* and *compound*.

Simple are — (straight) or ⌣ (curvilinear).

Compound are V. L. T. H. + (crucial, or if more than one radius stellate), U (u-shaped), and ⬭ (elliptical).

Compound incisions may be sometimes avoided, when the skin is loose and plentiful, by forcibly drawing upon the margin so as to dilate the wound.

Incision are made from *without inwards*, as for the extirpation of a tumour, or from *within outwards*, as laying open a fistula.

Incisions from *without inwards*.—The skin being applied to and stretched upon the deeper parts by the left hand of the surgeon, or by assistants, the operator takes the knife in the first or second position (Figs. 1 and 3), plunges it perpendicularly at once to a proper depth, and then inclines it at an angle of 45°. On withdrawing the knife; he again raises it to the perpendicular in order to avoid terminating the incision *en queue*,—that is to say, by a cut oblique with the skin. The cut should be made by slight pressure, and by a sawing movement. When necessary to avoid with care structures situated immediately beneath the skin, the knife is held in the third position (Fig. 6), and the parts are divided almost layer by layer, or it may be considered advisable to adopt the method of cutting from within outwards upon a grooved director.

Incisions from *within outwards*.—They may be made with or without a grooved director.

In one process, the knife being introduced in the second or third position beneath the skin, aponeurosis, or into a sinus, is raised to the perpendicular and made to cut through the tissues from heel to point.

In a second process, the knife being introduced in the first position, its point is made to perforate the tissues to the surface, and the cutting is effected from point to heel. By this second process a fold of skin may be cut through, as in the operation for strangulated hernia. A fold of integument is raised, and held at one extremity by the operator, at the other extremity by an assistant; the knife, held in the first position, is now made to pierce the fold, and cut its way to the surface.

Pl. 2.

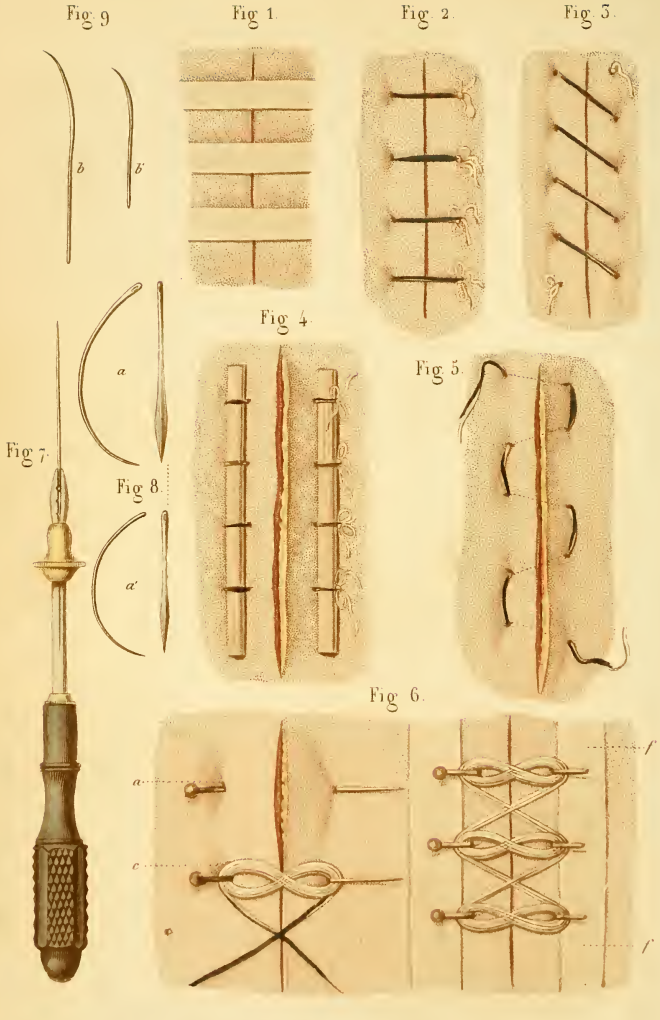


PLATE II.

CLOSURE OF WOUNDS.

The methods of closing wounds vary according to the nature of the solution of continuity, and according to the object which the surgeon has in view. When suppuration should take place the lips of the wound should be simply opposed, but when it is desired to obtain union by the first intention it is necessary that they should be adjusted very exactly, and so retained till the resulting inflammation shall have secured their union.

In some instances the divided tissues may be brought together by means of appropriate bandages or strips of adhesive plaster (Fig. 1), whilst in perhaps the majority of cases it is necessary to have recourse to an operative measure—that is, the *suture.*

Sutures (Figs. 2, 3, 4, 5, 6).

Sutures are of three varieties.

1. The simple suture (Figs. 2 and 3), which brings together the lips of the wound edge to edge.

2. The suture *à points passés* (Fig. 5), which brings together the lips of the wound by the deep part, and to some extent surface to surface.

3. The twisted suture (Fig. 6), which brings together the lips of the wound at once by their edges and by their depths.

1. *The simple suture* is made by passing a thread by means of a needle, curved or straight, through the two lips of the wound. The two ends of the thread are now to be tied with a reef-knot and cut off short. A sufficient number of sutures must be passed to adjust the lips of the wound in their whole length. This form is called the interrupted suture (Fig. 2). If the same thread be continued through several punctures, it is called the continued suture, or the Glover's suture (Fig. 3).

2. *Suture à points passés* (Fig. 5).—This suture is commenced like the simple continued suture, the thread being passed through the two lips of the wound ; but the thread, instead of returning

across the wound, runs along its borders alternately on the right and the left sides. From its appearance it has received the name of the zigzag suture (Fig. 5).

The quill suture (Fig. 4).—A variety of the preceding. It is made by passing as many double threads as sutures required deeply through the lips of the wound. A piece of wood or quill is passed through the loops formed by the doubled threads, whilst the free ends of the threads are tied moderately tight upon a corresponding piece of wood or quill on the opposite side of the wound.

A piece of ivory or vulcanite perforated for the sutures is preferable to the quill or wood.

3. *The twisted suture* (Fig. 6) is made by passing a steel pin deeply through the two lips of the wound. The lips are then pressed together, and a thread is passed, commencing at its centre, in the form of a figure 8, around the extremities of each pin, and made to cross itself on to the pin below. The operation is completed by cutting off the extremities of the pins ; and in order that they may not injure the skin a piece of plaster or lint is placed beneath the cut ends.

Fig. 7. A needle-holder used when force is required to make the needle penetrate.

Fig. 8. *a a′*. Flat needle of Boyer curved in the arc of a circle. *b b′*. Needle of Velpeau, with the eye lateral, curved and flattened only in its anterior half.

Fig. 1.

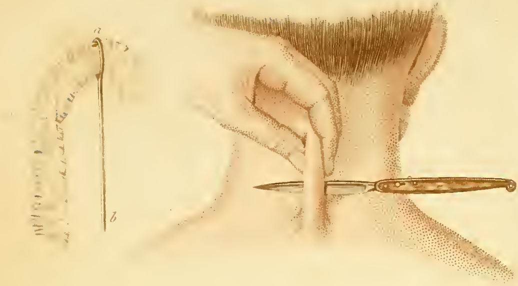


Fig. 1'

Fig. 3.

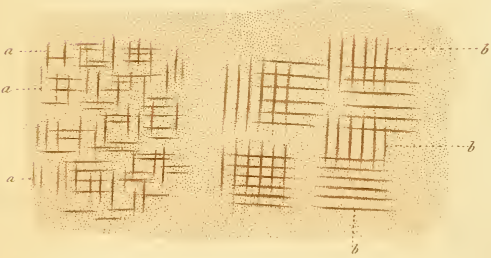


Fig 4

Fig. 3'

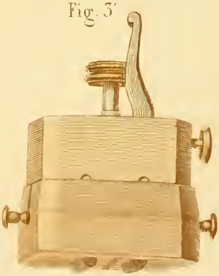


Fig 2.

Fig 4

PLATE III.

THE SETON.

A seton is the establishment of an issue by means of threads of silk or cotton, or a piece of tape.

SETON OF THE NECK.

A vertical fold of skin on the posterior region of the neck is raised and perforated at its base by a straight bistoury held in the first position. The silk or tape, *c*, previously oiled, is then passed by means of an eyed probe, and loosely tied. A poultice may be applied to the wound, or a piece of lint smeared with simple cerate, and supported by a band around the neck. The tape may be renewed at discretion.

The seton needle (Fig. 1′) dispenses with the bistoury and the eyed probe, in that it makes the opening, and on its withdrawal brings through the silk or tape.

VACCINATION.

The upper and outer part of the arm is generally chosen for inoculation of vaccine.

There are four methods : 1. Friction ; 2. Vesication ; 3. Scarification ; 4. Puncture.

The last two only will be described.

In vaccinating by scarification a portion of the skin of the arm, about half an inch square, is scratched in all directions by the point of a needle or sharp lancet. The epidermis of an infant is extremely thin, and a very light scratch is sufficient to draw blood. Care should be taken not to make the scratches deep enough to cause the blood to run, but its appearance in the line of the scratches is to be desired. The virus is then to be passed into the scarified surface.

In vaccinating by the puncture method, an ordinary lancet, or still better a vaccine lancet and needle, (Fig. 2) is made use of. The instrument is first charged with vaccine either by dipping the point in the liquid from an open vaccine vesicle (if the vaccination is made from arm to arm), or in the humective with the preserved vaccine virus. The lancet, held in the right hand like a pen, is then presented horizontally to the surface of the skin, and its point made to penetrate to about two millimetres beneath the epidermis. After five or six seconds the instrument is withdrawn, the epidermis being slightly raised at the same time in order to cause the vaccine to enter the puncture. A small drop of blood invariably escapes, which should be pressed into the wound by the lancet to avoid the loss of the virus.

PLATE IV.

BLEEDING FROM THE ARM.

Fig. 1. Anatomy.

The skin (1) and adipose tissue covering the veins in the bend of the arm, together with the subjacent aponeurosis (2), have been removed in order to show the relation which the deep parts have towards the superficial veins.

A, Radial vein, accompanied by some filaments (*a*) of the musculo-cutaneous nerve.

B, Median cephalic vein, with a branch (*b*) of the musculo cutaneous nerve beneath it.

C, Cephalic vein formed by the union of the two preceding. Along its inner border is the muculo-cutaneous nerve (*c*).

D, Median vein and filaments of musculo cutaneous (*d*).

E, Median basilic vein crossed in front or behind by branche (*e*) of internal cutaneous nerve. This is a large branch which usually has communication with the deeper veins. It crosses the brachial artery (F) and the median nerve (H), from which it is separated only by the bicipital aponeurosis (G).

I, Ulnar veins. M, Basilic vein, formed by the union of the median basilic with the ulnar veins ; *m*, internal cutaneous nerve.

Fig. 2. Operation.

The patient being seated or reclining, a handkerchief or broad tape is passed twice round the arm, about three or four finger-breadths above the bend of the elbow, and tied. The superficial veins dilate below the constriction, but care should be taken that the pulse at the wrist is not affected.

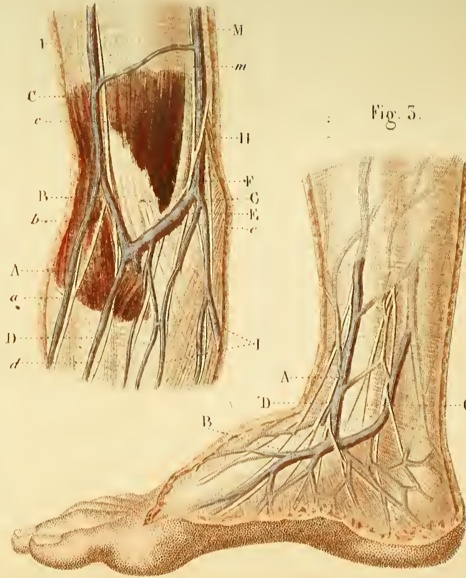
The surgeon next extends the arm of the patient, and fixes it firmly between his own arm and chest ; and with his left hand he then tenses the skin over the bend of the elbow, and at the same time with the left thumb presses upwards the blood in the vein upon which he is about to operate, in order to fully dilate it. Now

Fig 2.

Fig. 4.

Fig 1
2

Fig. 3.



taking a lancet between the thumb and finger of the right hand, and supporting his hand upon the arm of the patient by means of the other fingers, he carefully punctures the dilated vein in a line obliquely, or at right angles to its course (a', a', a'').

The flow of blood may be increased by the patient grasping a stick or other material from time to time.

When the desired quantity has been obtained, the bleeding may be arrested by the application of the thumb of the left hand to the opening in the vein. The ligature around the arm being then removed a small four-fold compress is to be applied to the wound, and there retained by means of a narrow figure of 8 bandage.

The vein usually chosen for venesection is the median basilic, though any well-dilated vein in the bend of the elbow would do.

The median basilic is generally the most apparent, but it must be remembered that it lies directly over the brachial artery, being separated from it by the bicipital fascia. There is therefore, always some danger of wounding the artery.

The Editor suggests a method which he has always adopted in performing venesection at the bend of the elbow. He never uses a lancet, but a small and sharp bistoury. When the vein is well dilated, and caused to bulge by the pressure of the thumb of the left hand, the knife is taken in the right hand in the second position; the right hand is now to be supported on the side of the arm to be bled by means of the little and fourth fingers. The knife is placed with its point close up to the vein, with its cutting edge upwards, and with the back of the blade resting on the arm of the patient, and slightly pressing into the arm, so that the point of the knife is a little below the level of the vein. The knife is now pushed onwards, and it cuts through the vein at right angles, about one-quarter to one-third of its circumference. In this method there can be no danger, for the point of the knife is never directed towards the artery, and no movement on the part of the patient could make the instrument to cut.

Fig. 3. Punctures and Scarifications.

Punctures (*a*, *a*, *a*) are made with the needle or a lancet to relieve an inflamed or œdematous part.

Scarifications (*b*, *b*, *b*) are superficial incisions made close together by means of a lancet or bistoury held in the third position.

Fig. 3′ is a scarificator in which a number of lancets (12 to 24) are set in action at the same time by means of a spring. This instrument is almost invariably used in cupping.

Fig. 4. Acupuncture.

Acupuncture is puncturing any particular tissue with a needle (Fig. 4, *a* and *b*). When the needles are connected with a galvanic battery it is termed galvano-puncture, an operation frequently performed in the treatment of nævi and aueurismal tumours.

BLEEDING FROM THE FOOT.

Fig. 3. Anatomy.

The internal saphenous vein (A) arises fram the plexus of veins (B) on the dorsum of the foot, and ascends in front of the internal malleolus (C). It is accompanied by filaments of the internal saphenous nerve (D).

Fig. 4. Operation.

The venous circulation is arrested by means of a bandage as in the arm, placed about two finger-breadths above the malleoli. The foot may be then put into a bath of hot water. After a minute or so the surgeon places the foot upon his knee, and with care fixes the internal saphenous vein, which otherwise rolls under the finger. He then punctures the vessel, as in bleeding from the arm.

The blood rarely flows in a jet : it is therefore customary to place the foot again into the hot water, till the colour of the water, or the time of immersion, leads one to believe that a sufficient quantity of blood has been obtained.

The dressing consists of a little square compress held upon the wound by a figure 8 or stirrup bandage.

Pl. 5.

PLATE V.

Fig. 1. Lancets:—1. Barley grain. 2. Oat-shaped. 3. Serpent tongue.

Fig. 2. B, Venesection of the external jugular; A′, Arteriotomy of the temporal artery.

BLEEDING FROM THE JUGULAR (Fig. 2, B).

The external jugular vein extends from behind the angle of the lower jaw to the middle of the clavicle. Directed obliquely from before backwards, it crosses the sterno-cleido-mastoid muscle, being covered by the skin and platysma.

Operation.

The patient seated, or, still better, reclining, the circulation in the vessel is prevented by compression of the vessel a little above the clavicle. For this purpose a thick compress is pressed upon the vessel by a bandage, which is passed around the neck and beneath the opposite axilla. When the vessel is sufficiently swelled the surgeon fixes it with the left index finger, and then makes the puncture. The opening which is made about the middle of the neck should be large, and in direction at right angles to the fibres of the platysma, otherwise the blood will escape only into the cellular tissue. It often happens that the blood does not escape in a stream, but runs down the neck.

The flow of blood is arrested by removing the compress, at the same time applying the finger to the wound, to prevent the introduction of air.

The dressing consists in drawing the wound together with a piece of plaster. Sometimes a pad and circular bandage are found necessary, in order to prevent the flow of blood.

ARTERIOTOMY.

Anatomy.

A′, puncture of the temporal artery.

b′, division of the skin.

c′, Pyramidal compresses for compression of the artery.

The temporal artery, a branch of the external carotid, ascends vertically over the root of the zygomatic process of the temporal bone. After a course of about two inches upon the temple it divides into two branches—a posterior and an anterior. The latter lies upon the epicranial aponeurosis, and is covered only by the skin, a position favourable for arteriotomy.

Operation.

The patient being seated, or lying, the temporal artery is sought for by its pulsations, and is then fixed by the left thumb and index finger. Then with a straight bistouri, held in the third position, the operator makes a short incision across the vessel, but not completely severing it. The blood escapes, sometimes in a jet, but more often dribbles. In order to arrest it the artery is compressed on the two sides of the wound by means of the pyramidal compresses held in position by a bandage tied with the packer's knot.

*** It is well to completely sever the artery before attempting to arrest the hæmorrhage, as the cut extremities of the vessel will then contract.

Fig. 1

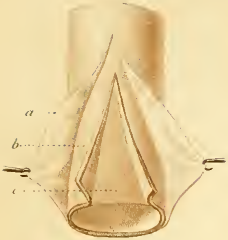


Fig. 2.

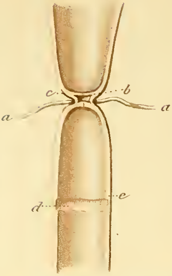


Fig. 3.

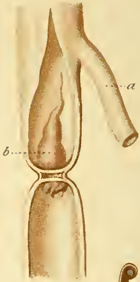


Fig. 7.

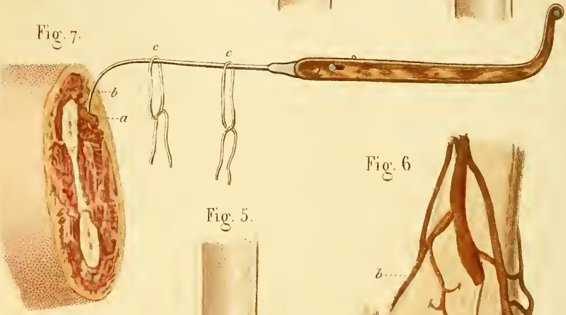


Fig. 6

Fig. 5.

Fig. 4.

PLATE VI.

LIGATURE OF ARTERIES.

1. *Effect of the Ligature upon Arteries.*

Fig. 1.—Arteries are composed of three tunics: *a*, external tunic—most vital, supple, and resisting; *b*, middle tunic—yellow, elastic, formed of circular fibres, possesses obscure vitality; *c*, internal tunic—slender, smooth, transparent, without vitality.

Fig. 2.—When a ligature is applied to an artery, the internal and middle tunics are torn through by the thread, and retract in such manner that the walls (*c*, *d*) of the external tunic, the only one which resists the ligature, are brought into contact by their internal face.

Fig. 3.—After the ligature of an artery, the collateral vessel (*a*) above dilates, and in the space between the ligature and the first branch above the blood stagnates, and forms a clot (*b*), which obliterates the artery after the separation of the ligature.

Figs. 4 and 5.—*Torsion* (*a*) has the same effect upon the coats of an artery as the ligature—that is, it tears through the internal and middle coats (*b*, *b*), which are pressed back above and below, whilst the external tunic (*c*) alone resists and twists to obliterate the calibre of the artery.

Fig. 6.—When the course of the blood is interrupted by a ligature or by any other circumstance, the circulation is re-established below by means of the dilatation of the anastomosis between the collateral branches above and below. Fig. 6 (Dupuytren Museum) represents an aneurism (*a*) of the popliteal artery cured by the employment of ice. The articular arteries (*b*, *b*, *b*, *b*) are considerably dilated, re-establishing the circulation in the lower part of the limb.

Fig. 7.—*a*, artery in a stump, seized on the point (*b*) of a tenaculum; *c*, *c′*, ligatures for the purpose of tying the artery.

2. *Ordinary Procedures in Ligaturing an Artery.*

In order to find an artery which it is intended to tie,—

Firstly. Determine the course of the vessel, both by anatomical knowledge and by the pulsation of the vessel.

Secondly. The skin being conveniently stretched, make an incision with a convex bistoury, held in the third position, along the course of the vessel, increasing the length of the incision according to the depth of the vessel.

This incision should comprise the skin and the cellular tissue.

Thirdly. Divide by means of the grooved director the enveloping aponeurosis, and turn aside the muscles, to seek the vessel, which is usually contained, together with its companion veins and nerves, in a common sheath.

Fourthly. Raise the sheath with dissecting forceps, and divide it with precaution sufficient only to introduce an aneurism needle.

Fifthly. Next lay aside the bistoury, and with the director and forceps free the vessel from the tissue around, taking care not to denude the vessel to too great an extent, and also to introduce the director between the vessel and the most important companion structure, in order not to wound that structure by the point of the director.

Sixthly. When the artery is denuded and raised upon the director, determine the pulsation, and then pass the ligature beneath it by means of an aneurism needle furnished with the thread, introducing the needle between the artery and the most important companion structure.

Seventhly and lastly. Tie the artery tightly in the first knot, drawing the thread over the two index fingers, like pulleys, in order to prevent too great an elevation, and a too great traction upon the artery ; then tie the second knot, and cut one end of the ligature, bringing the other out at the lower end of the wound.

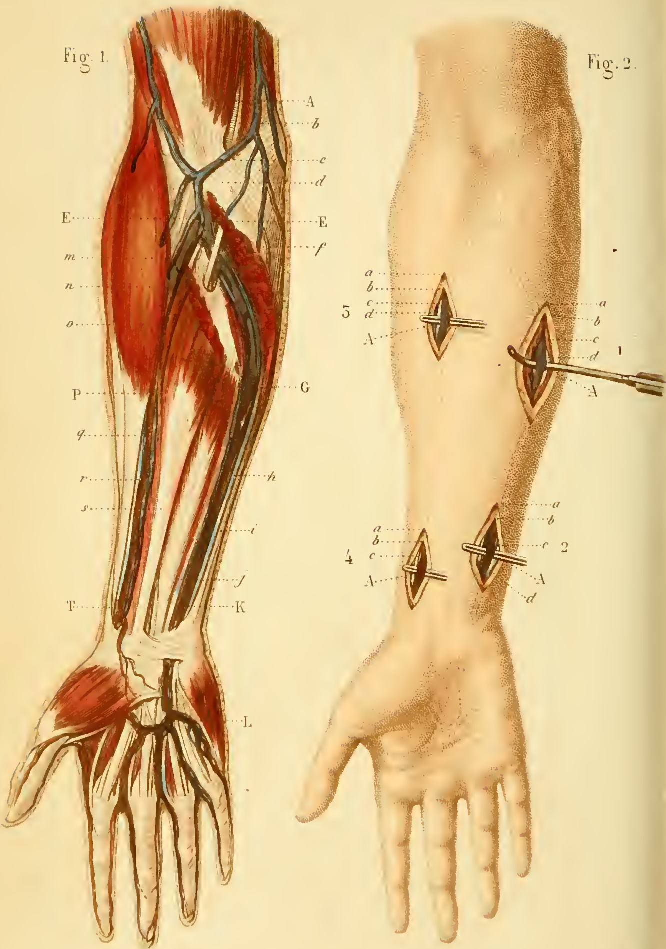


Fig. 1.
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4

PLATE VII.

LIGATURE OF THE ULNAR AND RADIAL ARTERIES.

Fig. 1. Anatomy.

A. Brachial artery, with the median nerve *b* lying to its inner side.

c. Median basilic vein crossing the course of the brachial artery and median nerve, from which it is separated by the bicipital fascia *d.*

E. Common origin of the radial and ulnar arteries.

f. Median nerve crossing the ulnar artery near its origin.

E G. Upper part of the ulnar artery lying upon the deep flexor, covered by the pronator radii teres, flexor carpi radialis, palmaris longus, and flexor sublimis digitorum, which, being cut through, permit the artery to be seen in company with its venæ comites.

G K. Lower part of the ulnar artery more superficially situated than the upper ; also accompanied by the venæ comites. It is in relation internally with the ulnar nerve and the flexor carpi ulnaris, and externally with the tendons of the superficial flexor.

L. The ulnar artery forming the superficial palmar arch.

E P. Upper part of radial artery, with its venæ comites, in relation internally with the outer border of the pronator radii teres *n*, and flexor carpi radialis *o* ; externally with the supinator longus *m* which overlaps it.

P T. Lower part of the radial artery almost subcutaneous with the venæ comites, and in relation, without, with the supinator longus and the radial nerve for the middle third of its course ; and within, with the tendon of the flexor carpi radialis.

Fig. 2. Operation.

Incision 1. Ligature of the ulnar artery in its upper third : division of—*a*, skin ; *b*, aponeurosis ; *c*, space between flexor carpi ulnaris and flexor sublimis digitorum ; *d*, ulnar nerve. A, ulnar artery.

Incision 2. Ligature of ulnar artery in lower third—*a*, skin ; *b*, aponeurosis ; *c*, ulnar nerve ; *d*, tendon of superficial flexor A, artery upon the director.

Incision 3. Ligature of the radial artery in its upper third—*a*, skin ; *b*, aponeurosis ; *c*, radial nerve ; *d*, internal border of long supinator. A, radial artery.

Incision 4. Ligature of the radial artery in its lower third—*a*, skin ; *b*, aponeurosis ; *c*, radial nerve. A, artery.

Ligature of the radial artery in the lower part of the fore-arm.

Incision No. 4.

Firstly. Make an incision about $1\frac{1}{2}$ inch in length on the outer side of the tendon of the flexor carpi radialis, dividing the skin and cellular tissue.

Secondly. Divide the aponeurosis upon a grooved director.

Thirdly. Seek out, isolate, and tie the vessel which lies close to the outer side of the tendon.

Ligature of the radial artery in the upper third.

Incision No. 3.

An incision $2\frac{1}{2}$ to 3 inches in length is to be made along the border of the long supinator if it can be felt, or else in the course of a line representing the direction of the artery extending from the middle of the bend of the elbow to the inner side of the styloid process of the radius, dividing the skin and cellular tissue, but avoiding the subcutaneous veins. The aponeurosis being next divided on a grooved director, the border of the long supinator is to be sought and drawn aside by a retractor. Beneath it will be found the radial artery, with its companion veins, from which it must be isolated before being ligatured.

Ligature of the ulnar artery in the lower third of the fore-arm.

Incision No. 2.

An incision $1\frac{1}{2}$ inch in length, dividing the skin and cellular tissue, is to be made along the outer side of the flexor carpi-ulnaris. The aponeurosis being next divided with the director, the tendon of the flexor carpi-ulnaris is to be drawn inwards, and the artery is there found between its companion veins.

Ligature of the ulnar artery in the middle of the fore-arm.

Incision No. 1.

An incision $2\frac{1}{2}$ to 3 inches long, dividing the skin and cellular tissue, is to be made in a line drawn from the trochlea to the elevation of the pisiform bone, then seek for the first inter-muscular space which becomes visible, proceeding from within outwards. Now the aponeurosis may be divided upon the director, and the flexor sublimis digitorum muscle turned aside, beneath which is the artery with its companion veins. After having isolated the vessel, it will be necessary to raise it with an aneurism needle, in consequence of the depth of the wound.

PLATE VIII.

LIGATURE OF THE BRACHIAL ARTERY.

Fig. 1.—Anatomy.

A, B. *Brachial artery.*—It extends from the lower border of the teres major to a little below the elbow joint. Situated internal to the humerus above, it descends curving from within outwards, and becomes anterior to it below. It is in relation in its upper fourth with the coraco-brachialis C, and below this with the internal border of the biceps D, which overlaps it in its two lower thirds in muscular subjects. Altogether below, it runs along the inner side of the biceps tendon, between it and the median nerve, and then courses beneath the bicipital aponeurosis *a*, which separates it from the median basilic vein *b*.

The *median nerve* E accompanies the artery in its course lying external to it above, crossing it at about the centre, and lying internal to it below.

The *ulnar and musculo-spiral nerves* are in relation with the vessel for about its upper sixth, lying internal and posterior to it respectively.

F, G. *The brachial veins.*—The internal is the more voluminous. They lie alongside the artery, and interlace by frequent anastomosis.

H. Inferior profunda artery accompanying the ulnar nerve.

Fig. 2.—Operation.

Incision 1.—*Ligature of the brachial artery in its lower part.*

a, division of the skin and cellular tissue ; *b*, of the aponeurosis ; *c*, median basilic vein, situated between the skin and aponeurosis, and curved inwards ; *d*, internal border of the biceps muscle ; *e*, median nerve lying internal to the artery ; F, the artery extricated from the common sheath, and raised upon a director.

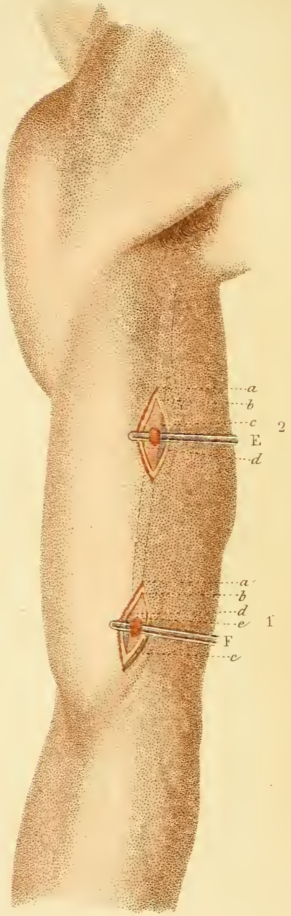
Incision 2.—*Ligature of the brachial artery in the upper part of the arm.*

a, division of the skin and cellular tissue ; *b*, of the aponeu-

Pl. 8.

Fig 1.

Fig. 2.



rosis ; *c*, companion vein ; *d*, median nerve on the outer side of the artery E, the artery upon a director.

1. *Ligature of the brachial artery at the bend of the arm.*

Incision 1.

(1). Recognise the tendon and internal order of the biceps muscle.

(2). Make an incision $2\frac{1}{2}$ inches in length along the inner border of the biceps. This incision must involve only the skin and cellular tissue, avoiding the median basilic vein, which must be pressed, according to circumstances, either inwards or outwards.

(3). Divide upon the director the aponeurosis which is here formed of the bicipital expansion.

(4). Beneath will be seen the artery accompanied by its veins, and having the nerve to its inner side ; raise with the forceps the sheath of the vessels and nerve, and incise it with care to an extent sufficient to isolate the artery; raise it upon the director and ligature.

2. *Ligature of the brachial artery at the upper part of the arm.*

Incision 2.

(1). Having determined the inner border of the biceps, make an incision along $2\frac{1}{2}$ inches in length, involving the skin and cellular tissue.

(2). Raise the aponeurosis upon a director.

(3). Seek the nerve nearest to the internal border of the biceps ; that is, the median nerve beneath and internal to which will be found the artery.

(4). Carefully open the common sheath, having first raised it with a pair of forceps ; then pushing the nerve outwards, isolate the artery, passing the director beneath it from without inwards.

PLATE IX.

LIGATURE OF THE AXILLARY ARTERY IN THE ARMPIT ITS LOWER THIRD.

Fig. 1.—Anatomy.

1. Great pectoral muscle drawn aside. 2. Small pectoral muscle. 3. Latissimus dorsi and Teres major. 4. Biceps. 5. Triceps. 6. Brachial aponeurosis.

A. *Axillary artery.*—A continuation of the subclavian artery, it commences at the lower border of the first rib, and terminates at the lower border of the Teres major. In its course it is divided into three parts by the pectoralis minor muscle. The lowest or third part of its course is in relation externally with the coraco-brachialis (*b*) muscle, and here it may be readily compressed against the humerus: internally it is covered by only the skin and cellular tissue, and its pulsation can be easily felt.

c, d, e, f. The branches of the brachial plexus closely surround the artery in the third part of its course.

c. The *musculo cutaneous nerve*, on the outer side of the vessel.

d. The median nerve in front of and somewhat to the outer side, commencing by two roots—one on each side of the vessel.

e. The *internal cutaneous*, and, *f*, the *ulnar* lie to the inner side. The musculo-spiral nerve is internal and behind, but is hidden by the vein.

G. The axillary vein lies internal to the artery, and overlaps both it and the nerves.

All the vessels and nerves of the axilla are connected together by a loose cellular tissue, which contains also lymphatic glands and vessels.

h, i. Subscapular arteries and veins.

K. Brachial artery—a continuation of the axillary, separated from the nerves and veins which surround it.

Fig. 2.—Operation.

a, incision of the skin; *b*, division of the aponeurosis; *c*, median nerve pushed upwards; *d*, axillary vein pressed downwards by a soft retractor; *e*, internal cutaneous nerve;

Fig 1.

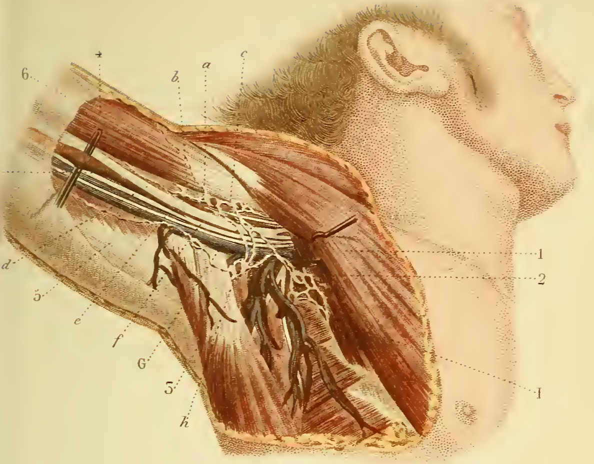


Fig 2.

f, aponeurotic sheath of the axillary vessels; *g*, axillary artery upon the director passed from within outwards, and from below upwards.

One operation now adopted for tying the axillary artery in the third part of its course, *i.e.*, below the pectoralis minor muscle, is called Lisfranc's method. It consists of (1) finding the position of the artery by drawing a longitudinal line such as would separate the anterior third of the axilla from the two posterior thirds, or by feeling the internal border of the coraco-brachialis muscle. 2. Incising the skin and cellular tissue in the course of the vessel for a distance of 2½ inches. 3. As soon as the fasciculus of vessels and nerves comes into view, relax the parts by slightly bending the arm. 4. Next ascertain the position of the coraco-brachialis, in order to find the artery. 5. By the aid of the director press first the median nerve and internal cutaneous nerve forwards, then the ulnar and musculo-spiral backwards, the artery and vein lying in the interval between them. 6. Isolate with precaution, and pass the director from behind forwards, so as to avoid the axillary vein.

A second, and perhaps the more simple operation, for tying the axillary artery in the third part of its course is the following:—

1. Supinate the arm, and extend it nearly at right angles to the trunk. 2. Make an incision two inches and a half in length along the border of the latissimus dorsi muscle, so as to run transversely across the inner side of the arm, and terminate at the inner border of the biceps muscle. 3. Divide the deep fascia upon a director. 4. Relax the arm, and the vessels may now be detected surrounded by the nerves of the brachial plexus. In order to isolate the artery, it will be necessary to press the median nerve forwards, and the ulnar and musculo-spiral nerves backwards. The director is to be passed from behind forwards, to avoid the vein.

PLATE X.

LIGATURE OF THE AXILLARY AND SUBCLAVIAN ARTERIES.

Fig. 1.—1. The clavicle and great pectoral muscle. 2. The axillary vessels exposed. 3. Trapezius. 4. Sterno-mastoid. 5. Omo-hyoid. 6. Deltoid. 7. Small pectoral.

A. Axillary artery—its upper part covered by the pectoralis major, from which it is separated by a layer of adipose tissue containing the cephalic and other branches of vein and artery, and the external anterior thoracic nerve: *a*, supra-scapular artery running along the upper border of the clavicle.

B. The axillary vein internal to and in front of the artery.

C. The cephalic vein lies in the groove between the pectoralis major and the deltoid, crossing the artery at the upper border of the pectoralis minor, and there emptying into the axillary vein.

D. The brachial plexus external and behind the artery. The external anterior thoracic nerve may cross the artery sometimes in front, sometimes behind.

Figs. 1 and 2.—A. The subclavian artery, arising from the brachio-cephalic artery on the right side, from the arch of the aorta on the left, ascends to curve over the first rib (*a*), and then descends as far as the first intercostal space, where it takes the name of axillary. From the point of origin it results that the left subclavian artery is longer in its ascending portion than the right. (See Plate XI., Fig. 1.)

The subclavian artery, after passing between the scalene muscles, descends upon the first rib, *a* (Fig. 2), in a groove external to the tubercle of insertion of the scalenus anticus, *b* (Fig. 2), a tubercle of some importance (Malgaigne).

Beyond the scalenus the artery lies in the subclavian triangle, limited by the clavicle, the sterno-mastoid (4), and the omohyoid, where it is covered at its highest part only by the deep cervical fasciæ, adipose tissue and skin; lower down by the subclavius muscle and the clavicle.

The first rib rises above the clavicle in subjects in whom

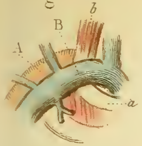


Fig 2.

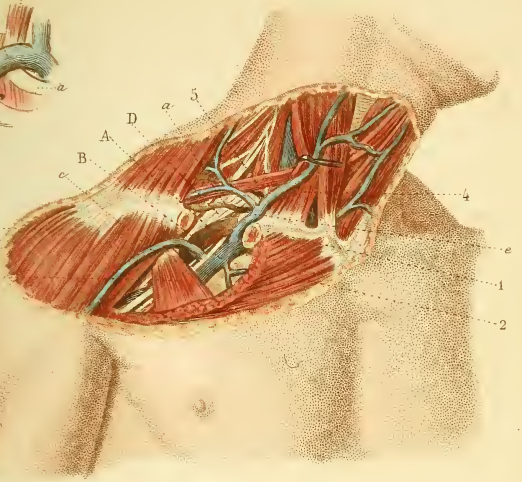


Fig 1.

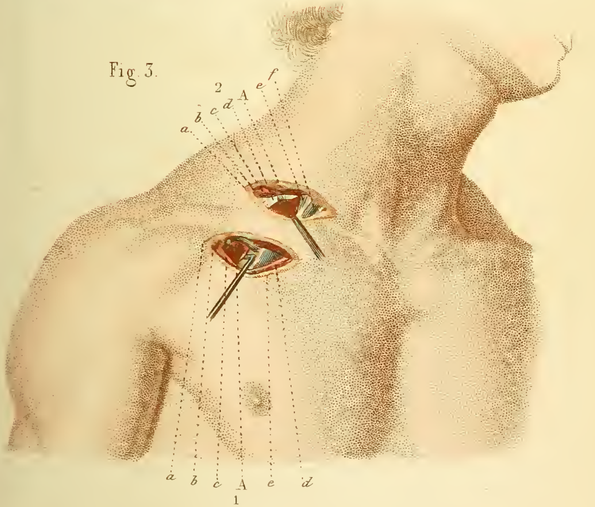


Fig. 3.

the neck is long, and the artery can then be compressed either directly or by forcibly lowering the clavicle.

B. The subclavian vein, in front of and below the artery, from which it is separated by the insertion of the scalenus anticus, *b* (Fig. 2). The external jugular vein (*e*) crosses the artery in front to empty into the subclavian.

C. The brachial plexus of nerves are altogether external to the artery.

Fig. 3.—Operation.

Incision No. 1.—*Ligature of the axillary artery.*

a, Incision of the skin ; *b*, of the subjoined aponeurosis ; *c*, upper border of the pectoralis minor ; *e*, fibres of pectoralis major cut across ; *d*, axillary vein ; A, axillary artery upon an aneurism needle below the level of the cephalic vein.

Incision No. 2.—*Ligature of the subclavian artery external to the scalenes.*

a, Incision in the skin ; *b*, in the aponeurosis ; *c*, omo-hyoid muscle ; *d*, brachial plexus of nerves ; *e*, scalenus anticus muscle ; *f*, subclavian vein ; A, subclavian artery.

LIGATURE OF THE AXILLARY ARTERY IN THE FIRST PART OF ITS COURSE.

First Method.

In this operation the vessel is ligatured in a triangular space limited above by the clavicle, below and externally by the pectoralis minor, below and internally by the sternal portion of the pectoralis major. The shoulder lying free, the elbow slightly away from the body, and the head inclined towards the opposite side, an incision is made parallel with the clavicle, and $\frac{3}{4}$ inch to 1 inch below it, compressing the skin and cellular tissue, and extending from the cellular interval between the great pectoral and the deltoid muscles as far as two finger breadths external to the sterno-clavicular articulation. The fibres of the great pectoral muscle being successively divided, the posterior sheath of the muscle comes into view. Then, to favour the separation of the lips of the wound, the shoulder may be lowered a little, and by means of the director the costo-coracoid membrane may be torn through. With the finger introduced into the wound, the small pectoral muscle is to be pushed downwards and outwards, and in the depths will be seen—1, the axillary vein inflated with blood; 2, the axillery artery external to and behind it; 3, the brachial plexus above, external and behind the artery.

In passing the ligature behind the artery, the vein must be pressed a little inwards, and the ligature passed between it and the artery.

Second method. (Chamberlayne.) One incision four inches long is made below the clavicle, and a second nearly the same length, corresponding to the cellular interval between the great pectoral and the deltoid muscles, taking care to avoid the cephalic vein. The triangular flap thus formed is turned downwards and inwards, and the artery is to be sought above the pectoralis minor, as in the preceding operation.

LIGATURE OF THE SUBCLAVIAN ARTERY.

The subclavian artery may be tied in the second or third parts of its course.

1. External to the scalenes.
2. Between the scalenes.

1st, External to the scalene.

(1). The patient being conveniently arranged, with the face turned towards the opposite side, a transverse incision is made above the clavicle, parallel to its posterior border, and extending from the external margin of the sterno-mastoid to the trapezius. The skin platysma and fasciæ, including the supra-clavicular nerves, may be divided layer by layer; or if the operator prefer, the whole may be divided by one incision, by drawing the skin downwards about three-quarters of an inch, and cutting on to the bone; the external jugular vein, if it cannot be avoided, may be cut through, first tying it above and below.

(2). By means of the forceps and director the deeper tissues may be torn through. The index finger may then be passed into the depths of the wound, to find the tubercle of origin of the scalenus anticus upon the first rib.

(3). The tubercle being recognised, the artery may be felt immediately behind it, and may be readily exposed by the director, after which the aneurism needle may be passed beneath the vessel, guided along the finger from before backwards, and a little from within outwards ; at the same time the finger placed above and external to the artery—that is, between it and the brachial plexus—supports the artery and prevents it from slipping. To facilitate this part of the operation, the shoulder should be lowered.

2nd, Between the two scalenes. (Dupuytren.)

This operation differs but little from the preceding. After having recognised the tubercle on the first rib, and made out the attachment of the scalenus anticus, a director is passed between the artery and the scalenus anticus, and the muscle is to be divided. The artery is now freely exposed, and may be ligatured. The objections to this operation are,—1. The point of ligature is too near the origin of large branches. 2. The phrenic nerve which runs along the scalenus, or immediately to its inner side, is exposed to danger. 3. The subclavian vein or the internal mammary artery may be wounded.

PLATE XI.

LIGATURE OF THE CAROTID, LINGUAL, AND FACIAL ARTERIES.

Figs. 1, 2, 3.—Anatomy.

Fig. 1. *Origin of the carotid and subclavian arteries; branches of the subclavians.*

a a, Arch of the aorta ; *b*, brachio-cephalic or innominate artery ; *d*, *c*, right subclavian and right carotid ; *e*, *f*, left subclavian and left carotid. Before passing between the scalenes (*g*), the subclavians give off the vertebral arteries *h h* ; inferior thyroids and transversales humeri, perhaps also the transversales colli, either separately or from a common trunk, the thyroid axes *i i*; internal mammaries *j j*; external to the scalenes, the posterior scapular *k k*, the thoracic axis *l*—which is, however, generally given off from the first part of the axillary artery.

Fig. 2. *Relation of the arterial with the venous trunks.*

a a, Internal jugular, in front of and external to the carotids ; *b b*, subclavian veins, anterior, parallel to, and a little below, the subclavian arteries : *c*, innominate vein, or right brachio-cephalic, in front of and external to the innominate artery ; *d*, left brachio-cephalic vein, crossing from without inwards in front of the left subclavian and carotid arteries ; *e*, inferior thyroid vein ; *f*, external jugular.

Fig. 3 :—1, Sterno-thyroid muscle ; 2, omo-hyoid ; 3, sternal origin of the sterno-mastoid cut across ; 4, masseter.

A. Right common carotid artery, extending from the innominate artery at the sterno-clavicular articulation to a level with the upper border of the thyroid cartilage. It runs obliquely from before backwards, and from within outwards, along the front and side of the neck, lying upon the pre-vertebral muscles, and in relation internally with the trachea, larynx, and pharynx. It is covered by the sterno-mastoid (3, 3), and in its lower half by the sterno-thyroid (1), the omo-hyoid (2) crossing it about the middle. These muscles separate it from the platysma and fascia, which structures alone cover it in its upper part.

Fig. 1.

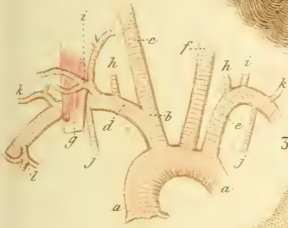


Fig. 3.

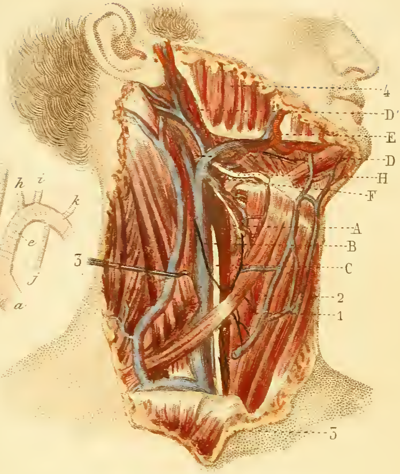
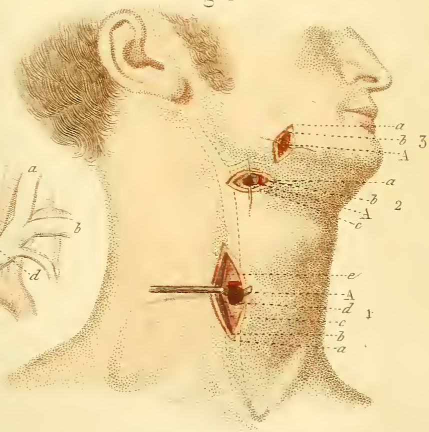


Fig 2.

Fig. 4



B. The internal jugular vein lies external to the artery, and overlaps it.

C. The pneumogastric nerve descends behind and between the artery and vein contained in the same sheath; below it passes between the subclavian artery and vein to enter the thorax. It furnishes a variable number of cardiac branches, which cross in front of the lower fourth of the artery. The sympathetic nerve is altogether behind the sheath of the vessels, and contained in loose connective tissue.

D. The internal carotid and the external carotid D′ arise by the bifurcation of the external carotid. The external carotid, lying at first internal to and then crossing outwards in front of the internal carotid, terminates at the level of the condyle of the lower jaw, where it divides into the temporal and internal maxillary arteries. At first superficial, it then dips beneath the hypoglossal nerve (H), the digastric and stylo-hyoid muscles, and the parotid gland.

E. The facial artery arises from the external carotid a little above the hyoid bone, passes beneath the digastric and stylo-hyoid muscles along the outer surface of the submaxillary gland, and curving upwards, gains the body of the lower jaw, then lies in the interstice which separates the masseter muscle (4) from the triangularis oris, and distributes itself upon the cheek and face.

F. The lingual artery, arising from the external carotid below the preceding, and at the level of the hyoid bone, is crossed by the hypoglossal nerve (H), and then turning beneath the hyoglossus muscle, runs to be distributed mainly in the tongue.

Operation.

Incision No. 1.—*Ligature of the carotid artery in the upper part.*

a, skin; *b*, cervical aponeurosis; *c*, pneumogastric nerve; *d*, sterno-mastoid muscle; A, carotid artery.

Incision No. 2.—*Ligature of the lingual artery.*

a, skin; *b*, platysma and fascia; *c*, incision of the hyo-glossus muscle; A, the lingual artery.

Incision No. 3.—*Ligature of the facial artery.*

a, skin ; *b*, platysma and fascia ; A, the facial artery.

DESCRIPTION OF THE OPERATIONS.

I. Ligature of the Brachio-cephalic Trunk.

This artery, commencing at the most interior part of the transverse portion of the arch of the aorta, terminates, after a course of about an inch and a half, behind the right sterno-clavicular articulation.

(1). The patient lying upon the back with the head extended, an ⌋ shaped incision is to be made, of which the horizontal stroke shall run from the sterno-clavicular articulation parallel with the clavicle, and about half an inch above it, and as far outwards as the centre of the bone. The perpendicular stroke is then to be extended upwards along the inner border of the right sterno-mastoid to a distance of about three inches.

(2). Divide upon the director the sternal origin and the greater part of the clavicular origin of the right sterno-mastoid muscle, which may then be turned upwards and outwards.

(3). The carotid artery is to be recognised, and it will then serve as a guide to find the trunk of the brachio-cephalic.

(4). Isolate with care, and by means of the finger as far as may be possible, the brachio-cephalic trunk, avoiding the pneumogastric and phrenic nerves and the internal jugular vein; then pass the ligature beneath the vessel by the aid of a curved director or aneurism needle, which must be introduced from before backwards and from right to left.

II. Ligature of the Common Carotid Artery.

The common carotid may be tied either above the omo-hyoid muscle or below it.

1. *Ligature in the upper part.*

The patient lying with the head extended and turned towards the opposite side, (1) make an incision about three inches in length along the inner border of the sterno-mastoid muscle, terminating a little below the cricoid cartilage; the incision will include the skin, cellular tissue, and platysma.

(2). Incise upon a director the deep cervical fascia, which here unites the sterno-mastoid with the sterno-hyoid and sterno-thyroid muscles.

(3). Then flexing the head so as to relax the muscles, and at the same time separating the muscles referred to, the omo-hyoid muscle is brought into view, crossing the depths of the wound.

(4). The artery and vein being now seen enveloped in a common sheath, on which lies the descendens noni nerve, the sheath may be carefully raised with the forceps and with precaution divided sufficiently to admit the director, whilst at the same time an assistant presses on the internal jugular vein at the upper part of the wound, in order to prevent the great dilatation of the vein, which is often of serious inconvenience to the operator.

(5). There remains only to tear with the sound the cellular tissue which unites the vessels together, and so to isolate the artery, which may be now raised upon the aneurism needle, passing the instrument from without inwards.

2. *Ligature at the lower part.*

(1). Make an incision $2\frac{1}{2}$ to 3 inches in length, commencing $\frac{2}{5}$ of an inch above the sterno-clavicular articulation, and extending upwards along the inner border of the sterno-mastoid.

(2). The skin and cellular tissue and cervical fascia being divided, the muscle is brought into view.

(3). The French advise that the sternal fasciculus should be divided; but it is sufficient to draw it aside, when the sterno-hyoid and sterno-thyroid are now seen.

(4). The latter muscles are to be drawn inwards, and the sheath of the vessels is thus exposed.

(5). The sheath is to be opened as far inwards as possible, so as to isolate the artery without injuring the vein, which has a tendency as soon as the sheath is opened to bulge in front of the artery. The director is to be passed from without inwards, so as to avoid the vein and the pneumogastric nerve, which latter lies behind and between the vessels enclosed within the sheath.

III. Ligature of the Lingual Artery (Plate XI., Fig. 4).

(1). Having recognised beneath the integument the great cornu of the hyoid bone, make an incision about $1\frac{1}{4}$ inch in length parallel with the cornu, and about $\frac{1}{6}$ inch above it, including the skin, cellular tissue, and platysma myoides.

(2). This incision will expose the lower border of the submaxillary gland, which must be raised upward in order to see the shining tendon of the digastric muscle.

(3). Immediately below this is the hypoglossal nerve, and about $\frac{1}{12}$ of an inch below this nerve the hyoglossus muscle must be divided transversely, to come exactly upon the line of the artery. The vessel may be now easily ligatured, as it is not in contact with any vein or nerve.

IV. Ligature of the Facial Artery as it passes over the border of the Lower Jaw (Plate XI., Fig. 4).

(1). Request the patient to firmly close the jaw. In this way the anterior margin of the masseter muscle may be clearly defined. On the border of the jaw, and at the anterior margin of the muscle, may be felt a slight depression in which the vessel lies, and may usually be felt pulsating.

(2). At this point make a vertical incision about an inch in length, involving the skin, platysma, and cellular tissue.

(3). The anterior fibres of the masseter are thus exposed, and along them runs the artery lying upon the maxillary bone, and often accompanied by the vein, which it is necessary to separate with care, in consequence of the dense cellular tissue surrounding it.

Pl. 12.

Fig 1

Fig 2

Fig 3

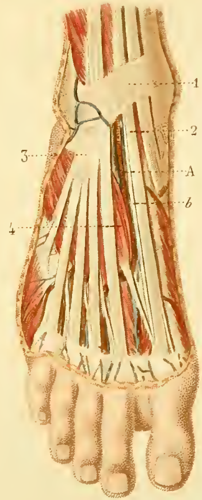


Fig. 4.

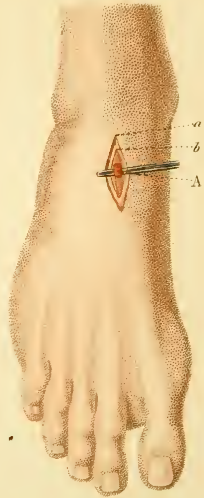


PLATE XII.

LIGATURE OF THE RADIAL ARTERY AND DORSAL ARTERY OF THE FOOT.

Fig. 1. Anatomy of the Radial Artery on the Dorsal Surface of the Carpus.

1. Post annular ligament of the carpus.
2. Extensor ossis metacarpi pollicis.
3. Extensor primi internodii pollicis.
4. Extensor secundi internodii pollicis.

A. The radial artery turning around the radio-carpal articulation passes beneath the extensor ossis metacarpi and extensor primi internodii pollicis (2 and 3), and then obliquely beneath the extensor secundi internodii pollicis to penetrate between the two heads of the abductor indicis, and thus gains the palm of the hand, where it ultimately forms the deep palmar arch. In this part of its course it is in relation with venous branches, and some nerve filaments from the radial nerve, covered only by the general aponeurosis and the integument.

Fig. 2.—Operation.

a, Incision in the intergument ; *b*, the aponeurosis ; A, the radial artery.

Fig. 3.—Anatomy of the Dorsal Artery of thr Foot.

1. Dorsal annular ligament. 2. Tendon of the extensor proproprius pollicis. 3. The common extensor of the toes. 4. Internal tendon of the extensor brevis digitorum.

A. The dorsal artery, a continuation of the anterior tibial artery, commences beneath the annular ligament of the tarsus (1), and extends from the middle of the intermalleolar space to the proximal extremity of the first interosseous space, where it penetrates the first dorsal interosseous muscle to reach the sole of the foot, and there anastomoses with the plantar arch. Covered by the aponeurotic layer which binds it upon the tarsus, and by the general aponeurosis and the integument, the dorsal artery descends upon the instep, accompanied by two satellite veins, and by the tibial nerve (*b*) internal to it. It courses along the outer side of the tendon of the extensor proprius pollicis (2), an important relation which can be made out by extending the great toe ; and external to it runs the inner head of the extensor brevis digitorum (4), which in muscular subjects somewhat overlaps it.

Fig. 4.—OPERATION.

a, Incision in the skin ; *b*, the aponeurosis ; A, the dorsal artery.

STEPS OF THE OPERATION.

Ligature of the radial artery on the dorsal surface of the carpus.

(1). By forced extension of the thumb determine beneath the skin the projection of the extensor secundi internodii.

(2). Make an incision about one inch in length, internal, and parallel to this tendon, the middle of the incision corresponding to the summit of the first intermetacarpal space.

(3). Divide the aponeurosis.

(4). beneath the aponeurosis, in the angle formed at the summit of the first intermetacarpal space, will be found the radial artery, accompanied by two veins.

(5). Disengage it from the veins with the point of the director and ligature.

Ligature of the dorsal artery of the foot.

(1). In the course of a line extending from the intermalleolar space to the first interosseous space that is along the outer border of the extensor proprius pollicis, make an incision one and a half to two inches in length, including the skin and cellular tissue.

(2). Divide the aponeurosis upon the director.

(3). Recognise the internal head of the extensor brevis digitorum.

(4). Beneath it will be found the artery lying upon the bone, and accompanied by two veins. Isolate with the director and ligature.

Fig. 1.

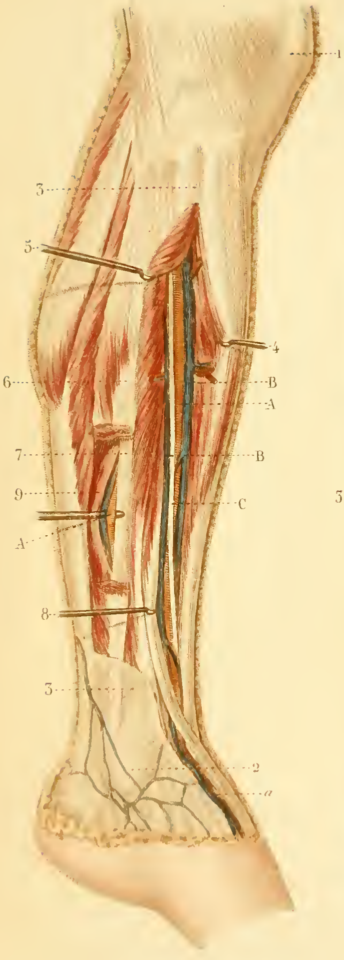


Fig. 2.

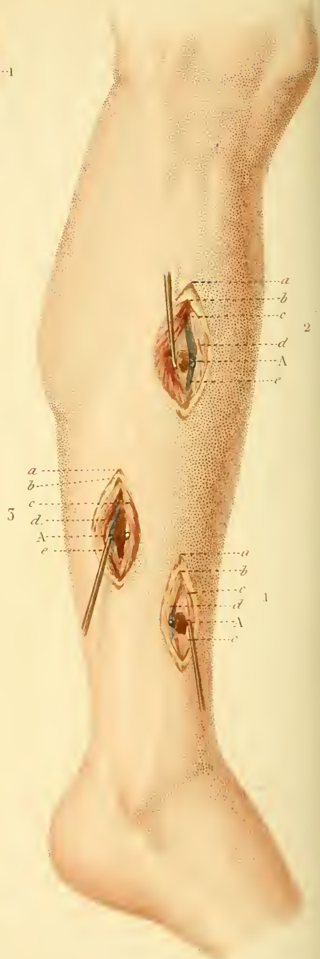


PLATE XIII.

LIGATURE OF THE ANTERIOR TIBIAL ARTERY.

Fig. 1.—Anatomy.

1. Patella. 2. External malleolus. 3. External aponeurosis of the leg. 4 and 5. Tibialis anticus and extensor communis digitorum turned aside, and thus exposing the vessels deeply situated in the intermuscular space. (6). Peroneal muscles divided. 7. The fibula.

A. The anterior tibial artery, the external and anterior branch of the bifurcation of the popliteal, arises beneath the fibrous arch of the soleus and terminates beneath the anterior annular ligament, when it becomes the dorsal artery of the foot. Its direction from above downwards, and somewhat obliquely from behind forwards, would be represented by a line drawn from the inner part of the head of the fibula to the centre of the tibio-tarsal articulation. This artery pierces the interosseous ligament from behind forwards at the level of the upper fourth of the leg, and descends nearly two-thirds of its length upon the ligament; below it lies upon the outer surface of the tibia turning to reach the front of the lower extremity of that bone. To its inner side lies the tibialis anticus (4) and the bone; to its outer side, the extensor communis digitorum on the upper third, and the extensor proprius pollicis in the lower two-thirds, the tendon of the latter muscle crossing it below from without inwards. To the outer side of this tendon, and in the same space with it, the artery passes beneath the annular ligament.

The extensor muscles and the tibialis anticus, between which lies the artery, are intimately united and bound down by the aponeurosis (3), a disposition which conceals their partition and renders their separation difficult.

B, B. The venæ comites accompany the artery in its whole length.

C. The anterior tibial nerve, at first external to the artery, crosses in front of it at the lower fourth, and becomes internal to it beneath the ligament.

A′. The peroneal artery, a branch of the posterior tibial, descends vertically along the posterior aspect of the fibula as far as the lower tibio-fibular articulation, being covered above by the soleus, then lying between the flexor longus pollicis and the tibialis porticus (9), and below upon the interosseous ligament.

Fig. 2.—Operation.

Incision No. 1.—*Ligature of the anterior tibial at its lower part.*

a, The skin ; *b*, the aponeurosis ; *c*, tibialis anticus muscle ; *d*, extensor proprius pollicis ; *e*, anterior tibial nerve ; A, the artery raised upon a Deschamps' needle.

Incision No. 2.—*Ligature of the anterior tibial in its upper part.*

a, The skin ; *b*, the aponeurosis ; *c*, extensor communis digitorium ; *d*, tibialis anticus ; *e*, anterior tibial vein ; A, the artery.

Incision No. 3.—*Ligature of the peroneal artery in its lower part.*

a, the skin ; *b*, the aponeurosis ; *e*, peroneus longus ; *d*, flexor longus pollicis ; *e*, external border of the soleus ; A, the artery.

DESCRIPTION OF THE OPERATIONS.

I. Ligature of the Lower Part of the Anterior Tibial Artery.

Followlng the line of the artery, or, better still, the external border of the tibialis anticus muscle, which can be readily perceived—

(1). Make an incision about three inches in length, comprising the skin and subcutaneous cellular tissue.

(2). Divide the aponeurosis upon a disector.

(3). With the index finger break down the connective tissue in the muscular interstice, and in the depth of the wound will be found the artery embracing the tibia, and accompanied by its two veins.

(4). Disengage it from the veins and ligature.

II. Ligature of the Upper Part of the Anterior Tibial Artery.

(1). At rather more than an inch external to the crest of the tibia, and in the course of a line which would extend from the head of the fibula to the centre of the ankle joint make an incision three inches and half in length, dividing the skin and cellular tissue.

(2). Divide the aponeurosis upon the director, and if difficult to find the intermuscular space this fascia may be divided crucially.

(3). The intermuscular space being seen or recognized by means of the finger on the outer side of the tibialis anticus, the muscles are to be freely separated by the finger, and the vessel will be detected lying upon the interosseous ligament and accompanied by the anterior tibial nerve to its outer and front part, and the two companion veins surrounding it.

(4). Isolate the artery and ligature with the aid of a rectangular aneurism needle.

III. Ligature of the Peroneal Artery.

(1). Recognize the outer border of the fibula, then half an inch behind, and parallel to it, make an incision about three inches in length, dividing the skin and cellular tissue.

(2). Divide the aponeurosis to the same extent on a director.

(3). Recognize, and then push inwards, the external border of the soleus muscle, which often overlaps the fibula. Next starting from the border of the bone, which is now uncovered, cut through a layer of fascia which covers the flexor longus pollicis, and then separate the muscle from its attachment to the fibula ; turn the muscle inwards, and the artery will be found lying upon the bone, and gradually approaching the interosseous ligament as it descends.

PLATE XIV.

LIGATURE OF THE POSTERIOR TIBIAL ARTERY.

Fig. 1.—Anatomy.

1. The patella. 2. Internal malleolus. 3. Internal surface of the tibia. 4. Internal aponeurosis. 5. Soleus muscle drawn backwards.

A. The posterior tibial artery commencing at the bifurcation of the popliteal terminates beneath the internal annular ligament, where it divides into the internal and external plantar. Its direction would be represented by a line drawn obliquely from the middle of the ham to a point behind the malleolus.

In its *upper third* the artery is deeply situated, lying upon the tibialis posticus (7), and covered by the deep aponeurosis, the soleus (5), and gastroenemius (9).

In its *middle third* it approaches nearer to the surface, descending parallel to the internal border of the tibia, separated from the bone by the common flexor of the toes (8), and covered by the deep aponeurosis and the internal border of the soleus (5).

Lastly, in the *lower third*, the vessel lying immediately beneath the aponeurosis runs behind the tendons of the tibialis posticus, and flexor communis digitorum, with the internal border of the tendo achillis (6) near behind it.

B, B. Two companion veins accompany the posterior tibial artery in its whole extent, frequently interlacing; (*b*) internal saphenous vein.

C. The posterior tibial nerve coursing along the posterior and outer part of the artery.

Fig. 2.—Operation.

Incision No. 1.—*Ligature of the lower part of the posterior tibial artery.*

a, The skin; *b*, the aponeurosis; *c*, the posterior tibial nerve; A, the artery.

Incision No. 2.—*Ligature of the middle third of the posterior tibial artery.*

a, The skin; *b*, aponeurosis; *c*, the border of the soleus;

Pl. 14.

Fig. 1.

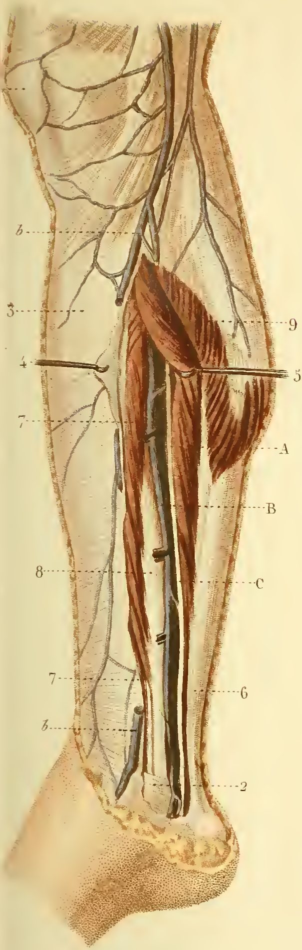
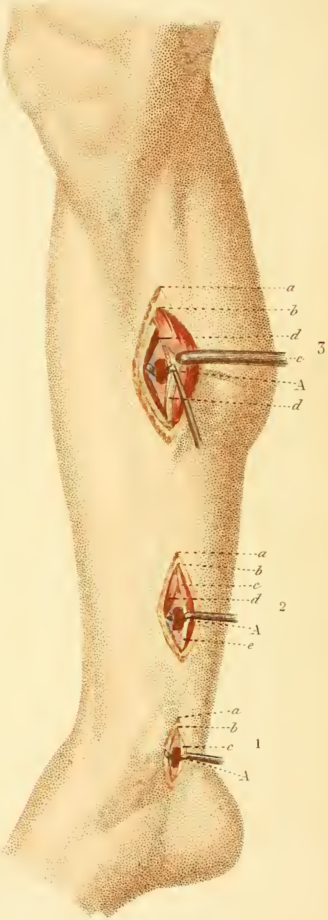


Fig. 2.



d, the common flexor ; *e*, the posterior tibial nerve ; A, the artery.

Incision No. 3.—*Ligature of the upper third of the posterior tibial artery.*

a, The skin ; *b*, the aponeurosis ; *c*, the gastrocnemius drawn back by a retractor ; *d*, an incision made through those fibres of the soleus attached to the inner border of the tibia ; A, the artery.

STAGES OF THE OPERATION.

1. *Ligature of the posterior tibial artery in the lower part or behind the malleolus.*

(1). At one-third of a inch behind the posterior border of the internal malleolus make a semilunar incision in the integument nearly two inches in length, the concavity embracing the malleolus.

(2). Divide the aponeurosis upon a director, carefully avoiding the synovial grooves on the posterior part of the malleolus.

(3). Beneath the aponeurosis and in front of the nerve, the artery is to be found between two companion veins.

2. *Ligature of the middle third of the posterior tibial artery.*

(1). At three-quarters of an inch behind the internal border of the tibia make an incision two inches and a half in length in the skin and cellular tissue.

(2). Divide the aponeurosis, and draw the border of the soleus muscle outwards.

(3). Incise the deep aponeurosis upon a director, and immediately beneath it will be seen the artery with its two veins.

3. *Ligature of the upper third of the posterior tibial artery.*

(1). At about one inch behind the internal border of the tibia make a longitudinal incision three and a half to four inches in length through the skin, cellular tissue and aponeurosis.

(2). By means of the index finger within the wound separate and turn outwards the internal border of the gastrocnemius.

(3). Next detach the fibres of the soleus arising from the internal border of the tibia and turn this muscle outward.

(4). Whilst these muscles are held backwards and outwards by a retractor, divide upon a director the deep aponeurotic fascia, beneath which can be seen the vessels.

(5). Isolate the artery, and pass the ligature with either a Cooper's or a Deschamps' needle.

Mannec's Method.

Instead of detaching the soleus muscle from the tibia, this author advises the division of this muscle layer by layer in its whole thickness, penetrating the posterior surface of the muscle at about three-quarters of an inch from the internal border of the tibia. The knife soon comes upon a thick pearly fibrous lamina upon which are inserted the fleshy fibres, the anterior aponeurosis of the muscle traversed by numerous vascular branches. On incising this aponeurosis, the deep aponeurotic fascia comes into view, beneath which lies the artery.

In performing this operation, the contractions of the muscles often impede the operator to such an extent that it becomes necessary to divide the muscle across its fibres.

Pl. 15.

Fig. 2

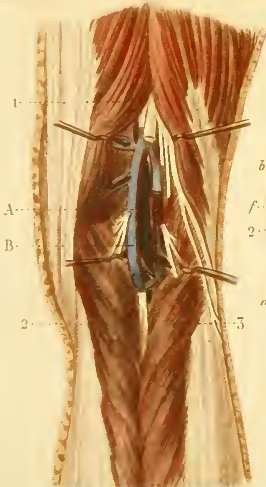
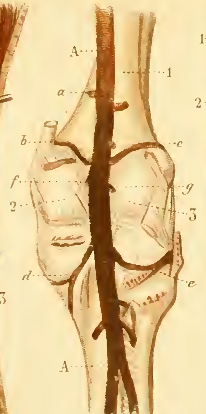


Fig. 3.



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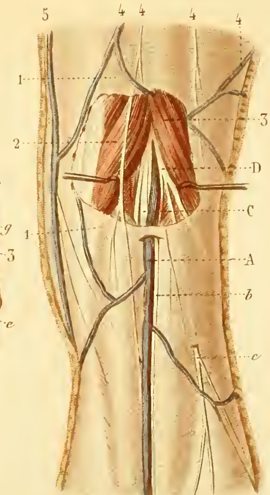


Fig. 4

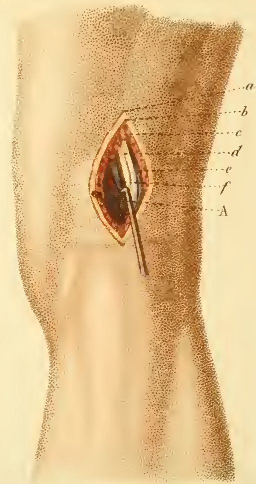


PLATE XV.

LIGATURE OF THE POPLITEAL ARTERY.

Figs. 1, 2, and 3.—Anatomy.

Fig. 1.—*Aponeurotic layer, superficial vessels and nerves.*

1—1. Popliteal aponeurosis in part removed. 2. Semimembranosus. 3. Biceps. 4. Cutaneous vessels and nerves. 5. Internal saphenous vein.

A. *External or short saphenous vein.*—It ascends for a distance vertically towards the middle of the popliteal aponeurosis, where it perforates; beneath the fascia it runs external to the popliteal nerve to enter the popliteal vein. It is accompanied by the external saphenous nerve (*b*).

C. *The popliteal or internal popliteal nerve.*—Sub-aponeurotic in the popliteal region, which it traverses vertically from above downwards to become the posterior tibial nerve; situated superficial to and a little external to the popliteal vessels, from which it is separated by a fine layer of adipose tissue, it furnishes beneath the aponeurosis many filaments to the popliteal region; from it is also given off the communicans poplitei (*b*) or external saphenous which perforates the fascia in company with the short saphenous vein.

D. *Peroneal or external popliteal nerve.*—More superficial and smaller than the preceding. It descends obliquely from within outwards, beneath the aponeurosis, to be distributed in the leg. In the popliteal space it gives off the communicans peronei, and a branch called the peroneal saphenous (*e*), which piercing the aponeurosis in a variable position, ultimately joins the external saphenous (*b*).

Fig. 2.—*Sub-aponeurotie dissection.*

The popliteal nerve is cut across, and the adipose tissue which occupies the space has been removed, leaving bare the popliteal vessels.

A. *The popliteal artery* extends from Hunter's canal to the lower border of the popliteus muscle; it is directed a little obliquely from within outwards, overlapped in its course and crossed near the centre by the popliteal vein (B), which at the lower part of the artery is somewhat internal and at the upper part external to the artery. These two vessels are covered superiorly by the belly of the semi-membranosus (1), and at the lower part by the two bellies of the gastrocnemius (2 and 3). They are bound together in their course by dense connective tissue, which renders it difficult to isolate them.

Fig. 3.—A. The popliteal artery, at first internal to the femur (1), lies below upon its posterior surface, then passing between the condyles (2 and 3) comes into contact with the tibio-femoral articulation. In its course it furnishes many branches, of which the chief are—the *superior articular* (*a b c*) ; *the inferior articular* (*d e*), which anastomose with the preceding in front of the knee ; the *azygos articular ;* and the *sural*, which are distributed to the gastrocnemius.

Fig. 4. OPERATION.

The popliteal artery may be ligatured either in the upper or the lower part of the popliteal space by the same operation—the only difference being that to find the vessel in the lower part it would be necessary to make an incision four inches in length, commencing one-third of an inch above the articulation, and following the direction of the interval which separates the two heads of the gastrocnemius.

Ligature of the popliteal artery in its upper part.

a, The skin ; *b*, the aponeurosis ; *c*, adipose tissue ; *d*, the popliteal nerve ; *e*, the external saphenous vein ; *f*, the popliteal vein ; A, the artery upon a Deschamps' needle.

STAGES OF THE OPERATION.

(1). The patient lying upon the belly with the leg extended, make a longitudinal incision through the skin and cellular tissue three and a half inches in length, down the centre of the popliteal space, and terminating between the condyles of the femur.

(2). Incise the aponeurosis upon a director, taking care to to avoid and to push outwards the external saphenous vein.

(3). With the index finger, or with the point of the director, separate the fat and cellular tissue, at the same time slightly flexing the leg upon the thigh, in order to separate the muscles more easily.

(4). Recognize the outer border of the semimembranosus muscle, and the popliteal nerve will be now seen coming from beneath it.

(5). Push the nerve inwards, and beneath and a little internal to it will be found the popliteal vein.

(6). Isolate the vein with caution, and also draw it cautiously inwards, when the artery will be found lying the deepest of all the structures.

(7). Carefully isolate the artery and ligature with an aneurism needle.

Marchal's Method.

The object of this operation is to tie the popliteal artery in its lower part, but instead of arriving at it through the popliteal space, the inner side of the leg is penetrated.

The patient lies upon the back with the leg flexed and lying on its outer surface. The surgeon, standing on the outer side of the limb, makes an incision 3½ inches in length, commencing below the internal tuberosity of the tibia and carrying it downwards along the internal border of the inner head of the gastrocnemius—that is, somewhat obliquely from without inwards and from behind forwards to within a third of an inch of the internal border of the tibia.

On dividing the skin, the internal saphenous vein is to be avoided. The gastrocnemius is next to be recognised; then, on flexing the leg upon the thigh, so as to relax that muscle, the index finger is to be introduced beneath it, so as to completely separate it from the deep muscles. The artery is now readily seen, with the nerve slightly to its inner side and surrounded in its lowest part by the satellite veins which accompany the tibial arteries.

Jobert's Method.

In this operation, which is the counterpart of the preceding, the object is to tie the popliteal artery in the upper part; but instead of approaching it through the popliteal space, an incision 3½ inches in length is made, commencing immediately above the inner condyle of the femur : the dissection is carried between the vastus internus and the muscles which form the inner boundary of the popliteal space.

PLATE XVI.

LIGATURE OF THE FEMORAL ARTERY.

Fig. 1.—Anatomy.

A. The femoral artery, a continuation of the external iliac, extends from the middle of the crural arch (1) to the end of Hunter's canal, where it becomes the popliteal. The vessel is in front of the femur in the upper part of its course, internal to it in the middle, and posterior to it in the popliteal region. In its upper fourth it is covered only by some lymphatic ganglia, the femoral aponeurosis and the skin—its superficial position allowing of its being compressed upon the body of the pubes or upon the head of the femur. Lower the sartorius muscle (*b b*) becomes its companion, covering it and also crossing it in such manner that the vessel corresponds to its internal border on the upper part of its extent, and almost to its external border in Hunter's canal.

C. The femoral vein accompanies the artery, lying internal to it above, posterior to it in the chief part of its extent, and a little external to it below. These two vessels, united together by a very dense cellular tissue in their two lower thirds, are in addition contained in a common aponeurotic sheath.

The internal saphenous vein (*d*), subcutaneous, runs along the inner border of the sartorius muscle, and empties itself into the femoral vein at the saphenous opening.

E. The anterior crural nerve, situated external to the artery, is separated from it by an aponeurotic layer which binds it to the psoas muscle.

F. The internal saphenous nerve lies external to the femoral artery, but in the lower fourth it penetrates the sheath of the vessels, and in Hunter's canal it crosses the artery to leave the sheath on the inner side, afterwards accompanying the internal saphenous vein.

The femoral artery is also crossed by the two branches of the internal cutaneous nerve (*g* and *h*).

Fig. 2.—Operation.

Incision No. 1.—*Ligature of the femoral artery in its lower fourth.*

a, the skin and subcutaneous cellular tissue; *b*, the aponeurosis; *c*, external border of the sartorius drawn inwards;

Fig. 1.

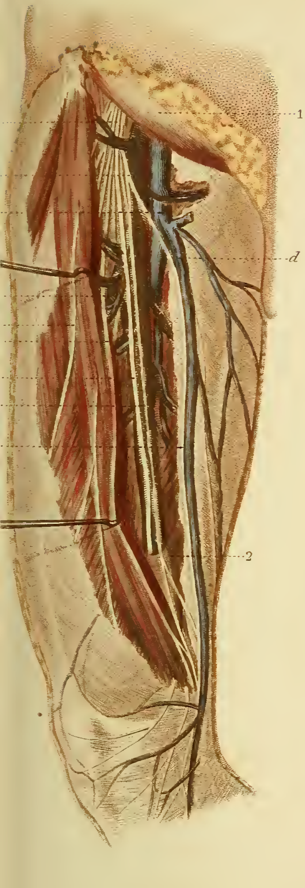
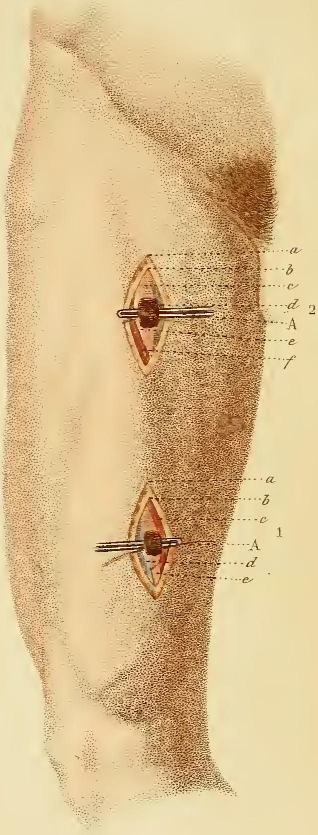


Fig. 2.



d, internal saphenous nerve ; *e,* tendinous sheath of the femoral vessels at Hunter's canal ; A, the artery.

Incision No. 2.—*Ligature of the femoral artery in its upper third.*

a, the skin and cellular tissue ; *b,* aponeurosis ; *c,* sheath of the femoral vessels ; *d,* femoral vein ; *e,* saphenous nerve ; *f,* internal border of the sartorius ; A, the artery.

STAGES OF THE OPERATION.

Ligature of the femoral artery in Hunter's canal.

(See Fig. 2, Incision 1).

The course of the artery is represented by a line drawn from the centre of the crural arch to the internal condyle of the femur.

(1). The thigh being partly flexed and turned outwards, make an incision through the skin and cellular tissue three inches long in the direction of the line referred to, and commencing rather below the middle of the thigh, so that the centre of the incision shall correspond to the union of the lower with the middle third of the thigh.

If preferred, the outer margin of the sartorius may be chosen for the line of the incision instead of the line representing the course of the artery.

In order to define the precise course of the sartorius muscle, it is well to make the patient put that muscle into action before being placed under the influence of the anæsthetic ; and if the operator so desire he may mark the border with ink.

(2). Divide the aponeurosis (*b*) on the director a distance of half an inch internal to the external border of the sartorius.

(3). Draw the sartorius inwards, and then with the index finger seek the interval between the adductor magnus and the vastus internus ; in this way the finger is brought against the entrance to Hunter's canal.

(4). With the greatest care the wall of Hunter's canal may be divided upon a director, and the artery may now be seen with the vein behind and external, the internal saphenous nerve above and crossing it.

(5). With the point of the director carefully separate a sufficient space around the artery within the dense cellular tissue which unites the vessels together, and pass the ligature from behind forwards.

Ligature of the femoral artery in the middle of the thigh.

HUNTER'S OPERATION.

Fig. 2, Incision 2.

The limb being placed as in the preceding operation—

(1). Make an incision through the skin and cellular tissue three inches long, in the middle third of the thigh and in the direction of the artery recognised by the representative line or along the inner border of the sartorius muscle. In this incision the saphenous vein is to be avoided.

(2). Incise the aponeurosis upon the director.

(3). Draw the sartorius muscle outwards, in order to expose the sheath of the vessels which is subjacent.

(4). With the point of the director in the right hand and the forceps in the left, make a small opening in the sheath over the position occupied by the artery.

(5). With the director isolate the artery carefully from the tissue around it, and pass the ligature from within outwards.

Ligature of the femoral artery in the upper third of the thigh.

SCARPA'S OPERATION.

(1). At three inches below the crural arch commence an incision through the skin and cellular tissue, and prolong it for a distance of three inches in the direction of the internal border of the sartorius muscle.

(2). Draw the saphenous vein inwards; but a number of lymphatic vessels cannot be avoided.

(3). Incise the aponeurosis upon a director.

(4). The sheath of the vessels can now be seen, and the artery can be felt pulsating; open the sheath with the director, as advised in the previous operation. The vein here lies internal and behind the artery, and the ligature must be passed from within outwards.

The chief danger in the operation consists in ligaturing the vessel too near the origin of its large branch—the profunda femoris—the circulation through which would tend to prevent the formation of the clot above the ligature, and thus materially increase the danger of secondary hæmorrhage.

Fig. 1.

Fig. 2.

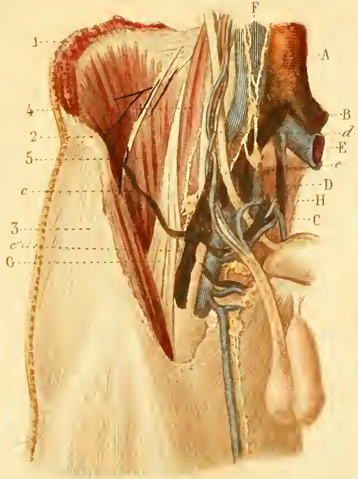


Fig. 3.

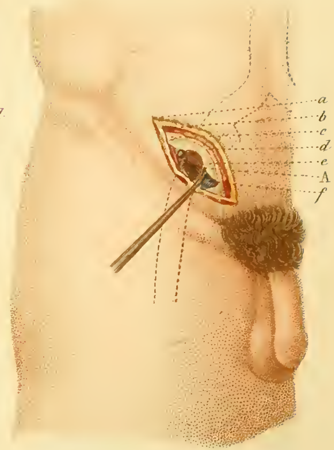


PLATE XVII.

LIGATURE OF THE FEMORAL ARTERY IMMEDIATELY BELOW THE CRURAL ARCH; OF THE ILIAC AND EPIGASTRIC ARTERIES.

FIGS. 1 and 2.—ANATOMY.

1—1. The cut fibres of the external and internal oblique and transversalis muscles. 2. Peritoneum and fascia transversalis; the fascia transversalis ensheathing the spermatic cord by an infundibuliform prolongation (3). 5. The crural arch. 6. The fascia lata, the part about the saphenous opening removed, to show the vessels.

A, Femoral artery; B, femoral vein an aponeurotic layer or septum separating the vein from the artery. C, Internal saphenous vein. D, lymphatic vessels and ganglia.

A′. The epigastric artery arises from the inner side of the external iliac, immediately above the crural arch. It passes beneath the vas deferens, or in the female the round ligament, and curves upwards and inwards, between the peritoneum and the fascia transversalis, to reach the deeper surface of the rectus muscle. It is accompanied by two veins.

Fig. 2.

1. Section of the abdominal muscles cut parallel to the crest of the ilium. 2. Anterior superior spine of the ilium. 3. Fascia lata. 4. Psoas muscle. 5. Iliacus muscle.

A, Aorta. B, Right common iliac.

This artery commences at the bifurcation of the aorta, at the lower border of the fourth lumber vertebra, and descends obliquely outwards as far as the sacro-iliac symphysis, where it divides into external and internal iliac (C and D).

The external iliac artery (C), continuing the course of the common iliac as far as the crural arch forms with that vessel a single trunk, almost rectilinear, applied above to the vertebral column and below to the psoas muscle (4). Before passing under the crural arch the external iliac gives origin to the deep circumflex iliac (*c*), and the deep epigastric arteries (*c′*).

The internal iliac artery (D) forms an acute angle with the preceding, and plunges into the pelvic cavity, where it at once divides into many branches.

The common iliac arteries are crossed at the level of the sacro-iliac symphysis by the ureter (*e*), and the spermatic veins (*d*).

E, The common iliac veins passing behind the right common iliac artery unite to form the vena cava inferior.

G, The anterior crural nerve. H, Lymphatic glands and vessels.

Fig. 3.—Operation.

a, the skin ; *b*, *c*, *d*, incisions in the aponeurosis and in the muscles forming the wall of the abdomen ; *e*, the peritoneum separated (but not incised) and raised upwards from the external iliac vein ; A, the external iliac artery upon a Deschamps' needle.

STAGES OF THE OPERATIONS.

Ligature of the common femoral artery.

(1). Recognise the position of the artery by its pulsations at a point a little internal to the centre of Poupart's ligament.

(2). Make an incision $2\frac{1}{2}$ inches in length in the course of the vessel, commencing at Poupart's ligament. It is here impossible to avoid small lymphatic vessels.

(3). Incise the crural aponeurosis with the greatest care upon a director, and immediately beneath will be seen the crural sheath containing the vessels, the vein being internal to the artery.

(4). With the point of the director denude the artery sufficiently to pass the ligature from within outwards.

Ligature of the deep femoral artery.

The deep femoral artery leaves the common femoral at a point about two inches below Poupart's ligament.

(1). Make an incision in the course of the vessel three inches long, commencing half an inch to one inch below Poupart's ligament.

(2). Incise the fascia lata upon a director to the same extent. The sheath of the femoral vessels is now seen, the artery being the external of the two.

(3). With the index finger separate the cellular tissue on the outer side of the artery, keeping the finger also rather beneath the vessel.

(4). By means of the finger the external circumflex artery will be felt, and by following this inwards the deep femoral artery can be detected.

(5). Isolate it from the surrounding tissue and its vein by the point of the director.

It is rarely necessary to ligature this vessel; but should occasion arise, it should be tied some distance below the origin of the circumflex vessels, otherwise there will be danger of secondary hæmorrhage.

Ligature of the external iliac artery.

The patient lying upon the back with the muscles of the abdomen relaxed—

(1). Make a curved incision three inches and a half in length, and one inch above Poupart's ligament, commencing from a point half an inch external to the external abdominal ring, and terminating at a point on a level with the anterior superior spine of the ilium, but nearly two inches internal to it. In cutting through the skin and cellular tissue some small vessels will be cut, which, if necessary, may be tied before proceeding with the operation.

(2). Incise upon a grooved director the muscular fibres and tendinous aponeurosis of the external oblique.

(3). In like manner cut through the internal oblique and transversalis muscles.

(4). By the index finger detach the fascia transversalis as low as Poupart's ligament.

(5). It is possible that it may be necessary to cut this fascia on the director. If so, the greatest care must be taken not to enter the peritoneum, but it is better when practicable, instead of cutting the transversalis fascia, to push on steadily and carefully with the finger, so as to raise the transversalis fascia with the peritoneum away from the vessels.

(6). Next measure the point at which the artery should be found a little internal to the centre of Poupart's ligament, and with the index finger pressed down upon that point determine the pulsation of the vessel.

(7). Next, whilst the wound is kept open by the fingers of an assistant, or by a soft retractor,—the sheath of the vessels being now seen, and the artery being the external of the two,—with the point of the director prick open the sheath, which is here thin, and pass the director carefully on each side of it, so as to prepare the way for the needle of Deschamps, which must be passed from within outwards.

Ligature of the epigastric artery.

This artery may be wounded in an operation for strangulated hernia, or by accident. If the artery is wounded close to its origin, it would be necessary to ligature the external iliac artery as well. The same method as the preceding must be adopted, only on arriving at the spermatic cord that structure must be drawn outwards, to see the position of the internal abdominal ring. At this point—that is, in contact with the inner side of the spermatic cord, and immediately behind the transversalis fascia—is the artery.

Ligature of the circumflex iliac artery.

This vessel, arising on the outer side of the external iliac artery opposite the epigastric, may be tied near to its origin by the same operation. It does not pierce the transversalis muscle until it reaches the middle of the crest of the ilium.

Ligature of the common iliac artery.

The patient lying upon the back with the thighs somewhat flexed,—

(1). Make an incision through the skin and cellular tissue in a curve three-quarters of an inch above Poupart's ligament, extending from the external abdominal ring to a point one inch internal to and one inch above the anterior superior spine of the ilium.

(2). By means of a director cut through the common tendon, and through the muscular fibres of the external and internal oblique and of the transversalis muscles.

(3). With extreme caution raise the transversalis fascia, so as to avoid injuring the peritoneum, and incise it upon the director, or tear it carefully with the finger.

(4). Now with the finger cautiously detach the peritoneum from the structures behind it sufficiently to expose the vessel in question.

(5). Isolate the vessel with the point of the director.

(6). With a rectangular aneurism needle pass the ligature behind the vessel about its centre.

The common iliac artery may be also ligatured by Stevens' method for ligaturing the internal iliac artery.

Ligature of the internal iliac artery—Stevens' method.

(1). Make an incision through the skin and cellular tissue five inches in length, external to the deep epigastric artery and parallel with it.

(2). Divide successively upon a director the abdominal muscles.

(3). By means of the finger carefully separate the peritoneum from the psoas and iliacus muscles, and from the brim of the pelvis, as far as the level of the bifurcation of the common iliac.

(4). Cautiously isolate the vessel with the index finger, and pass the ligature by means of the common aneurism needle.

Ligature of the gluteal artery.

The patient lying on the belly—

(1). Ascertain the position of the summit of the great trochanter, and also of the posterior superior iliac spine.

(2). Make an incision four inches in length, commencing at a point an inch and a quarter below the posterior superior iliac spine, and an inch and a quarter external to the sacrum, descending obliquely towards the summit of the great trochanter.

(3). Having cut through the skin and cellular tissue, and the fibres of the great gluteal muscle, the artery will be found situated immediately below the superior border of the great seratic notch.

(4). Press aside the pyriformis and middle gluteal muscles, which by their proximity conceal the vessel, then isolate the vessel and ligature it.

AMPUTATIONS.

When it is required to amputate a limb or a part of a limb by disarticulation, it is necessary (1) to discover the precise spot of articulation; (2) to penetrate it, in cutting through the structures which unite the bones; (3) so to manage the soft parts that the stump shall be sufficiently covered.

1. *Rules for recognizing the line of articulation.*

Nearly all the extremities of bones which enter into the formation of joints are provided with tuberosities prominent beneath the skin. These tuberosities, more or less close to the joint, occupy such positions as to serve as sure guides to the surgeon in defining the articulation.

(1). Seek first that which is the most distinct, as the smaller prominences are then more easily recognized.

(2). With this view place the limb in a convenient position, and if necessary exercise movements in order to make the osseous prominences more distinct, or to render visible and appreciable to the touch the tendons attached in the neighbourhood of the joint.

The folds of skin around a joint are often of service in discovering its situation. These folds, which are well marked about the digital articulation, are situated in some instances immediately over the articulation, and in others at a distance from it.

2. *Rules for penetrating a joint.*

The surgeon should possess such a knowledge of the position of the joints that he could readily traverse them with the knife, although masked by surrounding disease. It is not less useful to be well acquainted with the position, form, and extent of the ligaments, in order to divide them without hesitation.

A disarticulating knife should be narrow, to turn easily in the joint, and strengthened along the back in order not to break.

These points being attended to, the disarticulation may be proceeded with in conformity with the following general rules:

(1). Determine by the application of the thumb and index finger the two extremities of the articular diameter—thus the line which the knife must take will be defined.

(2). In penetrating a joint anteriorly, it should be extended; and if, on the contrary, it is to be penetrated from behind, it should be partly flexed, in order to increase the articular interspace.

(3). Always commence by dividing the principal ligaments which hold the bones together ; the lateral and dorsal being divided, the knife can usually be insinuated between the articular surfaces ; but if the articulation be dovetailed, as the tarso-metatarsal there may exist special means of attachment of the interosseous ligaments, which it will be necessary first to divide with the point of the knife.

(4). When the articulation is well opened, it will generally suffice to pull aside the articular surfaces by moderate traction. If the articulation is closely joined, it will be necessary to luxate it by force, care being taken to avoid undue injury to the parts ; then, if there should exist by chance ossified ligaments which do not yield to the knife, it will be necessary to separate them by the saw.

(5). When a joint is penetrated, the heel and the point of the knife ought to proceed parallel upon the same line ; and if when passing beyond the articular surfaces to leave the joint the surgeon fears to perforate the integument destined for the formation of the flap, it will suffice to separate them by the thumb and finger, and by gentle traction.

3. *Methods of operating.*

All amputations of the limbs may be arranged under three heads :

(1). *The circular operation.*—In this case all the parts are divided in a circular manner, and the section is covered solely by the skin, which has been previously drawn up like a sleeve before making the incision.

(2). *The oval or oblique operation.*—This form is usually adopted in the removal of the digits, and consists of an elliptical incision around a part or joint which results when the amputation is completed in a wound the form of which is oval.

(3). *Flap operation.*—In this case one or more flaps are cut of dimensions calculated to cover the surface of the wound without tension.

RULES FOR MAKING THE FLAPS.

(1). In cases where it is difficult to control hæmorrhage—for instance, amputation at the shoulder joint,—the less important flap or flaps should be first made, and when the disarticulation is completed the flap which will contain the large vessels may be cut.

(2). In making a flap outwards, care should be taken not to terminate it in a point. The cutting should therefore be effected by the whole length of the blade, carried with a slight sawing motion, and in a line obliquely from the point of puncture to the point at which it has been previously determined to terminate the flap. By this means the extremity of the flap will be rounded. Should the knife be carried deeply and parallel with the bone, the flap will contain an excess of the muscular tissues; and, on the contrary, should the knife be carried too superficially, approaching a parallel to the skin, the flap will terminate in a point. Projecting tendons or nerves may be cut off with the scissors.

(3). It is necessary, as far as possible, to select healthy tissues for the formation of the flaps. They may, however, be cut in an engorged or even lardaceous tissue, though in such case they are of course more liable to become gangrenous; indeed, a disarticulation may be performed when no integument remains wherewith to form a flap, the wound becoming ultimately covered with a cicatricial tissue.

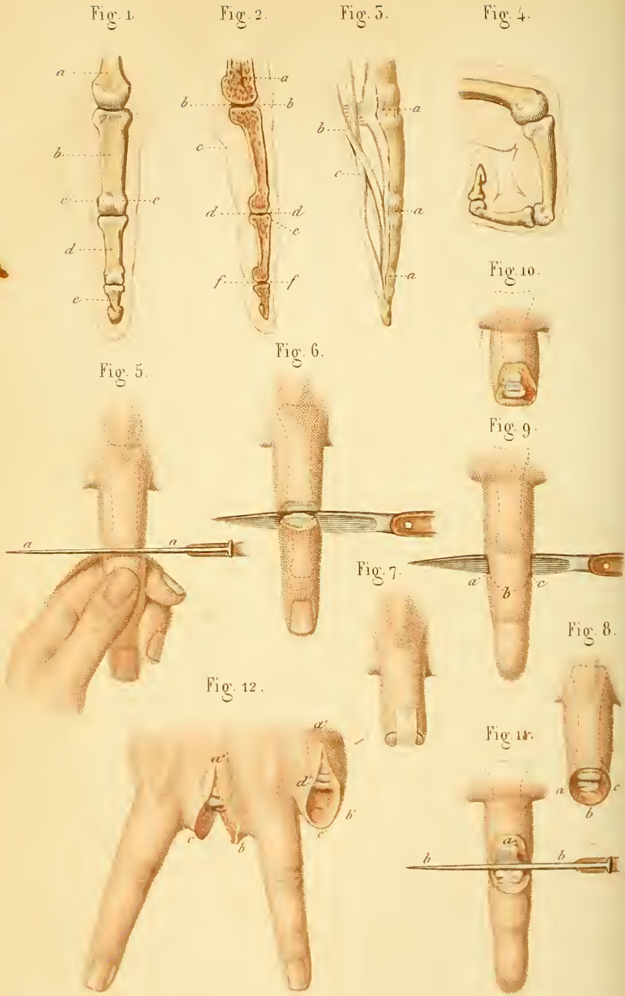


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.

PLATE XVIII.

DISARTICULATION OF TWO LAST PHALANGES OF THE FINGERS AND OF AN ENTIRE FINGER.

ANATOMY.

Fig. 1.—*Palmar view of the bones of a finger.*

a, Inferior extremity of the metacarpal bone ; *b*, shaft of the first phalanx ; *c*, head of the first phalanx ; *d*, second phalanx ; *e*, third or ungual phalanx.

The phalangeal articulations are true ginglymoid, permitting of only flexion and extension.

Each phalanx presents near the joint prominences of some size on the dorsal aspect (Fig. 2, *e*), and on the palmar aspect (Fig. 1, *c c*). To the two lateral ligaments is due the solidity of the joint. The extensor tendon behind and a loose anterior ligament, complete the means of union of a phalangeal articulation. The direction of the articular interspace is neally transverse, and corresponds to the cutaneous fold on the palmer surface, for the articulation of the first with the second phalanx, and to a line one-eighth of an inch below the fold for the articulation of the second with the third phalanx.

Fig. 2.—*Section of the bones of a finger, to show the relations of the joints with the folds of the skin.*

a, Lower extremity of the metacarpal bone ; *b b*, line of metacarpo-phalangeal articulation, situated at an inch or rather more above the level of the digital commissure ; *d d*, first phalangeal articulation at the level of the palmar fold of the skin ; *f f*, second phalangeal articulation about one-eighth of an inch below the palmar fold of the skin.

Fig. 3.—*Union of the phalanges with each other and with the metaoarpal bone.*

a, a, a, Dorsal surface of the joints ; *b*, tendon of the flexor sublimis ; *c*, tendon of the deep flexor.

Fig. 4.—*Bones of a finger flexed, to show the relation of the articulating surfaces during flexion.*

OPERATIONS.

Fig. 5.—*Disarticulation of the second phalanx by dorsal incision.*

First stage.—The joint is entered at once by the blade of the knife.

Fig. 6.—*Same operation.*

Second stage.—After having traversed the articulation the knife is turned beneath the bone, and brought forwards in order to cut a palmar flap.

Fig. 7.—*Operation completed.*

Flap applied to the stump by adhesive plaster. Instead, however, of employing plaster, it is better to adjust the edges of the skin by wire sutures.

Fig. 8.—*Modification of preceding method.*

(See description of the operations.)

Fig. 9.—*Disarticulation of the second phalanx by the palmar surface.*

a, b, c, form to be given to the palmar flap.

Fig. 11.—*Same operation.*

Second stage.—The flap *a* being raised, the joint is entered by the blade of the knife.

Fig. 10.—*Same operation completed.*

Fig. 12.—*Disarticulation of the entire finger.*

a, b, c, Wound formed by the double-flap method ; *a′, b′, c′, d′,* wound formed by the oval method.

DESCRIPTION OF THE OPERATIONS.

1. *Disarticulation of two last phalanges.*

Circular Method.

The hand being pronated, an assistant holds all the fingers flexed, except that to be operated upon. Then the surgeon extends the finger, at the same time holding the extremity with the thumb and index finger of his left hand, and with the knife held firmly makes a circular incision about two-fifths of an inch below the level of the joint if the last phalanx is to be removed, and one-third of an inch if the second phalanx is to be removed. The incision having included only the skin and cellular tissue, an assistant by continued and moderate traction draws back those tissues to the level of the joint, when the operator penetrates the joint by the dorsal surface and divides successively all the ligaments.

Flap Operation.

The method of two lateral flaps, and that of the palmar and dorsal flap are no longer employed, the single flaps being generally substituted.

Disarticulation by the dorsal surface.

The hand being pronated, an assistant holds the sound fingers as far as possible from that to be operated upon. The surgeon seizes the phalanx with the thumb and finger of the left hand and flexes it to an angle of 45°; then, with the knife held in the first position (plate I, fig. 1), he attacks the articulation by the dorsal surface, cutting perpendicularly one-tenth of an inch below the upper margin of the inclined plane formed by the semi-flexion of the phalanx—or, if this sign fails, incising at the level of the palmar fold for the second phalangeal articulation, or one-eighth of an inch below if the terminal phalangeal articulation. At the same time that the capsule of the joint is opened, the knife, guided from heel to point, should cut from left to right a small semicircular flap. Next, the edge of the knife should be carried right and left of the articulation, to divide the lateral ligaments entering the joint easily with the whole blade (Fig. 6). At this moment the operator seizes the phalanx by the sides, and the knife, after having turned around the base of the phalanx, is carried forwards beneath the bone, with its surfaces flat, to the extent of about one-third of an inch, in order to cut a small semicircular flap sufficiently large to cover the stump (Fig. 7). In cutting through the ligaments the operator should avoid cutting the base of the palmar flap.

Disarticulation from the palmar surface.

The hand being supinated, an assistant holds the sound fingers flexed. The surgeon seizes the phalanx with the thumb and index finger of his left hand, in such a manner that the thumb is applied to the end of the palmar surface, and the second phalanx of his index finger upon the dorsal surface of the articulation to be opened; then the operator, holding in the right hand a sharp pointed knife in the first position (plate I, fig. 2), with the blade flat, thrusts through the point of the knife one-eighth of an inch in front of the palmar fold for amputation at the third phalanx, and at the level of the fold for the second phalanx (Fig. 9). The knife now, by pressing and sawing, is carried along the anterior surface of the bone to the extent of about half an inch, after which the edge of the blade is raised, to cut a semilunar flap (Fig. 10). The flap being raised by the assistant, the edge of the knife is next applied perpendicularly, to divide with a single cut the anterior and lateral ligaments, when the instrument traverses the joint and removes the phalanx without making a dorsal flap. If, however, fear should be entertained lest the tissues should retract too greatly, the section of the skin on the dorsal surface might be made at one-tenth of an inch or more below the level of the articulation.

After the above descriptions, it is easy to understand how the surgeon could make, if desirable, two equal flaps, a palmar and a dorsal, or one flap shorter than the other, or even two lateral flaps.

The rules for the disarticulation of the third phalanx of a finger are applicable to the disarticulation of the second phalanx of the thumb

II. Disarticulation of an Entire Finger (Fig. 12.) Method by Two Lateral Flaps.

The hand being pronated, and the neighbouring fingers separated by an assistant, the surgeon ascertains precisely the level of the metacarpo-phalangeal articulation before commencing the operation. To such end he must recollect that the joint is habitually found at one inch, or rather more, above the digital commissure.

Another method, advised by Malgaigne, is to draw on the finger, when the articular surfaces may be slightly separated, and a depression between them may be recognised on the dorsal surfaces.

First Stage.—Having seized the first phalanx of the finger to be removed by the dorsal and palmar surfaces, it is to be flexed to an angle of 45°. With a finger knife held in the first position (Plate I., Fig. 1) the surgeon commences an incision over the articulation, in front of the head of the metacarpal bone, and extends it as far as the level of the digital commissure. The incision in the skin being made, the knife, drawn from heel to point, may be now made to divide in one cut all the tissues down to the bone. Arrived at the level of the digital commissure, as before said, the edge of the knife is to be turned suddenly perpendicular to the finger, so as to round off the extremity of the flap. Then the limb is to be raised, and the operator lowers the handle of the knife in such manner that the heel of the instrument may be made to cut an oblique palmar incision similar to that on the dorsal aspect.

Second stage.—In the preceding stage a single lateral semi-circular flap has been cut, which should be detached from the phalanx. Then the knife, still held in the first position, is to be turned with the blade flat upon the phalanx, and the handle at right angles to the hand of the patient, and carried by sawing and light pressure along the bone towards the articulation, until an obstacle is met with. The obstacle referred to is the base of the phalanx, around which tbe knife is to be carried carefully and without any jerking movement, when it will be made to penetrate the joint with facility.

Third stage.—The articulation is to be traversed by the narrow part of the blade, near to the point—to simplify which ome traction may be made upon the finger in order to enlarges the cavity of the articulation.

The joint being completely separated, the knife is then carried around the base of the phalanx and brought back along the opposite side of the phalanx as far as the digital commissure, and thus by a single cut the second flap is formed. When the double-flap operation is applied to the index or little finger there is only one flap in relation with the digital commissure. The other flap is more liable to retract; it is therefore convenient to give it a greater extent.

Oval Operation.

The surgeon having seized the finger, as in the preceding operation, makes with the heel of the knife an oblique incision, commencing on the dorsal surface at one-fourth of an inch beyond the articulation, and extending it as far as the digital commissure; he then raises the hand, and with the finger in extension continues the incision along the palmar groove which separates the finger from the hand; once arrived at the digital commissure on the opposite side, he again lowers the hand, and flexes the finger, to make the incision join the other extremity one-sixth of an inch below the point at which it was commenced. Then each lip of the wound is to be lightly dissected, and the joint attacked by the dorsal surface—first dividing the extensor tendon and then the lateral ligaments. The finger is now to be still further flexed and drawn upon, so as to loosen the joint, and at the same time the flexor tendons divided, as well as the surrounding soft parts.

The oval method is rarely used for disarticulation of the fingers.

PLATE XIX.

DISARTICULATION OF THE FOUR FINGERS AND OF THE FIRST AND FIFTH METACARPAL BONES.

Operations.

Fig. 1.—*Disarticulation of the four fingers.*

a b' c, Dorsal incision in front of the heads of the metacarpal bones. The knife is passed under the phalanges, to cut a palmar flap.

Fig. 2.—*a b c*, form of the palmar flap.

Fig. 3.—*Disarticulation of the metacarpal bone of the thumb.*

Modification of the oval method; *a b c*, form of incision (called racket incision).

Fig. 4.—The thumb being drawn across the palm of the hand, the disarticulation of the base (*a*) of its metacarpal bone is accomplished.

Fig. 5.—*Lips of the wound adapted.*

Fig. 6.—*Disarticulation of the fifth metacarpal bone.*

Oval method modified.—*a b c*, Form and direction to be given to the incision (called racket).

Fig. 7.—Preceding operation completed—form of the cicatrix.

DESCRIPTION OF THE OPERATIONS.

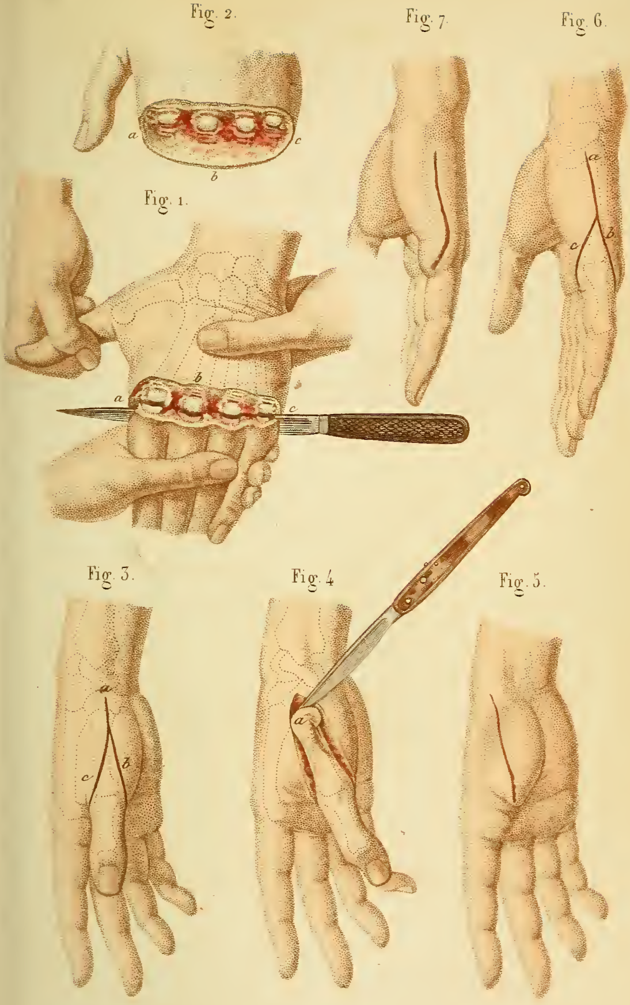
I. Disarticulation of the Four Fingers together.

Flap Operation.

The hand being pronated, the surgeon holds the four fingers in the palm of his hand, with the thumb upon the dorsal surface of the fingers, and moderately flexes them. An assistant stretches the skin, drawing it upwards.

Then with a narrow knife a semilunar incision with the convexity downwards is made, a good half-inch below the extremities of the metacarpal bones. The tendons are exposed by the retraction of the tissues, and are to be cut through—the knife then successively dividing all the metacarpo-phalangeal articulations, severing first the dorsal ligaments, then the lateral, and lastly the palmar. There remains now only to glide the knife beneath the lower surface of the phalanges, in order to

Pl. 19.



cut from behind forwards the palmar flap, which will be limited by the groove which unites the fingers with the palm of the hand.

II. Disarticulation of the Metacarpal Bone of the Thumb.

Oval Method.

The hand being supinated, an incision is made along the outer border of the dorsal surface of the metacarpal bone of the thumb, commencing half an inch above its articulation with the trapezium, and dividing all the tissues as far as the bone. About the middle of the metacarpal bone the incision is to be turned off towards the inner side of the first phalanx, at the level of the interdigital commissure. Then, pronating the hand, the incision is to be carried around the extremity of the metacarpal bone upwards, to join the original incision on the dorsal surface at the middle of the metacarpal bone. Next, the muscles are to be detached on each side of the bone, and after conveniently dissecting back the skin, the carpo-metacarpal joint can be entered by its dorsal surface. Next, luxating outwards the metacarpal bone, the disarticulation is accomplished by dividing the soft tissues which still retain the bone.

III. Disarticulation of the Metacarpal Bone of the Little Finger.

Oval Method.

The hand being forcibly pronated, an incision is commenced at about half an inch above the carpo-metacarpal articulation, and carried downwards in a straight line as far as the inner border of the first phalanx of the little finger, at the level of the digito-palmar groove. The operator now raises the little finger, and following exactly the digito-palmar groove, carries the knife around the base of the little finger and again ascends to the dorsum of the metacarpal bone, there to join the first incision at its lower third. The skin and soft tissues are next detached from the bone, after which the ligaments are destroyed by the point of the knife and the disarticulation is completed.

PLATE XX.

CARPO-METACARPAL AND RADIO-CARPAL DISARTICULATION.

Anatomy.

Fig. 1.

a, lower extremity of the ulnar; *b*, lower extremity of the radius; *c*, *d*, *e*, *f*, *g*, *h*, *i*, bones of the carpus; 1, 2, 3, 4, 5, first second, third, fourth, and fifth metacarpal bones.

The *carpo-metacarpal articulation* represents a broken line, of which the two extremities are easily recognized.

Externally it corresponds to the upper extremity of the first metacarpal bone. It will be sufficient to forcibly adduct this last, in order to make the articular extremity protrude where it is received into the concavity of the trapezium (*i*) and there retained by loose ligaments.

Internally the carpo-metacarpal articulation corresponds to the articulation of the fifth metacarpal bone with the unciform bone (*f*); the prominence of the base of this bone may be recognised beneath the integuments by running the finger along the bone from before backwards, and immediately above the base of the bone is the joint. The unciform apophysis which presents in front the unciform process also assists in recognising the position of the joint, which is to be found immediately beneath it.

The *radio-carpal articulation* is formed by the lower extremities of the radius and ulna, which being slightly concave, receive the convexity formed by the scaphoid (*d*), the semilunar (*c*), and the cuneiform (*e*). The pisiform more in front, and a little below the articular line, forms on the palmar surface of the wrist a prominence, around which the knife must be carefully turned in cutting the palmar flap. The styloid apophyses, that of the radius externally and that of the ulna internally, serve to recognise the joint. The apophysis of the radius descends one-sixth of an inch below that of the ulna, and the joint is found one-fifth of an inch above a line extending from the summit of one to that of the other.

The second cutaneous fold, which is found on the palmar surface of the wrist on leaving the hand, corresponds to the level of the radio-carpal articulation, and becomes of some

Pl. 20.

Fig. 1.

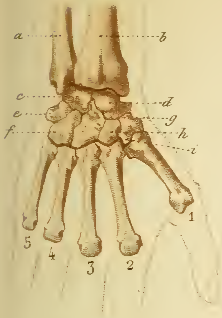


Fig. 3.

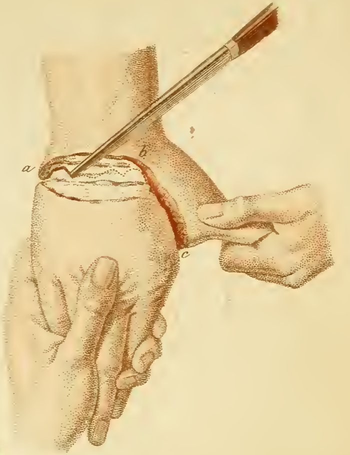


Fig. 2.

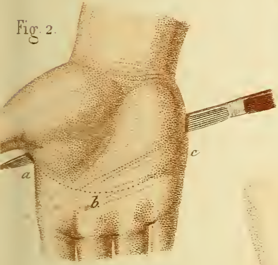


Fig. 6.

Fig. 4

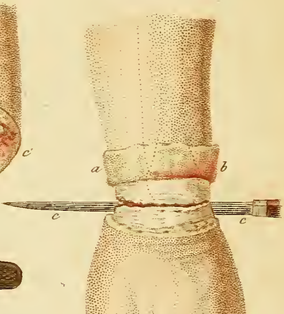
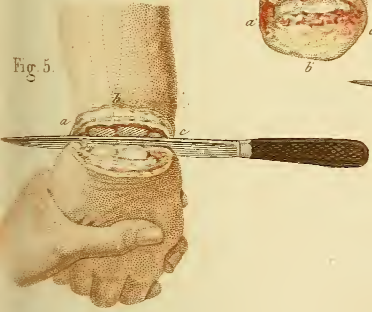


Fig. 5.



importance when the position of the styloid apophyses cannot be determined.

OPERATIONS.

Fig. 2.—*Disarticulation of all the metacarpal bones except that of the thumb.*

a, b, c, form of the palmar flap.

Fig. 3.—*Same operation.*

a, b, c, incision of the integuments on the dorsal surface—the knife penetrating the articulation.

Fig. 4.—*Radio-carpal disarticulation—circular method.*

a, b, sleeve of skin raised ; *c, c,* knife dividing the tendinous structures which surround the joint.

Fig. 5.—*Flap operation.*

a, b, c, semicircular incision on the dorsal surface of the wrist; the knife cutting the palmar flap.

Fig. 6.—*Wound and stump.*

a, b, c, form of the palmar flap.

DESCRIPTION OF THE OPERATIONS.

1. Carpo-metacarpal Disarticulation of the Four Fingers.

Single Flap Operation.

(Figs. 2 and 3.)

(1). The hand being strongly supinated, recognize, on the outer side, the articulation of the trapezium with the second metacarpal bone, and on the inner side the articulation of the unciform bone with the fifth metacarpal.

(2). Thrust through a narrow knife between the bones and the soft parts, passing it a little below the prominences of the unciform and trapezium, so as to bring it out a little below the thumb.

(3). Carry the blade of the knife downwards parallel to the anterior surface of the metacarpal bones, and cut a large palmar flap of elliptical form.

(4). Pronate the hand, and make a semilunar incision on the dorsal surface, carrying the whole blade across at about half an inch below the articulations.

(5). Whilst an assistant retracts the skin upwards, the surgeon holds the metacarpal bones of the patient with his left hand, and proceeds to disarticulate them from behind, commencing with the metacarpal bone of the little finger, or index, according to the hand operated upon.

2. Radio-carpal Disarticulation.

Firstly, the circular method (Fig. 4).

(1). One assistant forcibly retracts the skin of the fore-arm, whilst another holds the hand to be amputated.

(2). The surgeon makes a circular incision through the skin, and strikes the palmar and dorsal eminences.

(3). The skin is dissected and raised in the form of a sleeve as high as the radio-carpal articulation.

(4). A second circular incision is made, dividing the tendons.

(5). The joint is cut through from its dorsal towards its palmar surface.

(6). The styloid processes of the radius and ulna are to be sawn off.

Secondly, the single flap method (Figs. 5 and 6).

The hand being conveniently held in pronation, and the skin of the fore-arm strongly retracted by an assistant, the operator assures himself of the position of the prominences of the radius and ulna, and embracing them with the thumb and index finger of the left hand makes on the dorsal surface of the wrist a semilunar incision, with the concavity downwards, the two extremities of which fall a little below the styloid apophyses of the radius and ulna.

After the division of the skin and cellular tissue, the integuments retract above and below, and leave the wrist bare. Then a second incision in the direction of the articulation divides the extensor tendons and the posterior radico-carpal ligament. The lateral ligaments are next divided, and the knife carried around the bones of the carpus to their anterior surface, in order to cut the anterior or palmar flap, which should be about one inch in length. In order that the knife shall not be arrested in cutting the flap, the edge should be inclined along the integument, so as to avoid striking against the osseous prominences of the carpus, and to avoid cutting away the pisiform bone in the thickness of the flap. With the incision just indicated, the osseous angles are not liable to protrude from the wound, but it is well to saw off the styloid processes; if any tendon be inconveniently long, it may be excised.

Pl. 21.

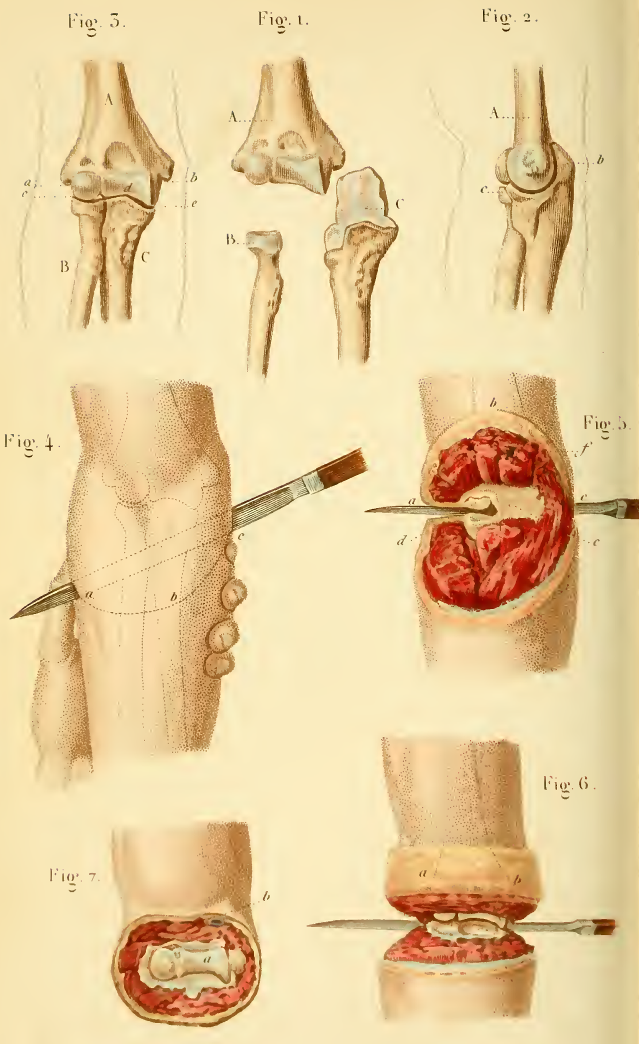


PLATE XXI.

DISARTICULATION OF THE ELBOW.

Anatomy.

Fig. 1.—The articulation is formed by the extremity of the humerus (A), the upper extremity of the radius (B), and the upper extremity of the ulna (C).

Fig. 2.—The radius articulates with the humerus by juxtaposition only; but the ulna receives the trochlea into a cavity formed by the olecranon (*b*) posteriorly, and the coronoid process (*c*) in front. This anatomical disposition allows the joint to be attacked by the full knife only on its outer side.

The osseous surfaces are maintained in contact by anterior, posterior, and lateral ligaments.

Fig. 3.—To recognise the articulation the two condyles must be determined; the internal (*b*) is easily felt beneath the integument; the external (*a*) is less prominent, and indefinitely continuous with the external border of the humerus. The two condyles are situated on a nearly horizontal line (*a b*), to which the shaft of the humerus would be perpendicular. The articular interline (*c d e*) lies below the horizontal line (*a b*), and its two extremities (*c* and *e*) are unequally distant from it. In effect the external extremity (*c*) is about one-third of an inch below the lowest point of the external condyle, whilst the internal extremity (*e*) is three-fifths of an inch below the lowest point of the internal condyle.

Operations.

Fig. 4.—*Flap operation.*—*a, b, c,* form of anterior flap.

Fig. 5.—Anterior flap raised.—*a,* humero-radial articulation opened; *e,* anterior ligament not yet divided over the humero-ulnar articulation.

Fig. 6.—*Circular method.*—*a, b,* sleeve of skin raised.

Fig. 7.—Wound resulting from disarticulation by the circular method. *a,* inferior extremity of the humerus; *b,* section of the brachial artery.

STEPS OF THE OPERATIONS.

1. *Single flap.* (Figs. 4, 5.)

The forearm is to be forcibly supinated and slightly flexed; then the surgeon, standing on the inner side of the limb, embraces with his left hand the lateral parts of the articulation, and lightly draws upwards the skin of the forearm. With a narrow-bladed knife he punctures the limb on the inner side, about one inch below the prominence of the internal condyle, and after carrying the instrument in contact with the bones of the forearm brings it out at a point two inches below the external condyle, cutting an anterior semilunar flap three inches and a half in length. This flap is to be reflected by an assistant, who at the same time retracts the skin of the arm in order to raise up the angles of the wound, and the surgeon carries the knife outwards at the base of the flap, dividing all the tissues, and entering the joint full blade between the humerus and the radius; then with a transverse incision he circumscribes the limb, dividing all the structures on the posterior surface as far as the internal angle of the wound. There now remains only to divide with the point of the knife the anterior and lateral humero-ulnar ligaments, and after dislocating the articulation, to divide the tendon of the triceps.

The great obliquity of the base of the flap, which would appear to result from the direction the knife takes, is effaced on the living subject by the retraction of the tissues, which is much more extensive on the outer than on the inner side.

2. *Circular operation.* (Figs. 6, 7.)

The arm being held as in the preceding operation, the surgeon, standing on the outer side of the limb, divides the skin in a circular manner at three fingers' breadth below the articulation, and then dissects it upwards in the form of a sleeve as high as the joint; after which he divides the anterior muscles, then the lateral ligaments; and disarticulating the joint from before backwards, ends by dividing the tendon of the triceps. In this operation the artery is cut above its bifurcation, and the form of the wound favours an early union.

Pl. 22.

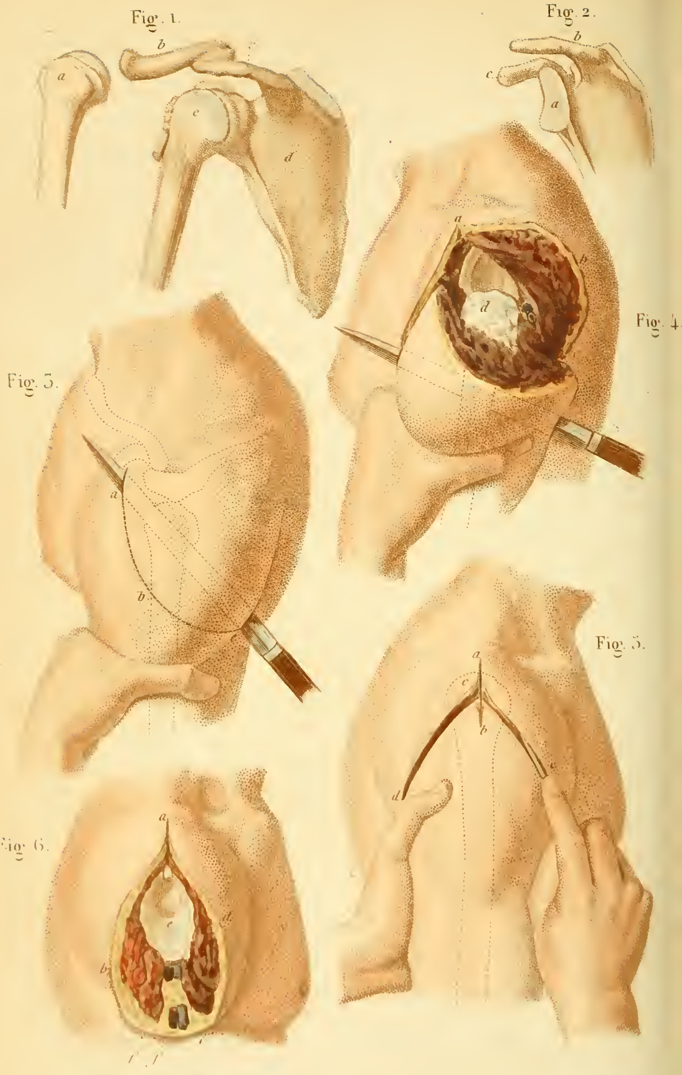


PLATE XXII.

DISARTICULATION OF THE SHOULDER.

Anatomy.

Fig. 1.—*a*, head of the humerus; *b*, clavicle; *c*, acromion process; *d*, infra-spinous fossa of the scapula; *e*, head of the humerus, held in the glenoid cavity by the capsular ligament.

Fig. 2.—*a*, glenoid cavity—an elongated pear-shaped facette which embraces one-third of the head of the humerus; *b*, acromion process; *c*, coracoid process.

The head of the humerus is attached to the glenoid cavity by a loose capsular ligament, which would permit the separation of the articular surfaces, were they not maintained in contact by the action of the several muscles which surround the joint.

The acromion and coracoid processes form an arch which protects the articulation above. The acromion, situated nearly two-fifths of an inch above the glenoid cavity, projects outwards over the joint for more than an inch. The coracoid, lower and more internal, is nearer to the head of the bone.

Operations.

Fig 3.—*a*, *b*, *c*, form of the posterior flap.

Fig. 4.—*a*, *b*, *c*, posterior flap reflected; *a*, head of the humerus disarticulated.

Fig. 5.—*a*, *b*, first incision, vertical; *c*, *d*, posterior incision, starting from the first; *c*, *e*, anterior incision, also starting from the first.

Fig. 6.—*a*, *b*, *c*, *d*, resulting wound of the amputation by preceding method; *e*, glenoid cavity and portions of the capsular ligament; *ff*, axillary vessels.

STEPS OF THE OPERATIONS.

1. *Disarticulation of the shoulder.—Double flap operation.*

(Figs. 3, 4.)

First step.—When the left shoulder is to be disarticulated, the arm is to be raised, and the humerus rotated inwards; then the surgeon assures himself by manipulation of the position of the acromion and coracoid processes, and with a long narrow knife, held nearly parallel with the humerus, punctures the posterior wall of the axilla at its extreme outer part, and immediately below the insertion of the latissimus dorsi and teres major, The knife now passes along the posterior and outer surface of the humerus, and arrives beneath the acromion process. Its point is now slightly altered in direction, made to penetrate the capsule of the joint, and is brought out in front of the clavicle in the triangular space between the acromion and coracoid processes and the clavicle. The deltoid is next seized with the left hand, and the knife descends full blade on the outer side of the humerus, to cut an external or posterior flap about three inches and a half in length. In this flap the knife has divided the tendons of the latissimus dorsi, teres major, teres minor, a large portion of the deltoid, and the capsule of the joint.

Second step.—After cutting this flap, the head of the humerus is easily drawn away from the glenoid cavity, and may be rotated first outwards, then inwards, in order to cut through the attachments of the subscapularis, supra-spinatus, and infra-spinatus. The blade is now passed through the joint behind the head of the bone, and is carried along the inner surface of the bone, to form the anterior or internal flap; at the same time the artery which is contained in the thickness of the flap is readily compressed by the assistant. When the right shoulder is to be disarticulated, the first section is reversed, the knife entering at the clavicular triangle, and brought out in front of the posterior border of the axilla.

2. *Oval method.* (Figs. 5, 6.)

(1.) Make a vertical incision on the outer side of the shoulder, including all the tissues, as far as the bone commencing at the border of the acromion process, and terminating one inch and a quarter below the level of the anatomical neck of the humerus.

(2.) Next make two oblique incisions, starting from the first, which, the one anterior and the other posterior, shall cut respectively the integuments and fleshy parts of the anterior and posterior walls of the axilla, close to their humeral insertions.

(3.) Turn aside the tissues and open the joint, at the same time drawing lightly upon the bone, so as to separate the head from the glenoid cavity.

(4.) Luxate the bone, passing the knife behind it, and complete the operation by cutting the tissues which correspond to the pit of the axilla, and in which are contained the axillary vessels compressed by the hand of the assistant. The wound resulting from this operation is a veritable oval.

Fig. 1.

Fig. 3.

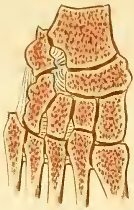


Fig. 2.

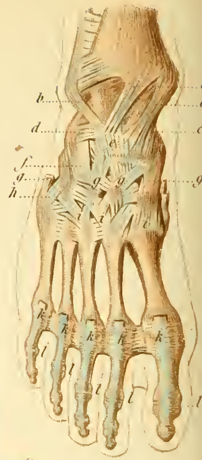


Fig. 4.

Fig. 6.

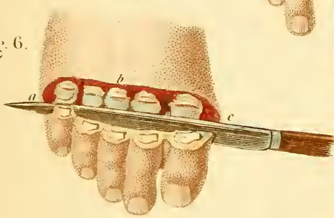


Fig. 5.

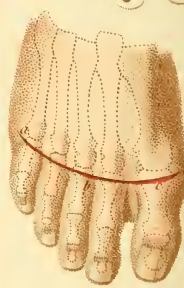


Fig. 9.

Fig. 7.

Fig 8

PLATE XXIII.

DISARTICULATION OF THE TOES.

Anatomy.

Fig. 1.—*Osteology of the foot—dorsal surface.*—*a* and *b*, inferior extremities of the tibia and fibula ; *c*, astragalus ; *d*, os calcis ; *e*, scaphoid ; *f*, cuboid ; *g*, internal cuneiform ; *h*, middle cuneiform ; *i*, external cuneiform ; 1, 2, 3, 4, 5, first, second, third, fourth, and fifth metatarsal bones ; *k*, phalanges.

Fig. 2.—*Ligaments in the dorsal surface of the foot.*—*a*, *a*, anterior tibio-astragaloid ; *b*, anterior fasciculus of external lateral ; *c*, internal calcaneo-scaphoid ; *d*, calcaneo-astragaloid ; *e*, superior astragalo-scaphoid ; *f*, superior calcaneo-cuboid ; *g*, *g*, *g*, scapho-cuneiform ; *h*, cubo-metatarsal ; *i*, *i*, *i*, cuneo-metatarsal ; *k*, metatarso-phalangeal articulations ; *l*, lateral ligaments of the phalangeal joints.

Fig. 3.—*Horizontal section of the tarsal bones ; inter-osseous ligaments.*

Operations.

Fig. 4.—*Disarticulation of the first and third toe.*—*a*, *b*, *c*, *d*, wound resulting from disarticulation by the oval method ; *e*, head of the first metatarsal bone ; *f*, *g*, *h*, wound resulting from disarticulation by the double flap operation ; *i*, head of the third metatarsal bone.

Fig. 5.—*Disarticulation of the five toes.*—*a*, *b*, *c*, form and direction of the incision to be made in front of the heads of the metatarsal bones.

Fig. 6.—The integuments being retracted, the knife glides beneath the toes to cut a plantar flap.

Fig. 7.—Wound resulting from preceding operation.—*a*, *b*, *c*, form of the plantar flap.

Fig. 8.—*Disarticulation of the first metatarsal bone.*—*a*, *b*, *c*, *d*, racket form incision.

Fig. 9.—*a*, *b*, *c*, incision for removal of the first metatarsal bone by disarticulation, without the toe (see resections).

STEPS OF THE OPERATIONS.

1. *Disarticulation of a single toe.* (Fig. 4.)

The description of the disarticulation of the fingers is in every respect applicable to that of the toes, so that it is unnecessary here to repeat. It may be well to state, however, that the oval operation is most commonly employed, because a toe is generally removed in its entirety, the small size and inutility of the phalanges not indicating their preservation as in the hand.

Many surgeons advise, in the disarticulation of the great toe (fig. 8), the removal at the same time of the head of the metatarsal bone, otherwise its prominence produces a deformity which is painfully irritated by the shoe. (See resections for this special case, and for amputation of the metatarsal bones.)

2. *Disarticulation of the five toes.—Flap operation.* (Figs. 6, 7.)

(1.) The operator, grasping all the toes in his left hand, makes, with a narrow knife, a semicircular incision extending on the left foot, or on the right foot *vice versa*, from the inner side of the head of the first metatarsal bone to the outer side of the head of the fifth, passing in front of their articulations with the phalanges (fig. 5).

(2.) With the point of the knife the articulations are to be successively opened, and the ligaments divided. (3.) The knife is then to be glided beneath the bases of the phalanges, to cut with the full blade a plantar flap (see fig. 6).

Pl. 24.

Fig. 1 bis

Fig. 1.

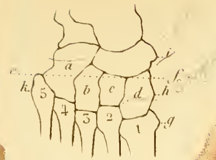


Fig. 2.

Fig. 3.

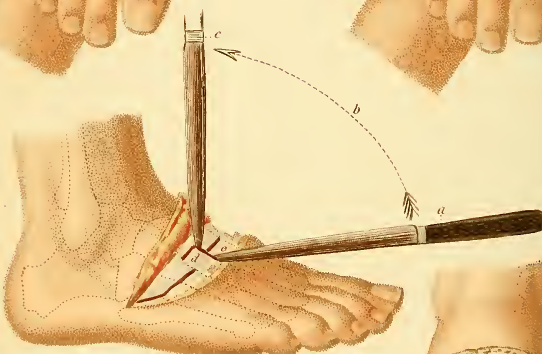


Fig. 4

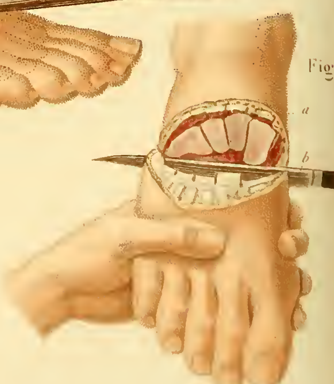


Fig. 5.

PLATE XXIV.

TARSO-METATARSAL DISARTICULATION. (HEY'S OR LISFRANC'S OPERATION.)

Anatomy.

Fig. 1.—The tarso-metatarsal articulation—formed behind by the cuboid (*a*) and the three cuneiforms (*b*, *c*, *d*); in front by the five metatarsal bones—presents an irregularly curved line, the direction and sinuosities of which should be well understood.

Externally the cuboid (*a*) articulates with the fifth and fourth metatarsal bones, the line running obliquely from without inwards, and from behind forwards. This line is slightly broken, the articulation with the fourth metatarsal being more transverse than that with the fifth. About one-twelfth of an inch more in front is the articulation of the third metatarsal bone with the external cuneiform (*b*); again, one-eighth of an inch to the rear is the articulation of the second metatarsal bone with the middle cuneiform (*c*); lastly, about one-third of an inch in front of the preceding is the articulation of the first metatarsal bone with the internal cuneiform (*d*).

This anatomical disposition presents to the notice of the operator two essential points:—(1) The internal extremity of the tarso-metatarsal articulation situated nearly three-quarters of an inch in front of a line (*e*, *f*) drawn transversely from the external extremity. (2) The base of the second metatarsal bone morticed in by the three cuneiform bones.

The dorsal cubo-metatarsal and cuneo-metatarsal ligaments are connected with the bones at some distance either in front of or behind the articular interline, a disposition which admits of a separation at the joints when the ligaments are divided not precisely at a level with the interline. The inter-osseous ligaments, more powerful on the plantar than on the dorsal surface, are easily divided; those, however, which are connected with the second metatarsal bone in the mortice—the veritable key of the articulation—offer a resistance which necessitates a particular manœuvre for their division.

In order to recognise the articulations, (1) On the inner side, follow with the finger, from before backwards, the inner side of the first metatarsal bone as far as the tuberosity (*g*); a tenth to a twelfth of an inch behind this is the articular interline corresponding to an indentation between the tuberosity (*g*) and the tuberosity (*h*) of the internal cuneiform. Again the articulation may be found at about an inch in front of the tuberosity of the scaphoid bone (*i*).

(2.) On the outer side, follow with the finger, from before backwards, the outer side of the fifth metatarsal bone as far as the tuberosity (*k*); the joint commences immediately behind and internal to this, but in some cases this tuberosity projects beyond the articulation.

Operation.

Fig. 1 *bis* (repeated).—*a*, *b*, *c*, form and direction of the incision to be made in front of the tarsal bones.

Fig. 2.—*a*, *b*, *c*, dorsal tarso-metatarsal ligaments divided.

Fig. 3.—Operative manœuvre for luxating the key of the articulation. *a*, *b*, *c*, arc of a circle described by the knife; *d*, second metatarsal bone; *e*, first metatarsal.

Fig. 4.—Dorsal artery of the foot. The knife, *b*, cuts the plantar flap.

Fig. 5.—*a*, *b*, *c*, *d*, wound resulting from the amputation; *a*, *b*, *c*, form of the plantar flap.

STEPS OF THE OPERATION.

First step.—The foot must project beyond the bed or couch on which the patient lies. The surgeon assures himself, by the anatomical points indicated, of the precise position of the joints; then, in the case of the right foot, he grasps with the palm of the left hand the plantar surface of the foot, his thumb being placed on the posterior and outer extremity of the fifth metatarsal bone, and his indicator or middle finger on the line of articulation between the cuneiform and first metatarsal bones. Then, with the knife in the right hand, he makes from without inward, on the dorsal surface, a semilunar incision, with the convexity forward, passing about two-thirds of an inch below the joints, dividing all the tissues as far as the bones, and connecting the two extremities of the articulation.

Second step.—The surgeon carries the point of the knife on the outer side of the articulation, there penetrates and opens the joint as far as the external cuneiform bone. He now carries the point of the knife one-twentieth of an inch forward, incises transversely, and opens the articulation as far as the second metatarsal bone. He next attacks the articulation of the first metatarsal bone (fig. 2).

Third step.—It remains to destroy the mortice which engages the head of the second metatarsal bone within the bones of the tarsus. For this purpose the point of the knife is introduced between the internal cuneiform bone and the second metatarsal, in such a manner that the cutting margin is turned upwards, and inclined at an angle of forty-five degrees with the toes; then the knife is raised to a right angle, at the same time passing along the inner side of the mortice to divide the internal inter-osseous ligament. Now the surgeon withdraws the knife, and with its point divides the posterior and external dorsal ligaments of the mortice.

Fourth step.—All the means of union being divided, light pressure is applied to the end of the foot to separate the articular surfaces, and the inter-osseous ligaments which still remain intact are successively divided. Next the plantar ligaments are cut through, and the knife glided beneath the bases of all the metatarsal bones, avoiding the tuberosities of the first and fifth. There remains only to cut the plantar flap, two inches and a half long on its inner side, and one inch and a half on its outer.

PLATE XXV.

MEDIO-TARSAL DISARTICULATION, TERMED CHOPART'S.

Anatomy.

Fig. 1.—The medio-tarsal articulation—formed posteriorly by the astragalus (*a*) and the calcaneum (*b*) ; in front by the cuboid (*c*) and the scaphoid (*d*)—presents a transverse articular line curved like an italic *S*, of which the anterior convexity is internal, and the posterior convexity external. The *internal extremity* of the articulation is about one inch in front of the internal malleolus (*g*), and one-fifth of an inch behind the tuberosity (*h*), of the scaphoid.

The *external extremity* (*i*) is three-fifths of an inch behind the tuberosity (*j*) of the fifth metatarsal bone. It corresponds to a prominence which the cuboid forms where articulating with the calcaneum, a prominence situated on the outer border of the foot, about an inch in front of the external malleolus (*k*).

The middle part of the articulation is immediately in front of the head of the astragalus, which can be made prominent by bearing strongly the point of the foot downwards. External to this prominence is a cavity, readily detected by the finger, between the astragalus, the cuboid, and the calcaneum. Under this is the articulation.

In order to enter the joint, it is necessary to understand the different obliquities of the articular surfaces. The pin (*l*), introduced between the astragalus and the scaphoid, indicates the direction to be taken by the knife when attacking the articulation from its inner side. The pin (*m*), introduced between the calcaneum and the cuboid, on a level with the prominence described above, indicates the direction to be taken by the knife when the joint is to be opened on its outer side.

Fig. 2.—When introduced into the joint, the knife follows the osseous surfaces between the astragalus (*a*) and the scaphoid (*b*); first obliquely forward (*c*), then raised perpendicularly (*d*).

Fig. 3.—If operating on the right foot, the knife, at first held

Pl. 25.

Fig. 1.

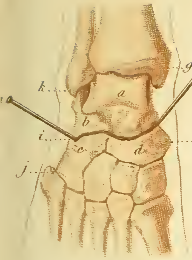


Fig. 2.

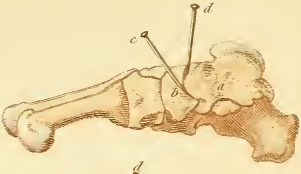


Fig. 3.

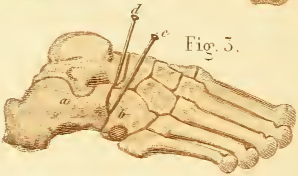


Fig. 4.

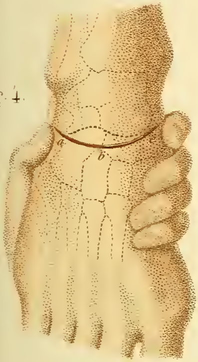


Fig. 5.

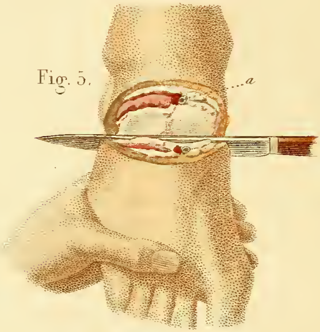


Fig. 6.

Fig. 7.

somewhat obliquely (*e*), will be elevated a little (*d*) between the calcaneum (*a*) and the cuboid (*b*) when attacking the joint on its outer side. The internal ligament which occupies the centre of the region, and which unites three bones, and holds the four together, should be divided by the point of the knife as soon as the separation of the bones will permit. In old subjects it is sometimes ossified, a peculiarity which necessitates the use of the saw. The other ligaments require no further notice.

Operations.

Fig. 4.—Ordinary operation.—a, b, c, form and direction of the incision in front of the joint.

Fig. 5.—The joint opened, the knife cutting the plantar flap. *a*, dorsal artery of foot.

Fig. 6.—a, b, c, form of the plantar flap; *d* and *d'*, dorsal and plantar arteries.

Fig. 7.—Sedillot's operation.—a, b, c, form of the anterior incision.

STEPS OF THE OPERATIONS.

Chopart's Medio-tarsal Disarticulation. (Figs. 4, 5.)

1. *Ordinary operation.*—(1.) The line of articulation having been made out as already explained, grasp the sole of the foot with the palm of the left hand, placing the thumb on the outer side of the articulation (if it be the right foot), and the index or middle finger on the tuberosity of the scaphoid. (2.) Make a semilunar incision, extending from the thumb to the index, across the dorsum of the foot, and descending three-fifths of an inch below the joint. (3.) After having retracted the integument, the knife must be carried back in the wound, to divide the tendons, and to open the articulation; the directions of the articular surfaces already pointed out must be recollected, and care must be taken to divide all the fibrous bands which unite the scaphoid with the astragalus, by the whole blade, without attempting to penetrate the joint with the point of the knife, a movement which is rendered impossible by a slender ledge of the scaphoid bone overlapping the head of the astragalus. (4.) Gentle pressure with the left hand upon the foot enables the surgeon to

define more clearly the line of the articulation, and also to distinguish fibrous bands which may yet remain uncut. (5.) The articulation being freely opened, and all the means of union divided as far as the plantar surface, the blade of the knife is passed behind the bones, and the fore part of the foot bent at a right, angle, in order that it may be glided beneath them ; then returning the foot to its natural position, the plantar flap is cut, the knife being brought out at a point one-fourth of an inch in front of the sesamoid bones. In cutting this flap, care must be taken to prevent the blade being arrested by the projecting portions of the scaphoid, cuboid, and first and fifth metatarsal bones.

2. *Operation of M. Sedillot.* (Figs. 6, 7.)

After having recognized the outline of the articulation, a transverse incision is to be made, starting from a point a little in advance of the calcaneo-cuboid articulation, and terminating in the middle of the dorsum of the foot, external to the tendon of the tibialis anticus. From this point a second incision is to be made obliquely from behind forwards, and from without inwards, which will extend to a point two fingers' breadth short of the metatarso-phalangeal joint of the great toe : this incision is now to be continued from within outwards, on the plantar surface obliquely, to join the first incision near the calcaneo-cuboid articulation. The integuments and cellulo-fatty tissue alone are to be divided. The internal flap thus formed is next to be dissected back as far as the tubercle of the scaphoid bone, behind which the joint is to be entered. There remains now to disarticulate in the ordinary manner, and to terminate the operation by cutting through the deeper tissues at the level of the plantar incision.

Fig. 3.

Fig. 1.

Fig. 5.

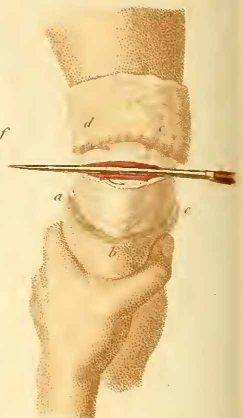


Fig. 2.

Fig. 4.

Fig. 6.

PLATE XXVI.

Anatomy.

Fig. 1.—*Tibio-femoral articulation, anterior surface.* *a*, femur ; *b*, patella ; *c*, tibia ; *e*, fibula ; *g*, external lateral ligament ; *f*, internal ligament ; *d*, inferior patellar ligament.

Fig. 2.—Antero-posterior vertical section, showing the crucial ligaments, *d*, and the popliteal artery, *e* ; *a*, femur ; *b*, tibia ; *c*, patella.

This articulation presents some important anatomical peculiarities. The internal condyle of the femur descends lower than the external by two-fifths of an inch. Both are received into concave facettes on the tibia ; the semilunar cartilages adherent to the tibia fill up the space of the glenoid cavity in which each condyle rolls. The popliteal artery (fig. 2, *e*), lodged in the posterior intercondyloid space, is in immediate contact with the posterior surface of the articulation.

The means of union are—in front, the superior and inferior patellar ligaments ; on the sides, the external and internal lateral ; behind, the posterior ligament. Independently of the exterior ligaments, two crucial ligaments, strong and resisting, maintain the osseous surfaces in contact, and limit their movement.

In order to recognize the line of articulation, (1) the head of the fibula must be felt ; the articulation is about four-fifths of an inch above. (2) The femur presents, upon the lateral surfaces of its condyles, two tubercles, the most prominent points of which may be easily felt beneath the integument ; at about four-fifths of an inch below each is the joint. Finally, (3) the lower border of the patella is at the level of the articulation.

Operations.

Fig. 3.—*Disarticulation of the knee—flap operation.*

a, *b*, *c*, form of the anterior incision.

Fig. 4.—Same operation. Articulation opened, the knife cuts the posterior flap. *a*, *b*, *c*, form of the flap.

Fig. 5.—Disarticulation of the knee—circular method.

a, b, c, section of the skin ; *d, e*, sleeve of skin raised; the knife enters the articulation anteriorly.

Fig. 6.—Disarticulation of the knee—oval method.

a, b, c, oblique section of the skin ; *d, e*, the skin raised; the knife enters the joint from before backwards.

STEPS OF THE OPERATIONS.

1. *Disarticulation of the knee—flap operation.*—(1) The leg being extended, make a semilunar incision in front of the knee, and below the patella, extending from one condyle of the femur to the other. (2) Flex the knee, and make a second incision in the line of the first, freely opening the joint. (3) Divide the lateral and the crucial ligaments. (4) Carry the blade of the knife behind the tibia and the fibula, and cut a flap at the expense of the muscles of the calf, of sufficient length to cover the wound —about four inches.

2. *Circular method.*—(1) Make a circular incision through the skin and cellular tissue around the leg, three or four fingers' breadth below the patella. (2) Dissect up the skin and cellular tissue as high as the condyles of the femur. (3) The sleeve of skin being held up by an assistant, flex the knee, and carry the blade of the knife through the ligamentum patella, to open the joint ; then cut through all the ligaments ; and finally, with one incision, sever the nerves, vessels, and muscles of the popliteal space at the level of the articulation.

3. *Oval method* (Fig. 6).—Trace a line in ink, starting from the crest of the tibia, three fingers' breadth below the ligamentum patellæ, and carrying it obliquely backwards and upwards towards the popliteal space to a point two fingers' breadth below a line exactly corresponding to the ligamentum patellæ. (2) Continue the line behind the leg and on the other side in a similar manner, to the starting-point on the crest of the tibia. (3) Let the knife follow this line, dividing the skin and cellular tissue only. (4) Dissect the skin and cellular tissue as high as the condyles of the femur. (5) Disarticulate the joint, as in the circular operation.

Fig. 1.

Fig. 2.

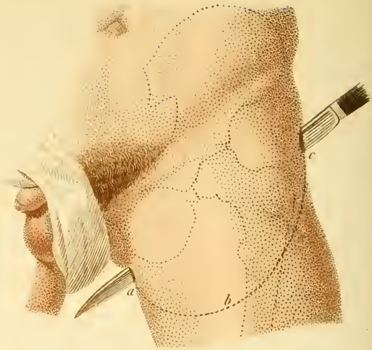


Fig. 3.

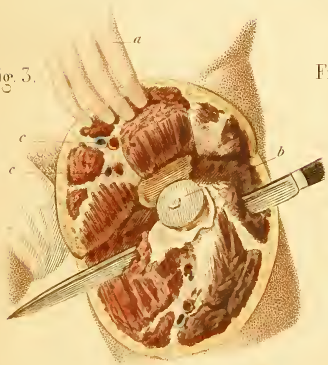


Fig. 5.

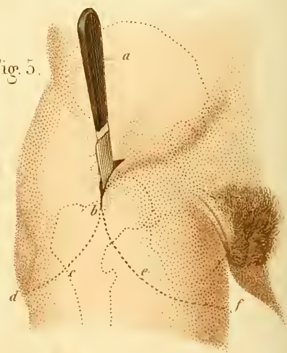


Fig. 4.

Fig. 6.

PLATE XXVII.

DISARTICULATION OF THE THIGH.

Anatomy.

Fig. 1.—*a*, Internal iliac fossa ; *a'*, femoral artery; *b*, femur ; *c*, head of femur covered by the capsular ligament ; *d*, anterior superior iliac spine ; *e*, anterior inferior iliac spine ; *f*, spine of the pubes ; *g*, tuberosity of the ischium ; *h*, lesser trochanter. The ilio-femoral articulation is formed by the acetabulum and the head of the femur ; the head of the femur is not completely received into the cotyloid cavity, but is maintained there by a large and resisting capsular ligament, and by the round ligament, a fibrous cord which attaches the head of the femur to the depth of the cavity. The capsular ligament is attached to the anterior inferior iliac spine and to the circumference of the cotyloid cavity. It must be incised very near its cotyloid attachments, cutting around the prominence of the acetabulum in order to easily disengage the head of the femur. The plane of the circumference of the cotyloid brim looks obliquely forwards and downwards, whence it results that the head of the femur is more covered behind than in front, a point which it is well to know in order not to be misled by the cotyloid prominence when attacking the joint from behind. In order to recognise the articulation, we must be guided by the following anatomical data:—

1. The anterior inferior iliac spine is four fifths of an inch above the circumference of the cotyloid cavity ; the anterior superior iliac spine is nearly two inches above the same cavity, and four-fifths of an inch external to it.

2. When the patient is standing, an oblique line passing from the anterior superior iliac spine to the tuberosity of the ischium traverses the cotyloid cavity at the junction of its posterior third with its anterior two-thirds.

3. The anterior rim of the cotyloid cavity is one inch and a half external to the spine of the pubes.

4. The axis of the horizontal ramus of the pubes prolonged by an imaginary line would traverse the cotyloid cavity at the junction of its upper with its middle third.

5. The superior border of the great trochanter is on a level with the upper third of the ilio-femoral articulation.

This articulation, superficial in front, where it is only covered by the psoas and iliacus, and the vessels, is protected internally and behind by a considerable mass of muscles; externally the muscular mass is less abundant.

The *femoral artery* (A′) passes in front of the joint, on a level with the junction of the middle third with the internal third of the head of the femur; lower down it approaches the shaft of the femur, and crossing behind it becomes the popliteal artery.

Operations.

Fig. 2.—*Disarticulation of the thigh—flap operation.* — The knife transfixed from without inwards cuts the anterior flap, *a*, *b*. *c*.

Fig. 3.—*Same operation.*—The flap is raised by the hands of an assistant, who compresses the vessels in his grasp; the head of the femur, *b*, is luxated, and the knife passed behind it to cut the posterior flap; *c*, *c*, section of the femoral vessels.

Fig. 4.— *Wound resulting from the preceding operation.*—*a*, *b*, *c*, the anterior flap raised; *a*, *d*, *c*, posterior flap; *e*, cotyloid cavity; *f*, *f*, section of femoral vessels.

Fig. 5.—*Same operation, with lateral flaps.*—The knife, *a*, is transfixed in such a manner as to cut successively two flaps, the one internal, *b*, *c*, *f*; the other external, *b*, *c*, *d*.

Fig. 6.—*Same operation.*—The internal and external flaps being cut, the head of the femur is disarticulated.

STEPS OF THE OPERATIONS.

1. *Single flap operation.*—The patient is arranged with the buttocks projecting beyond the table. If the left limb is to be operated upon, the knife is plunged in at a spot midway between the anterior superior spine of the ilium and the great trochanter, and carried deeply, parallel with the fold of the groin, grazing the neck of the femur, and transfixing the capsular ligament as it passes, to be brought out at a point one inch below and in front of the ascending ramus of the ischium. Then the blade of the knife is carried down the limb parallel with the femur, to cut

an anterior semilunar flap five inches in length. An assistant, who has his thumb compressing the femoral artery on the pubes, thrusts his fingers into the wound as the knife proceeds, and raises the flap as soon as it is cut, now grasping the femoral vessels in its thickness. A second assistant, who holds the leg with his right hand, and the lower part of the thigh with his left, now abducts the thigh, rotates it outwards, and forcibly extends the hip joint, so as to make the head of the femur prominent within the capsule. The surgeon next rapidly cuts through the capsule, and the head protrudes, exposing the ligamentum teres, which is at once cut, together with posterior fibres of the capsular ligament, and the dislocation of the bone completed. The second assistant now draws upon the leg so as to increase the space between the head of the femur and the haunch bone, and at the same time adducts and rotates the limb inwards, to bring the trochanter major to the front. In this position the surgeon can easily divide the muscles connecting the trochanter with the trunk, and he now carries the knife backwards between the femur and the haunch bone, and divides the soft tissues vertically, without making a posterior flap.

There are some modifications of the flap operation: thus, Larrey tied the femoral artery before commencing the operation; Ashmead cut the anterior flap from the skin downwards into the deeper tissues; Lenoir, after making the anterior flap, cut the structures behind by a circular incision before proceeding to disarticulate; Lalouette and Delpech made an internal instead of an anterior flap.

2. *Double lateral flap operation.* (Figs. 5, 6.)

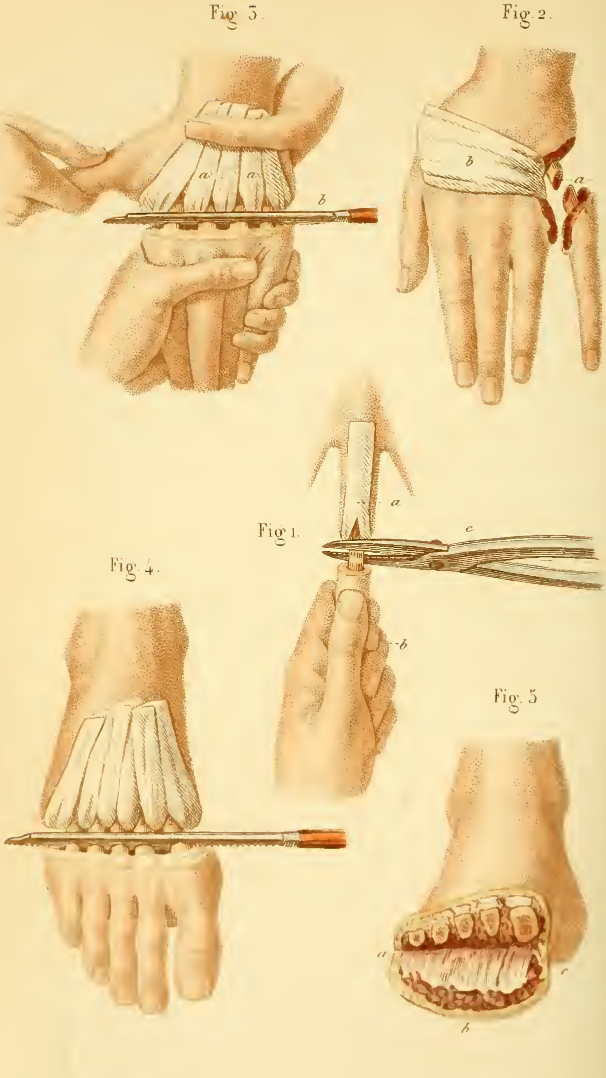
The patient lying with the buttocks projecting beyond the bed, the surgeon proceeds to make out the exact position of the anterior and external parts of the joint according to the anatomical data above given. He then thrusts in the knife immediately to the outer side of the articulation, with the edge of the blade towards the great trochanter, making the point to pierce immediately below the tuberosity of the ischium. As the knife is about to penetrate the posterior surface of the thigh, an assistant draws the skin outwards, in order to increase the size of the outer flap. By a sawing movement the knife is now turned around the great trochanter, and then along the outer side of the femur to cut an external flap (*a*, *b*, *c*, fig. 6), about two and a half to three inches in length.

To form the internal flap, the soft parts are drawn inwards by an assistant, and the knife, with the edge directed downwards, is thrust through the limb, entering in front immediately beneath the head of the femur on the inner side of the neck of the bone, and passing out posteriorly in the posterior superior angle of the former incision: care is to be taken not to strike the point of the knife against the pelvis. The knife is now carried downwards, grazing the inner surface of the bone, and avoiding the lesser trochanter, to cut an internal flap (*d*, *e*, fig. 6), the same length as the outer flap. The flaps are to be pressed aside by an assistant, and the arteries tied, and the surgeon, seizing the femur with his left hand, draws the edge of the knife down the capsular ligament, over the head of the bone, and opening the joint, completes the disarticulation.

3. *Oval operation.*

The patient lying upon the sound side, (1) the point of the knife is thrust in half an inch above the great trochanter, and cuts its way obliquely downwards and outwards to a point a little below the tuberosity of the ischium. (2) The knife, again replaced in the upper angle of the wound, is cut obliquely downwards and inwards over the femur to the same extent. (3) The outer muscles are divided as deeply as possible, after which the articulation is attacked on its outer aspect, and the femur luxated outwards. The joint is traversed by the knife to reach the inner side of the femur. Now an assistant compresses the vessels in the anterior flap, whilst the surgeon, having the heel of the knife in the extremity of the second incision, and the point in the extremity of the first incision a little below the tuberosity of the ischium, and the blade of the knife internal to the shaft of the femur, cuts downwards an anterior flap.

Pl. 28.



AMPUTATIONS IN THE CONTINUITY OF THE BONES.

PLATE XXVIII.

AMPUTATIONS OF THE FOOT AND HAND.

Operations.

Fig. 1.—*Amputation of a phalanx.*—*a*, a tape or small bandage to retract the soft tissues; *b*, position of the left hand of the operator seizing the extremity of the finger, whilst the right, armed with Liston's bone forceps, *c*, severs the bone.

Fig. 2.—*Amputation of the fifth metacarpal bone.*—*a*, the bone sawn obliquely from above downwards, and from within outwards, the hand being pronated; *b*, bandage protecting the soft parts from the saw.

Fig. 3.—*Amputation of four inner metacarpal bones—circular method.*—*a a*, tapes passed between the bones in order to draw back the soft parts whilst the bones are sawn through.

Fig. 4.—*Amputation of the metatarsal bones—plantar flap operation.*—Tapes are passed between the bones as in amputation of the metacarpal bones.

Fig. 5.—*Same operation completed.*—*a*, *b*, *c*, form of the plantar flap.

STEPS OF THE OPERATIONS.

1. *Amputation of phalanges.* (Fig. 1.)

The circular method is generally employed. After cutting through the skin by a circular incision, it is to be dissected upwards a quarter of an inch; the tissues surrounding the bone are then divided, particularly the tendinous sheaths on the palmar surface; after which the bone may be cut through with a watchmaker's saw, or with the bone forceps. The skin is to be drawn down over the osseous extremity, and the sutures applied to form a transverse cicatrix, a position the least exposed to injury in flexion of the fingers.

2. *Amputation of a metacarpal bone, and of the finger which it supports.*

It is convenient in this case to employ the oval operation, absolutely the same as in the dislocation ; only, when the bone is uncovered, a piece of wood or cardboard should be passed behind it to keep off the tissues, and protect them from the saw. The saw employed is one of small size, termed the metacarpal saw. The fifth metacarpal bone should be cut obliquely from within outwards, and the second obliquely from without inwards.

It is difficult to use the saw in dividing the third or fourth metacarpal bone, bone forceps are therefore substituted. Experience shows that whether the forceps or the saw is used is a matter of no import so far as concerns cicatrisation.

3. *Amputation of the four metacarpal bones.* (Fig. 3.)

A flap is made in the palm, and the operation performed is precisely the same as for disarticulation of the four fingers, (see Plate xx., fig. 2) ; then with a narrow finger knife the bones should be freed of their muscles and periosteum ; after which a five-headed bandage may be arranged in the inter-osseous spaces to protect the tissues from the saw.

4. *Amputation of a single metatarsal bone, and of the toe which it supports.*

The operation is the same as for disarticulation of a metatarsal bone ; only, instead of dissecting the bone as high as its articulation, it is denuded only as far as the point where it is intended to resect it. The oval operation is the most convenient and generally adopted. The first and fifth metatarsal bones are to be bevelled in such manner that the point of the bevel lies on the side of the neighbouring metatarsal bone, and cannot, consequently, wound the integuments.

5. *Amputation of all the metatarsal bones.* (Figs. 4, 5.)

The plantar flap is to be first cut. For this purpose, the knife may be passed through the sole of the foot at the point at which it is intended to sever the bones, and drawn forwards to cut a flap one and a half to two inches in length ; then the two extremities of the base of the flap are to be united by a semilunar incision across the dorsum of the foot, dividing the skin and extensor tendons about half an inch below the line at which the bones are to be cut. The flap is to be raised, the skin on the dorsum of the foot retracted, and the bones denuded, and then with a saw all the bones divided simultaneously from the dorsal surface towards the sole of the foot.

Pl. 29.

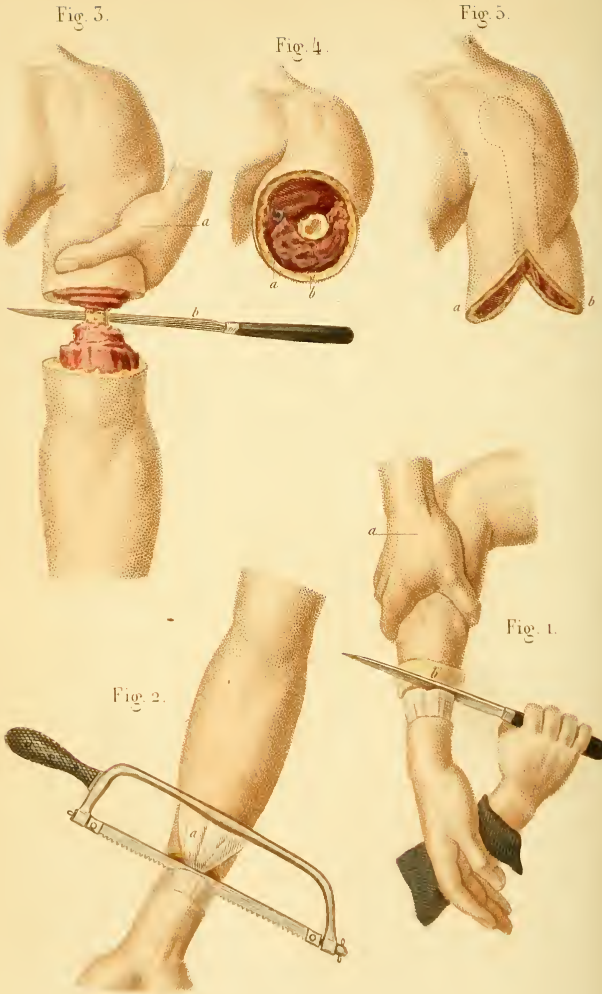


PLATE XXIX.

AMPUTATION BY A LONG AND SHORT RECTANGULAR FLAP. (TEALE'S OPERATION.)

There is a variety of the flap operation introduced by Mr. Teale, and by him termed amputation by the long and short rectangular flap, which is applicable to any amputation in the continuity of the bones, and may therefore be here described once and for all.

It consists of two flaps, which involve all the tissues down to the bone, the anterior being four times the length of the posterior, and great stress is laid by the originator on the necessity of avoiding any large bloodvessel or nerve in the formation of the anterior flap, which it will be seen forms the main cushion beneath the cut ends of the bones.

Each flap is quadrangular, and corresponds to one half the circumference of the limb. Two lateral incisions, one on each side the limb, are first made, commencing at the point where it is intended to divide the bone, and carried downwards to a distance measured precisely equal to one half the length of the circumference of the limb. The lower extremities of these two vertical lines are united by a cross cut over the front of the limb, carried through all the tissues down to the bone. The anterior flap thus marked out is to be dissected up from the bone or bones as high as the point where the limb is to be amputated, and where the vertical lines commenced.

In making the posterior flap, the knife is carried in one sweep through the skin and tissues down to the bone at a point measured down the vertical lines one-fourth their length, and the flap is then to be dissected up to the same level as the an terior flap, so that the posterior flap is one-fourth the length o the anterior. When the skin is approximated by sutures, the anterior flap wraps around the ends of the bones, and the junction of the flaps is in a dependent position convenient for the escape of pus.

In making the vertical incisions, the main arteries can generally be avoided ; for instance, in the arm or thigh, the internal incision would be immediately in front of the line of the brachial or femoral artery, whilst the external incision would be on the opposite side of the limb, half-way round, measured from the internal.

In the forearm these incisions would be made along the prominent parts of the radius and ulna, and in the leg along the posterior borders of the tibia and fibula.

It will be readily seen that a serious disadvantage in this operation is the great length of the anterior flap, and corresponding amount of damage done to the soft parts, and consequently the tendency of this flap to slough.

AMPUTATION OF THE FOREARM AND OF THE ARM

Operations.

Fig. 1.—*Amputation of the right forearm—circular method.*—*a*, hand of an assistant supporting the forearm. The operator standing outside the limb, incising the muscles.

Fig. 2.—Same operation—third step. A three-headed bandage, *a*, passed between the bones serves to retract the soft parts, and to protect them against the action of the saw.

Fig. 3.—*Amputation of the left arm—circular method.*—*a* hand of an assistant raising the soft parts whilst the operator divides the deep muscles.

Fig. 4.—Appearance of the stump ; the operation completed. *a*, vessels ; *b*, humerus.

Fig. 5.—*Double flap operation ;* operation completed. *a*, internal flap ; *b*, external flap.

STEPS OF THE OPERATIONS.

1. *Amputation of the forearm—circular method.*

The forearm being held by assistants midway between pronation and supination, the operator should stand internal to the limb if operating on the left arm, external if the right, and proceed as follows :—

First step.—Make a circular incision through the skin and cellular tissue as far as the aponeurosis. Dissect the skin upwards in the form of a sleeve. If the limb is voluminous and conical, it will be necessary to divide the skin laterally in order to be able to raise it.

Second step.—Divide the muscles in a circular manner, following the outline of the sleeve of skin. In this incision the deep muscles escape the knife, it is therefore necessary to divide them by passing the knife through the interosseous space, first on the extensor, and then on the flexor aspect, dividing all the tissues around each bone (see amputation of the limb, plate xxx., fig. 2 and 2 *bis*).

Third step.—Introduce a three-headed bandage into the interosseous space, wherewith to raise the soft tissues, then apply the saw to both bones at the point where they cease to be denuded, and draw it once or twice from heel to point, guided by the nail of the left thumb, until its teeth become engaged. Now with the saw cut through both bones. It will be found that the section of the radius will be completed first. When the section of the ulna is nearly completed, the action of the saw should be directed with care, and the assistant who holds that part of the limb to be removed should avoid all pressure on the bones, otherwise the end of the bone will be splintered instead of being cut clean, an accident very liable to result in necrosis of the stump.

Fourth step.—Ligature the arteries which are the radial and ulnăr, anterior and posterior interosseous ; then, the skin being turned down, adapt it with sutures in such manner as to obtain a transverse cicatrix.

2. *Double flap operation.*

The arm is to be supported by an assistant almost at right angles to the body, the operator standing outside the right arm or inside the left.

The anterior flap is to be first cut by transfixion.

(1) The assistant holding the limb forcibly supinated, feel the limits of both bones with the thumb and index finger of the left hand ; then (2) transfix the limb immediately in front of both bones, and cut a semilunar flap, including the muscles, about two and a half to three inches in length.

The assistant now forcibly pronates the limb whilst the posterior flap is cut.

(1.) Do not transfix to make this flap, but with the full blade cut a semilunar flap two inches in length downwards from the surface to the aponeurosis, commencing from the one angle at the base of the anterior flap, and carrying the incision round to the other angle. (2.) Dissect the skin and cellular tissue as high as the base of the anterior flap. (3.) Let the assistant raise both flaps; then by a circular incision, and by piercing the interosseous membrane, denude the bones. (4.) Cut through the bones with the saw, as explained in the preceding operation.

Amputation of the arm—circular method. (Figs. 3, 4.)

The arm being held by an assistant at right angles to the patient, the surgeon is to stand external to the limb, and proceed as follows:—

First step.—Incise in a circular manner the skin and cellular tissue as far as the aponeurosis; the skin which is loosely connected may be easily retracted.

Second step.—With a second circular incision at the level of the retracted skin, cut through the muscles as far as the bone. The assistant now retracts the skin, and also the mass of muscles.

Third step.—Another circular incision through the highest part of the deep muscular fibres denudes the bone, and cuts through the periosteum.

Fourth step.—The soft parts may now be drawn up by a two-headed bandage, and the humerus is to be sawn through.

The arteries to be ligatured are the brachial and perhaps one or both profundas.

Double flap operation.—The arm being held in the same position by the assistant, the operator transfixes the arm immediately in front of the humerus, and cuts a semilunar flap three inches long. Then, with the arm forcibly rotated inwards, he cuts a posterior semilunar flap, rather less in length, either by transfixion or from the surface downwards. The latter is to be preferred, as it is not always possible in transfixion to carry the knife through the angles of the first cut. A circular cut to denude the bone. and its section with the saw, completes the operation.

Pl. 30.

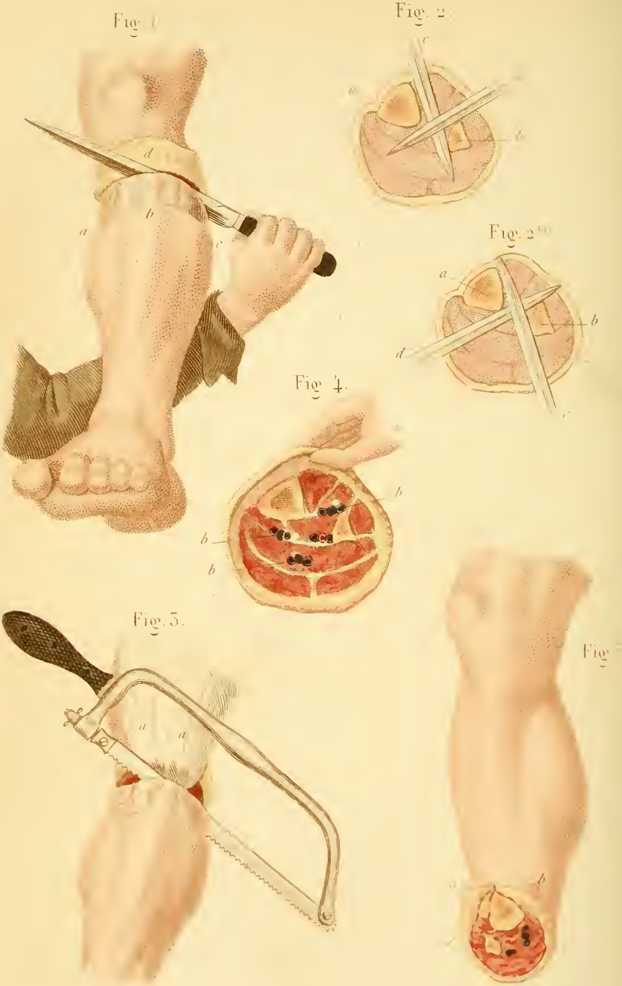


PLATE XXX.

AMPUTATION OF THE LEG.

Operations.

Fig. 1.—*Amputation at the seat of election.* * *Circular method.*

a, b, c, Circular incision through the integuments ; *d,* sleeve of skin raised. The knife commencing to incise the muscles.

Fig. 2 *and* 2 *bis.—Same operation.*—Section of the deep muscular parts about the bone.

Fig. 3.—*Same operation.*—A three-headed bandage (*a a*) passed between the bones, serves to retract the soft parts and protect them against the saw.

Fig. 4.—*Wound resulting from the preceding operation.*—The hand of an assistant (*a*) supports the sleeve formed by the integument ; *b, b, b,* vessels of the leg.

Fig. 5.—*Amputation of the leg at the lower part : M. Lenoir's operation.*—Appearance of the wound after the operation ; *a, b,* angular flaps formed by the division and dissection of the skin forming a sleeve split in front ; *c,* tibia ; *d,* fibula.

STEPS OF THE OPERATIONS.

(1.) *Amputation of the leg two or three fingers' breadth below the tuberosity of the tibia. Circular method.* (Figs. 1, 2, 2 *bis*, 3).

The patient lies with both legs projecting beyond the table, and the assistant holding the limb to be amputated in a horizontal position.

First step.—The assistant retracts the skin; then, by a circular incision, the skin and cellular tissue are to be cut through. The incision should be commenced at the crest, and completed in one

* The term, "seat of election," was applied to a point two or three inches below the knee-joint. It was the rule to amputate at this point in patients among the working classes who would be compelled to wear the wooden peg, the object being to avoid the long stump projecting at right angles to the knee.

sweep. The skin is next to be dissected upwards for about two inches, and then turned up as a sleeve.

Second step.—The knife is to be carried in a circular manner through the tissues as far as the bones on a level with the skin turned up.

Third step.—The knife is carried around each bone, through the interosseous membrane (*see* figs. 2 and 2 *bis*, in which a double-edged knife is used), and the three-headed bandage introduced.

Fourth step.—The saw is now to be applied to the tibia, directed by the left thumb, and drawn from heel to point two or three times, until its teeth become engaged; the section of the two bones is then to be completed, taking care that the fibula shall be divided before the tibia, otherwise the former bone will be splintered.

Many surgeons saw off the projecting crest of the tibia to avoid its puncturing the integument.

The arteries to be ligatured (fig. 4) are the anterior and posterior tibial, the peroneal, and sometimes the sural arteries.

M. Lenoir's operation (fig. 5) differs from the ordinary circular operation in that he proposed a vertical incision in the skin along the crest of the tibia, before turning it back as a sleeve.

Integumental flap operation.—The thumb and index finger of the left hand being placed on the posterior limits of the two bones, a semilunar flap, involving only the skin and cellular tissue, two inches and a half long, is cut on the anterior and outer part of the leg, extending from the point of the index finger round to the thumb. The flap is reflected to a level with its base. A posterior flap of the same length is now to be cut in the same manner and reflected. The muscles are to be cut and the bones severed with the saw on a level with the line of reflection of the skin flaps.

Double flap operation.—The posterior flap is to be made first by transfixion.

The thumb and index finger of the left hand are to be placed, as in the preceding operation, on the posterior limits of the two bones, the palm of the hand grasping the limb in front. The knife is now made to penetrate the tissues immediately in front of the thumb, behind the two bones, and, grazing the surface of the bones, it should come out at the point of the index finger. The knife is then carried downwards, to cut a posterior semilunar flap three inches or more in length, according to the size of the limb, and to the part of the limb on which the operation is being performed.

The anterior flap is to be cut in the skin only. The blade of the knife is to be applied to one angle of the wound at the base of the posterior flap, and drawn across the front and outer part of the limb, through the skin and cellular tissue only, to cut a semilunar flap two inches and a half in length. The integument is then to be dissected up to a level with the base of the first flap. The next step is to denude the bones, by cutting around them, and through the interosseous membrane. The bones may then be sawn through, and the crest of the tibia removed at discretion. If this operation be performed in the upper third of the leg, a superabundance of muscle is cut in the posterior flap, and it is necessary to slice away the excess after the flap is cut. For this reason, it is usual to perform either the circular or the skin flap operation in this region.

Long and short rectangular flaps (Teale's operation), see description (page 85).

PLATE XXXI.

AMPUTATION OF THE THIGH.

Operations.

Fig. 1.—*Circular method.—Ordinary plan.*—The hand of an assistant, *a*, compresses the femoral artery ; *b*, *c*, *d*, circular incisions of the integuments.

Fig. 2.—The same operation. The muscles having been cut through as far as the bone, a split bandage, *a*, *a*, is applied in order to raise the soft parts and to protect them from the saw.

Fig. 3.—The same operation finished—view of the stump ; *a*, section of the femur ; *b*, orifices of the femoral vessels.

Fig 4.—*The flap operation.—M. Sédillot's method.*—*a*, the first flap raised ; the knife, *b*, plunged in obliquely, cuts a second flap in the line, *c*, *d*.

STEPS OF THE OPERATIONS.

The circular method.—Ordinary plan (Figs. 1, 2, 3).

The patient lying down, the thigh slightly flexed upon the pelvis, and uncovered throughout, should be kept sufficiently apart by assistants. The surgeon should stand on the inside of the limb.

First step.—Make a circular incision in the skin as low as possible above the knee, and from 4 to 5 fingers' breadths below the point where the bone is to be sawn through. The skin should be retracted by the aid of an assistant while the surgeon divides the cellular tissue which retains it, and which is strongest near the popliteal space.

Second step.—The knife, following the edge of the retracted skin, makes a circular incision through the superficial muscles, and when the latter have been retracted, the surgeon then divides in a circular manner the deep muscles as far as the bone ; and lastly, after applying the split bandage, for the protection of the soft parts, the bone is sawn through in the ordinary way (fig. 2).

Third step.—The arteries to be secured are the *femoral*, situated internally beneath the sartorius ; the *superficial* and *deep muscular*, and the *perforating* arteries. The lips of the wound should be brought together in such a manner as to leave an oblique cicatrix.

Double flap operation.—The posterior flap may be made by

Fig. 1.

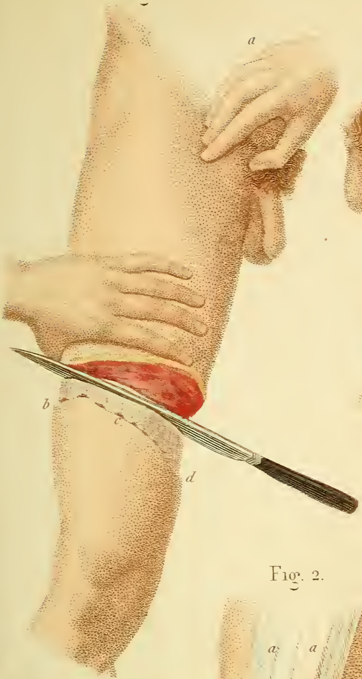


Fig. 4.

Fig. 2.

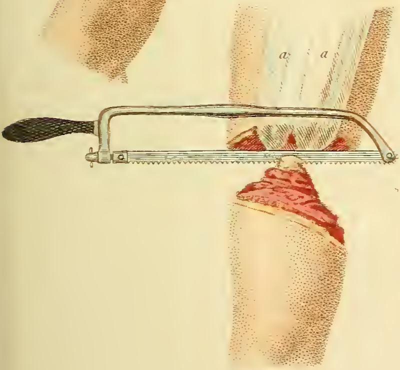
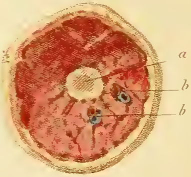


Fig. 3.



transfixion. The point of the knife may be entered on either side, carried beneath the bone and slightly raised, to be brought out about the central part of the opposite side. If possible, it is well to keep the main vessel in the posterior flap, as less important branches would be severed by so doing. The knife is now carried obliquely downwards to the surface, to cut the posterior flap. The anterior flap is not made by transfixion. The knife is carried from one angle of the base of the posterior flap round on the anterior surface of the thigh to the opposite angle, forming a flap in the skin and cellular tissue about the size and shape of, or slightly shorter than, the posterior flap, which has been already cut. At the discretion of the operator the integument and cellular tissue may be now dissected up to the level of the base of the posterior flap, or the knife may be carried more deeply in order to raise the muscles also in the flap. Next, both flaps are raised by the assistant, the knife carried in a circular manner around the bone, and the saw applied. The arteries that may require a ligature are the femoral, perhaps the deep femoral, according to position of the amputation, perforating and muscular branches.

Lateral flaps.—Vermale amputated the thigh by two lateral flaps, with the object of giving a more free exit to the discharges. Both flaps are formed by transfixion, the knife being entered in front of the femur at a central point, passed around the bone, and brought out at a corresponding point on the opposite side. The flaps are then cut of an equal length, the outer one being the first made because not containing any vessel of importance.

Teale's long and short rectangular flap.—(See page 85.)

Single skin flaps have been described by Carden and Spence. In this operation a long flap is cut in the skin and cellular tissue only on the front of the thigh; this flap being turned back, the knife is carried, at the base of the flap, in a circular manner, through all the soft tissues around the bone, including the skin on the back of the thigh.

Reason and practice teach us to avoid single skin flaps, owing to their tendency to slough; but occasions occur in which disease or injury leave the surgeon little choice in the matter. Mr. Carden proposes the operation for amputation immediately above the condyles.

Supra condyloid amputation (Gritti).—This operation consists of an anterior skin flap, carried a little below the patella, and made to include that bone, so that when the flap is applied, after the condyles are sawn off, the posterior surface of the patella, first denuded of its cartilage, is in contact with the cut end of the shaft of the femur. A posterior flap is also formed, the lower extremity of which reaches only to a level with the head of the fibula.

PLATE XXXII.

ESECTIONS WHICH ARE PERFORMED ON THE UPPER EXTREMITY.

Operations.

Fig. 1.—*Resection of the wrist joint.—M. Velpeau's plan.*—*a, b, c, d,* the quadrilateral flap of skin cut from the posterior surface of the radio-carpal articulation.

Fig. 2.—*Resection of the inferior extremity of the ulna.*—*a*, triangular flap of skin raised up ; *b*, inferior extremity of the ulna ; *c*, spatula passed under the bone to protect the soft parts from the action of the saw, *d*.

Fig. 3.—*Resection of the elbow joint.—M. Moreau's plan.*—*a*, hand of the assistant raising the quadrilateral flap which has been dissected from below upwards, in order to expose the joint from its posterior aspect ; *b*, spatula inserted beneath the inferior extremity of the humerus while the bone is excised by the saw, *c*.

Fig. 4.—The same operation finished.—*a, b, c, d,* the quadrilateral flap in place, and reunited by means of the twisted suture.

Fig. 5.—*Extirpation of the radius.*—*a, b,* long incision made on the external surface of the forearm, in order to reach the radius ; *c*, left hand of the surgeon raising the inferior extremity of the radius, whilst, with the bistoury, *d*, held in his right hand, he disarticulates the bone ; *e*, radial artery, accompanied by the radial nerve.

STEPS OF THE OPERATIONS.

1. *Resection of the metacarpo-phalangeal articulation.*

Either the head of the metacarpal bone is removed, or the end of the phalanx, or both, according to circumstances.

In the middle of the dorsal surface of the metacarpal bone an oblique incision is made, commencing about $\frac{3}{4}$ of an inch from the point where the bone is to be removed, and terminating close to the commissure of the finger. A second incision resembling

Pl. 32.

Fig. 1.

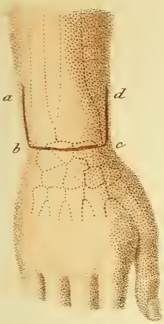


Fig. 4.

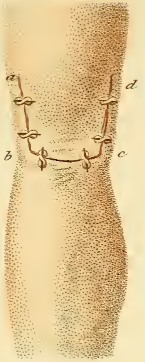


Fig. 2.

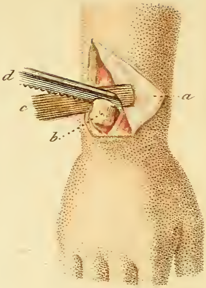


Fig. 5.

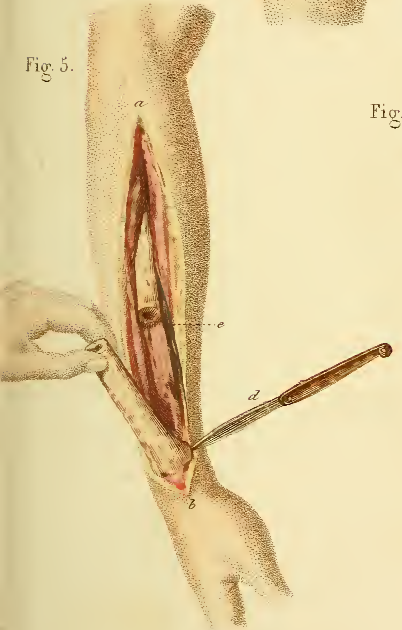


Fig. 3.

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the first is then made, which, running in the direction of the other commissure, will thus form a V-shaped flap, with its base below. Having dissected and turned back this flap, the extensor tendon is to be drawn aside without dividing it, and the interosseous muscles detached on each side. The joint is then exposed by cautiously cutting through the lateral ligaments so as not to disturb the flexor tendons. The phalanx is then dislocated from behind, circumscribing as exactly as possible the diseased parts. At this stage of the operation, the bone, or its head, is cut with Liston's forceps, or by means of a little tail-like or metacarpal saw, taking care to pass underneath the bone a piece of wood or cardboard, for the sake of protecting the soft parts. In performing this operation on the index or the little finger, it will be as well to form the flap upon the free side of the finger so as not to expose the extensor tendon.

2. *Extraction of the first phalanx.*

Performed upon the thumb with success, and with the preservation of the movement of the small phalanx. This operation may also be indicated in the case of the other fingers.

An incision should be made upon the dorsal surface of the phalanx, commencing about $\frac{3}{4}$ of an inch above the metacarpo-phalangeal articulation, and prolonged to about $\frac{1}{4}$ of an inch beyond the articulation of the first phalanx with the second, The skin is next to be dissected and the tendons drawn aside, after which the metacarpal joint is exposed by cutting through the lateral and capular ligaments, and without disturbing the flexor tendons. The phalanx is then completely dislocated, and at the same time well cleared, while its extraction is completed by exposing its inferior articular surface.

3. *Resection of the metacarpal bones.*

(1.) A longitudinal or crucial incision is to be made upon the dorsal surface of the metacarpal bone to be operated on, the extensor tendons being drawn to one side. (2.) The interosseon muscles are to be divided on each side, and either the carpo-meta-carpal or the metacarpo-phalangeal articulation exposed according to the intention of removing the upper or the lower half of the metacarpal bone. (3.) After having properly protected the soft parts by means of a small bandage passed under the metacarpal bones, the diseased bone is removed with Liston's forceps or with the chain-saw. (4.) The excision completed, the fragment of excised bone is to be turned round from before backwards in order to complete its separation from the soft parts.

When the first or the fifth metacarpal bone is to be removed, the section of the bone should be made in an oblique direction, so as to avoid the angular projection which would inevitably result from a perpendicular section (Plate XXVIII., fig. 2).

4.—*Resection of the wrist joint.*

In performing this operation we can either remove the lower end of the radius alone, that of the ulna alone, or the carpal extremities of both bones together with all the carpal bones and the bases of the metacarpal bones.

(*a.*) *Resection of the lower end of the ulna* (Plate XXXII. fig. 2).

The hand being forcibly pronated, a longitudinal incision is to be made over the internal surface of the ulna, terminated by a transverse incision made over the back of the articulation. The triangular flat thus formed is to be carefully dissected and the bone exposed, after which the disarticulation is effected, taking care to draw aside the tendons and to avoid the blood-vessels. Finally a spatula, *c*, is passed beneath the extremity of the bone, and the operation completed with the metacarpal saw, *d*.

(*b.*) *Resection of the inferior extremities of the radius and ulna* (Plate XXXII., fig. 1).

(1) The hand being pronated and well supported, two longitudinal incisions are made over the border of the radius and ulna, *a*, *b*, and *d*, *e*. These incisions are then to be connected on the posterior surface of the wrist by a transverse incision, *b*, *e*; (2) the skin is then to be dissected in such a manner as to form a quadrilateral flap which can be reflected from below upwards on the forearm; (3) the disarticulation of the joint is then to be

effected by carefully detaching the surrounding soft parts, especially avoiding injury to the tendons and also to the radial and ulnar arteries which lie in front; (4) a piece of cardboard or a spatula passed beneath the bones will protect the soft parts whilst the saw severs the bone.

In M. Dubled's operations two longitudinal incisions are made over the radius and ulna respectively. By the internal incision he extirpates the ulna, then he passes to the end of the radius, which he disarticulates and cuts out by means of the external incision.

M. Roux joins to the longitudinal incisions of M. Dubled two transverse incisions, which extend upon the back of the wrist as far as the border of the group of extensor tendons; the two transverse incisions are thus separated by a portion of skin corresponding to the middle of the back of the wrist, which protects the extensor tendons.

M. Velpeau reunites the two longitudinal incisions of M. Dubled by a tranverse one made above the wrist joint. The result is a large quadrilateral flap with its base below, and which is dissected and reflected from above downwards. In other respects the operation is the same.

Resection of the wrist joint, including the carpus and bases of the metacarpal bones.—Lister's operation.—Two incisions are made on the back of the hand. The *radial incision* is planned to avoid injury to the radial artery and to the extensor secundi internodii pollicis and extensor indicis. It is commenced at a point in the middle of the lower extremity of the radius level with the styloid process, and carried with a slight obliquity outwards to the outer side of the carpo-metacarpal articulation of the index finger parallel with the extensor secundi internodii pollicis; it is now turned parallel with the outer border of the second metacarpal bone for half its length. The soft tissues over the trapezium are now raised by the handle of the scalpel or with the finger-nail, and pushed outwards, and the tendons of the extensor carpi radialis, longior and brevior, are cut through as they run inwards to their insertions. The trapezium is next to be separated from the rest of the carpus by means of the bone forceps.

The *ulnar incision.*—The knife is entered on the internal subcutaneous surface of the ulna, two inches above the joint, and carried obliquely downwards to the middle of the shaft of the fifth metacarpal bone, reaching its palmar aspect. The extensor carpi ulnaris is then cut at its insertion into the base of the fifth metacarpal bone, and now the handle of the knife may be passed beneath all the extensor tendons of the hand so as to clear the posterior surface of the carpal bones. The posterior and internal lateral ligament of the wrist are now exposed and may be divided. The joint being thus opened, the knife may be carried through the joint to the anterior surface of the ulna, and the soft tissues carefully separated from that surface of the bone; then the knife is turned and carried downwards to separate the pisiform bone from its articulation with the cuneiform, the bone not being removed, but allowed to remain attached to the tendon of the flexor carpi ulnaris. In cutting through the articulation of the pisiform the knife impinges upon the unciform process of the unciform bone, and this is better removed by the bone forceps. The anterior ligament of the wrist is next to be divided, and the bones of the carpus may be now made to protrude through the ulnar incision; here they may be grasped with the forceps and drawn upon, whilst any undivided attachments may be released with the knife. By turn the ulnar and radius and the bases of the metacarpal bone, may be made to protrude through the wound, and may be sawn away according to necessity.

If the trapezium is diseased it may be dissected away, care being taken not to injure the radial artery.

5. *Resection of the elbow joint.*

In this operation we can, according to the nature of the case, either extirpate all the three bones which are included in the joint, or we can limit the operation to two or even one of them.

I. *Resection of the inferior extremity of the humerus* (Plate XXXII., Figs. 3, 4).—*Moreau's operation.*

(1.) The arm being semiflexed, and the posterior surface of the joint turned towards the operator, two longitudinal incisions are made over the margins of the humerus, beginning from the external condyle on one side and from the internal condyle on the other, and prolonging them for about three inches upwards. (2.) By uniting these two incisions by a transverse one which divides the skin and the triceps muscle immediately above the olecranon a quadrilateral flap is obtained, which, after being raised from below upwards, is to be held by an assistant, *a* (Fig. 3). (3.) The bone is next to be carefully isolated from the surrounding tissues, especially from the ulnar nerve, which, having been disengaged from the bone, is to be drawn to one side by an assistant. (4.) The bone thus denuded a spatula may be inserted to protect the soft parts, while the diseased portion of bone is cut through with the ordinary saw, *c* (Fig. 3). Lastly, the fragment of bone is removed by cutting through in succession the adherent structures, and throwing open the joint from behind forwards.

II. *Resection of the upper extremity of the bones of the forearm.*

M. Moreau's plan may be made use of by prolonging the external lateral incisions along the radius as far as the point where the bone is to be excised. The radius is then to be separated from the ulna and the soft parts; a spatula or bandage applied in the usual manner; and the end of the radius excised, preserving, if possible, the insertion of the biceps.

If it is desired to remove the end of the ulna, it should be exposed in the same manner, by prolonging the internal lateral incision. Then proceed as with the radius, and if the operation permits of it, preserve the attachment of the brachialis anticus.

When it is necessary to remove the extremities of all the bones entering into the formation of the elbow joint, a single incision may be employed instead of those just indicated. This incision should be about five inches in length, extending longitudinally on the posterior aspect of the joint, its centre being at the olecranon process.

III. *Extirpation of the radius* (Plate XXXII., Fig. 5).

(1.) Make a longitudinal incision over the external anterior margin of the radius, *a*, *b*, cutting through the skin and soft parts so as to expose the bone. (2.) Then, having thoroughly denuded the bone, pass behind it a chain-saw, or, if any ordinary saw is to be used, a spatula, to protect the soft parts. (3.) Isolate the fragment of the radius, avoiding injury to the neighbouring vessels and nerves.

6. *Resection of the scapulo-humeral articulation.*

First by the simple incision.—A vertical incision is made along the anterior border of the deltoid, commencing below the coronoid process; then, at each angle of the deltoid incision, a transverse cut is made through the fibres of deltoid, but not including the integument, the object being to separate the lips of the wound, and to facilitate the opening of the capsule of the joint, without which the head of the bone cannot be drawn out.

M. Malgaigne's plan.—A similar vertical incision is made over the deltoid, but more externally than in the former operation. This incision will be opposite the apex of the coraco-clavicular triangle, by making it reach as far as that point. The skin, the muscles, and the capsule of the joint are divided down to the bone with one stroke of the knife; and then the joint is exposed at its upper and anterior part, close to the glenoid cavity. The lips of the wound being separated with ease, the knife can be freely manœuvred so as to allow the head of the bone to be dislocated, and its excisions effected with the chain-saw or the ordinary saw.

2. *The flap operation.*—As a rule, one flap only is made. Moreau and Maune make a quadrilateral flap; the former making one with its base above, the latter one with its base below. Morel cuts a semilunar flap with its base above. Sabatier makes a triangular one in the same direction. M. Malgaigne recommends a posterior-lateral flap after the method which M. Lisfranc adopts for the disarticulation of the shoulder joint, etc. Directly the flap is cut, the joint is exposed, and the bone disengaged and drawn out, while the vessels and nerves are protected. The excision is made with the ordinary saw.

7. *Resection of the clavicle.*

(*a.*) *Resection of its scapular end.*—M. Velpeau thus describes the plan which he adopted in 1828 in the case of a woman who had long suffered from necrosis of the external third of the clavicle. "I first," says M. Velpeau, "made a crucial incision, the two branches of which were each about four inches in length. Having dissected and reflected back the flaps, and divided the acromio-clavicular ligaments, and some of the fibres of origin of the deltoid and trapezius muscles, I was able, by the leverage afforded by a piece of wood thrust into the joint, to lift up the diseased bone and to detach it from the sound parts. In case too much force is used, we should be very careful to isolate the soft parts before and behind, to pass under the lower surface of the bone the chain-saw, and to cut it from behind, in order to disarticulate and remove it."

(*b.*) *Resection of the sternal end.*—In one instance M. Davie performed this operation by making an incision about three inches in length over the internal extremity of the clavicle, and in the axis of this bone. He divided the ligaments as far as possible ; then he excised with Scultet's saw the end of the bone to the extent of rather more than an inch from its articular surface, and, to avoid injuring the neighbouring parts, he passed a piece of hard leather beneath the bone while it was being excised. After the bone had been cut through, he was obliged, in order to raise the internal fragment, to break down with the handle of the scalpel, which he used as a lever, the interclavicular ligaments, which he had not been previously able to reach, and which still retained the bone in its place.

(*c.*) *Complete extraction of the clavicle.*—Mott, of New York, successfully performed this operation in a case of osoteo sarcoma. His operation was as follows: He made a curvilinear incision, with its convexity below, extending from one extremity of the bone to the other; he then made a second incision above, from the acromion to the external jugular vein, cut through the platysma and a portion of the trapezius, and passed beneath the bone close to the acromion a director which served as a guide for the chain-saw with which section of the clavicle was effected. The extraction of the ends of the bone was rendered difficult on account of the size of the tumour, and the deformity of the parts concerned.

To simplify this operation, MM. Valpeau and Malgaigne recommend that three incisions should be made, so as to form a quadrilateral flap with its base above, and which could be dissected and reflected back in that direction.

8. *Excision of the scapula.*

Janson excised a large part of the infra-spinous portion of the scapula, which was the seat of a tumour. Two elliptical incisions were made round the tumour, and the two lips of the wound dissected and reflected.

Then recognising that the supra-spinous portion of the scapula was sound, he separated with a saw all the diseased parts, thus preserving the use of the joint.

Pl. 33.

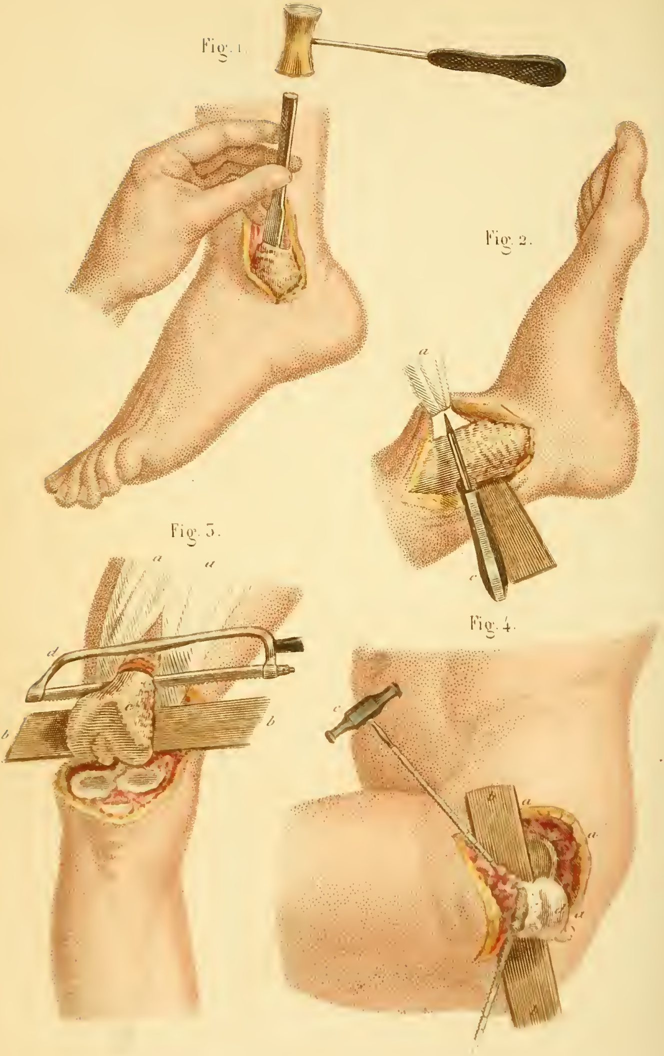

PLATE XXXIII.

RESECTIONS WHICH ARE PERFORMED ON THE LOWER EXTREMITY.

Fig. 1.—*Resection of the lower end of the fibula.*—The operator by means of a chisel, and a mallet, removes the external malleolus.

Fig. 2.—*Resection of the lower end of the tibia.*—*a*, a linen bandage for the purpose of raising the parts lying in front of the bone ; *b*, a piece of wood to keep back the soft parts behind, and protect them from the saw, *c*.

Fig. 3.—*Resection of the lower end of the femur.*—*a*, a split bandage for the same purpose as above mentioned ; *b*, piece of board protecting the soft parts behind from the saw, *d ; e*, lower end of the femur dislocated forwards.

Fig. 4.—*Resection of the head of the femur.*—*M. Sédillot's plan.*—*aa*, a semilunar incision, with its convexity above extending around the great trochanter; *bb*, piece of board placed under the head of the dislocated femur ; *cc*, the chain-saw, excising the head of the bone from within, outwards.

STEPS OF THE OPERATIONS.

1. *Resection of the first metatarsal bone.*—The first metatarsal bone is the only one on which this operation is performed.

(1.) *Resection of the anterior extremity of the first metatarsal bone.*—M. Blaudin makes on the inside of the foot a quadrilateral flap with its base behind. The flap being dissected and the lips of the wound kept apart, the extensor tendon is drawn to one side ; then having opened the metatarso-phalangeal joint, the head of the bone is dislocated at the same time that the bistoury separates the soft parts on each side. The latter must be protected in the usual manner, while by means of a metacarpal saw, or, what is better, of the chain-saw, the diseased part is removed by sawing in a direction perpendicular to the axis of the bone.

The form of the incision can be modified according to the circumstance of the case. (2.) For the complete extraction of the first metatarsal bone, a quadrilateral flap is made as before, and reflected back as far as the level of the scaphoid bone, or a curved incision may be made, with the curve upwards, extending from the tarso-metatarsal to the metatarso-phalangeal joints. At first the metatarso-phalangeal joint should be operated on, as it is looser than the other, then, raising and drawing out the head of the bone, all the adherent structures should be cut through in succession, and the operation finished by opening the articulation of the metatarsal with the cuneiform bone. M. Velpeau prefers to saw through the middle of the bone with the chain-saw, and to extract the two halves separately.

2. *Excision and removal of the tarsal bones.*—The cuneiform and cuboid bones, and especially the astragalus and os calcis, have been removed or excised in certain cases of caries, dislocation, contusion, etc. ; but there are no fixed rules for the performance of these operations. They are subject to the very variable conditions under which the patient may be placed. In order to separate the bone, it is often necessary to use the gouge and mallet.

3. *Excision of the tibio-tarsal joint* (Plate XXXIII, Fig. 1, 2.)—*M. Roux's, plan.*—(1.) Make along the outer side of the fibula a longitudinal incision down to the bone, about three inches in length, and extending downwards to a little below the apex of the external malleolus. From the lower end of the first incision, make another in a transverse direction, but only through the skin, and extending no further than the tendon of the peroneus tertius muscle. By this means a triangular flap is formed, which is to be raised, and afterwards the sheaths of the peroneal muscles opened, the latter pushed behind, and the bone cleaned posteriorly, taking care to avoid the vessels and nerves. The chain-saw is then to be inserted between the tibia and fibula so as to cut the bone from within outwards, and the lower end of the fibula can be thus removed. (2.) The leg being now placed on its outside, the excision of the tibia may be proceeded with. To accomplish this, make a similar incision on the inner side of the tibia. From the lower end of this first incision make another through the skin only, and in a transvere direction as far as the tendon of the tibialis anticus. The triangular flap should

be dissected and raised in order to isolate the tibia from the surrounding parts, avoiding injury to the tendons, vessels, and nerves; the extensor tendons, and the anterior tibial vessels are pushed forward, and the excision of the bone effected with a little straight-bladed saw, the soft tissues being protected by a thin wooden board. The chain-saw might also be advantageously used, as it could be inserted round the tibia without any risk of wounding the tendons, and would saw through the bone from behind forwards. After the tibia is excised, the upper surface of the astragalus may be sawn off if necessary.

3. *Extraction of the fibula.*—The operation is begun by exposing the middle of the bone for the purpose of dividing it with the chain-saw. Afterwards its upper and lower extremities are successively extracted. In some cases, moreover, merely a portion of the ends of the fragments may be excised without interfering with the joint.

4. *Excision of the femoro-tibial articulation* (Fig. 3).—*Syme's operation.*—(1.) The leg being fixed at a right angle upon the thigh, a curved incision, with its convexity above, is made above the knee-cap, extending from one lateral ligament to another, and at once laying open the joint. (2.) A second curved incision, with its convexity below, is thus made beneath the knee-cap, and joining the angle of the first, so that the knee-cap is enclosed within an elliptical flap, which is to be removed. The lateral and deep ligaments are then to be divided with the point of a knife, and the femur and tibia made to project, taking care that the soft parts are carefully detached from behind, and that the popliteal vessels are not wounded. During the excision of the ends of the bones, a piece of board must be applied behind them in the usual manner, and the soft parts further protected and raised by a bandage.

Moreau's plan for the excision of the knee is analagous to that for the elbow. He makes two lateral incisions up the thigh as far as the point where the bone is to be excised. These are united by a transverse incision passing below the knee-cap. After raising the quadrilateral flap the knee-cap is extirpated. The ends of the bones can then be easily exposed and excised.

5. *Resection of the hip-joint.*—*M. Velpeau's plan.*—By

making a semilunar incision from the antero-superior process of the ileum to the tuberosity of the ischium behind the joint, a large flap with its convexity below can be cut at the expense of the surrounding soft parts. Then raise the flap and divide the posterior half of the capsule of the joint at the same time that the thigh is adducted and flexed, in order to divide the inter-articular-ligament, to pass a knife between the head of the bone and the cotyloid cavity, and divide the remaining portion of the fibrous capsule. The head of the bone may then be drawn out and excised.

M. Sédillot's plan (Fig. 4).—He makes a semilunar flap with its convexity above, and embracing the great trochanter and penetrating as far as the joint. The head of the bone is then drawn out, and its excision accomplished by means of the chain-saw.

Fig. 1.

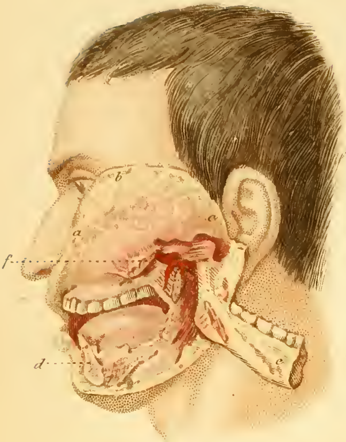

Fig. 2.

Fig. 3.

Fig. 4.

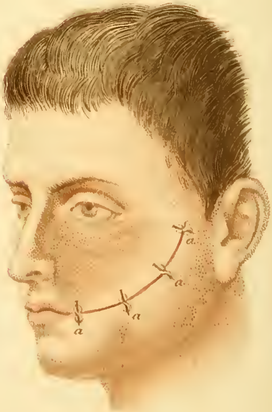

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PLATE XXXIV.

RESECTION OF THE INFERIOR AND SUPERIOR MAXILLARY BONES.

Fig. 1.—*Resection, through the articulation, of half of the inferior maxilla.—M. Lisfranc's plan.—a, b, c,* superior quadrilateral flap thrown back ; *d,* the inferior maxilla sawn through near the symphysis of the chin ; *e,* the left half of the bone dislocated outwards ; *f,* the internal maxillary artery ; *g,* submaxillary gland.

Fig. 2.—*Resection of the middle half of the body of the inferior maxilla.—Dupuytren's plan.—a* and *b,* flaps made by a perpendicular incision running in the median line through the lower lip ; the surgeon placed behind the patient excises the bone, *d,* with a cock's crest saw, *c.*

Fig. 3.—*Removal of the superior maxillary bone.—M. Velpeau's plan.—a, b, c,* a superior flap thrown up ; the superior maxilla, *d,* has been detached by means of a chisel and mallet, or bone forceps, and the surgeon with a bistoury, *e,* divides the adjoining soft parts.

Fig. 4.—*The preceding operation finished.—a, a, a,* row of twisted sutures.

METHODS OF OPERATING.

1. *Resection and complete extirpation of the superior maxillary bone.—Gonsoul's plan, modified by Velpeau.*

The patient being seated upon a low chair, and his head kept slightly turned backwards, and supported against the chest of an assistant, a large incision with its convexity below is made upon the cheek, beginning at the commissure of the lips, and dissected outwards and then upwards as far as the temporal fossa. This large flap is then to be dissected from below upwards, and reflected upon the forehead. The maxillary bone being thus exposed, its connections with the other bones of the face are to be successively destroyed. (1) Divide with one blow of the chisel, or bone forceps, the external orbital apophyses on a level with the fronto-malar suture ; (2) the zygomatic arch is treated likewise ; (3) in the same manner the os unguis and the nasal process are separated ; (4) all the soft parts which unite the ala nasi to the jaw-bone are to be dissected off, and the bone itself separated from its neighbour on the opposite side, either with the bone forceps, or with a little saw ; (5) the soft parts are then to be detached from the floor of the orbit, carrying the chisel or forceps flat as deeply as possible into the floor, in order to make an oblique cut from above downwards, and from before backwards, and so to divide at one blow the superior maxillary nerve and the connections of the bone with the pterygoid process. Lastly, the operation is terminated by dividing with a bistoury, or curved scissors the velum palati, and the other soft parts which still fix the maxillary bone.

Instead of the integumental incision being made across the cheek, it may be made through the upper lip into the nostril, and then along the ala of the nose to the inner canthus of the orbit.

2. *Resection and removal of the inferior maxillary.—Resection of the middle part of the body of the bone.—M. Dupuytren's plan* (Fig. 2).

The patient is to be seated upon a chair slightly elevated, and in such a manner as not to be able to touch the ground. An assistant standing behind the patient keeps the head fixed against his chest, while, at the same time, he compresses the two facial arteries just where they pass over the jaw. The surgeon standing in front of the patient seizes with his left hand one of the angles of the lower lip, while an assistant, taking hold of the other end of the lip, keeps it clear of the jaw, and in a state of tension. It is then, with one stroke of the knife, divided vertically, and in the median line down to the bone, by an incision which is to be prolonged until it is on a level with the prominence of the hyoid bone, cutting only through the skin and cellular tissue. Two flaps, one to the right, the other to the left, are over to be detached, keeping close to the bone, and to be given to assistants. The bone now being exposed as much as is required, an incision is made through the periosteum at the point where it is proposed to make the excision, and the corresponding teeth are extracted in order to facilitate the action of the saw. To effect the excision of the bone, Dupuytren stands behind the patient, and operates with a small hand-saw ; but the chain-saw may be more advantageously used, and then it will not be necessary to pass behind the patient. The section being completed on both sides, the bone is to be seized with the left hand, while, with a blunt-pointed bistoury, carried from below upwards, the posterior surface of the bone is cleared by dividing in succession from left to right all the muscles that are attached to it. At the same time an assistant keeps the tongue out of reach of the bistoury by means of a spatula. In some cases the tongue, falling back, has produced suffocation ; but such an accident must be guarded against by keeping the head inclined forwards.

3. *Resection or disarticulation of one-half of the inferior maxilla.*

1. Make a horizontal incision along the inferior border of the jaw, and extending from the symphysis to the angle of the bone, and upon the two extremities of this incision let fall two vertical ones, of which let the internal one divide the inferior lip in the median line, while the external one commences at the zygomatic arch and passes behind the ramus of the jaw. There is thus formed a quadrilateral flap which is to be reflected from above downwards. Then cut through the bone in the middle, clean with the knife its posterior surface, and detach in succession all the soft parts as far as the angle of the jaw. On reaching the joint, insinuate behind the coronoid process below the zygomatic arch a button-end bistoury, which will serve to divide the temporal muscle, while at the same time the jaw is depressed in such a manner as to admit of its coronoid process being disengaged, and its condyle dislocated. Lastly, cut through the pterygoid muscle and the articular ligaments, and forcibly withdraw the bone, so as to detach the vessels of the ramus of the jaw, and avoid injuring the internal maxillary artery.

The whole or the half of the horizontal portion of the inferior maxilla may be removed, according to the extent of the disease.

The removal of the whole lower jaw has been successfully performed by Walther of Bonn.

RESECTION OF THE BONES OF THE TRUNK.

1. *Resection of the ribs.*—The patient lying in a convenient position, the affected ribs are exposed by incisions of a length proportionate to the extent of diseased bone. Having thus marked out the limits of the section, a cock's crest saw or a Heine's saw should be used. In all cases, however, the pleura should be previously separated from the internal surface of the rib with the end of a director and a bandage passed beneath the bone. After the rib has been divided, it should be raised with a soft elevator, and the intercostal muscles carefully divided and cleared from the border of the bone, so as to avoid injuring the intercostal artery or the pleura.

2. *Resection of the sternum.*—This is usually effected by the combined operations of trepanning and resection. We cannot beforehand lay down rules for this operation, considering the various pathological conditions in which it may be required. The essential point is to avoid the mammary vessels on the sternal end of the ribs, and the pleura beneath.

3. *Resection of the spinous processes of the vertebræ and of the pelvis.*—For the excision of the spinous processes, an incision should be made of sufficient size to fully uncover the vertebra, and the muscles lying in the vertebral groove should be separated. After the bone has been exposed, the diseased portion may be removed with a Hay's saw. The bones of the pelvis may be excised to a more or less considerable extent. The peculiarity of each case will alone suggest to the surgeon the means he should adopt.

Pl. 35.

Fig. 1.

Fig. 4.

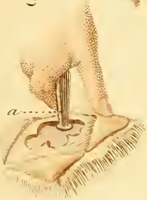

Fig. 3.

Fig. 2.

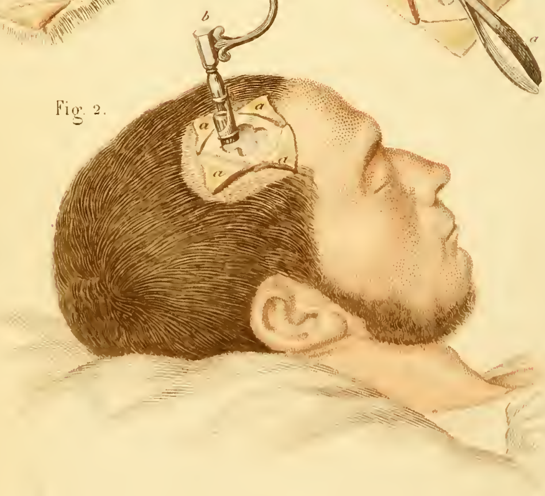

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PLATE XXXV.

TREPANNING OF THE CRANIAL BONES.

ANATOMY.

Fig. 1.—*A vertical and antero-posterior section of the cranium.*—A view of the cerebral hemisphere covered with its membranes, in order to show the position of the middle meningeal artery and the sinuses of the dura-mater.

a, a, a, branches of the middle meningeal artery.—This artery enters the interior of the cranium by the foramen spinosum Its anterior branch, which is the largest, furrows the anterior and inferior angle of the parietal bone, half its diameter being lodged in a groove in the bone. It is often entirely embedded in the bone, and only comes in contact with the dura-mater after it has run through an osseous canal of considerable extent. The posterior branch, which is not so large, runs over the squamous portion of the temporal bone. It is above the level of the anterior and inferior angle of the parietal bone that an injury to the middle meningeal artery is to be feared.

b, b, b.—*The course of the superior longitudinal sinus.*—This sinus is lodged between the two cerebral hemispheres, and is formed by the doubling in of the falx cerebri, of which it is a process. It is not placed in any groove in the bone except behind for about a fifth part of its length. Beginning at the crista galli of the ethmoid bone, it terminates at the internal occipital protuberance cn a level with the torcular herophili.

d. The right lateral sinus.—The lateral sinuses are lodged for about half their diameter in a groove which separates the superior from the inferior occipital fossæ. They begin at the internal protuberance, and are directed horizontally towards the petrous portion of the temporal bone. They are situated superficially to the extent only of two and a half inches. They turn inwards and downwards to empty themselves at the posterior lacerated foramen.

Fig. 2.—*Application of the trepan.*—*a, a, a, a,* the four flaps resulting from a crucial incision into the integuments ; *b*, the trepan in the act of being applied.

Fig. 3.—*Excision by means of clippers.*— *a*, removal of the angular pieces of bone left.

Fig. 4.—*The operator armed with a lenticular knife*, *a*, levels the edges of the wound in the bone.

Method of Operating.

The patient should be lying down, and his head, resting on a board furnished with a cushion, should be kept in position by assistants. The surgeon should then make a V or a T shaped, or a crucial incision through the integuments ; and the flaps should be dissected and reflected back. The periosteum should be raised before applying the drill trepan, or the French trepan, or, still better, the English trephine. If the trepan is used, it should be furnished with a perforator ; then holding it in the right hand like a pen, the point of the perforator is to be applied to the denuded bone, the ebony plate which surmounts the trepan being held between the thumb and the index finger of the left hand at the same time that the chin is pressed against the plate, and the right hand turns the arm of the trepan from right to left. The perforator is the first to make an impression, but soon the teeth reach the bone, and describe a circular groove. When the latter is sufficiently well-marked, and deep enough to engage the crown of the instrument, the perforator should be raised and replaced by the retractor. The operation is continued by gradually accelerating the rotatory movements, with moderate pressure. From time to time the trepan should be withdrawn in order to clear its teeth, and to examine with a stylet whether it has uniformly pierced the bone, or whether it has pierced it in some parts and not in others. Should this have happened we must endeavour to raise the disc of bone with the retractor.

When the operation is over, if the section is not quite complete, the projecting points of bone should be removed with the lenticular knife.

With the trephine the operation is perhaps more simple. The trephine first armed with the perforator is applied, and then is moved alternately from right to left and from left to right, and with an amount of pressure that is sufficient to make an impression upon the bone. The perforator is then to be raised and the operation continued until the perforation of the bone is complete, observing the same rules that regulate the use of the French trepan.

When it is desirable to apply the trepan more than once, the points should be at some distance from each other, while the intervening portions of bone may be removed with the cock's crest saw. Or the crowns of the trepan may be applied in such a manner that they encroach one upon the other, the angles of bone which intervene between them being removed with the cutting forceps. If we wish to raise by means of this operation pieces of depressed bone, an elevator should be applied between the cranium and the dura-mater without disturbing this membrane. If it is necessary to let out fluid effused beneath the dura-mater, a longitudinal or crucial incision should be made with a bistoury.

OPERATIONS WHICH ARE PERFORMED UPON THE ORGAN OF VISION.

OPERATIONS UPON THE EYELIDS.

Anatomy.—The Eyelids.

The following elements partly enter into the structure of the eyelids.

1. *The skin*, which is delicate, soft, elastic, and loosely united to the subjacent tissues.

2. *A layer of cellular tissue*, uniting the skin to the muscular layer. This tissue, being very loose, is favourable to the development of encysted tumours. It is often the seat of serous infiltrations and erysipelatous inflammation, and which subsequently give rise to traumatic lesions of the eyelids and face.

3. *The muscular layer*, composed of the most central fibres of the orbicularis palpebrarum, and forming thin pale arches over the eyelids, which are not connected at the external commissure. The upper eyelid has also its own muscle, the levator

palpebræ superioris, which is situated behind the orbicular muscle. This muscle takes origin within the orbit, and is attached to the tarsal cartilage by a thin aponeurosis. It receives its nervous filaments from a fasciculus of the third nerve, and it regulates the elevating movements of the upper eyelid, whilst the action of closing the lid is under the influence of the facial nerve. It is to paralysis of this muscle that blepharoptosis is for the most part due.

4. *The tarsal cartilages*, situated behind the muscular layer, and consisting of small fibrous lamellæ, constitute as it were the skeletons of the lids, which maintain them in their proper form and position. The cartilage of the upper lid is about double the depth of that of the lower one. Both are united internally and externally by a palpebral ligament, with which is connected the orbital aponeurosis.

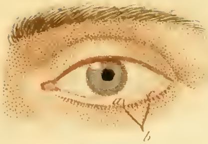
5. *The Meibomian glands* are situated between the tarsal cartilages and the conjunctiva. They open by minute ducts on the face and border of the eyelids. Their hypertrophy gives rise to very small tumours, which are frequently noticed on the conjunctiva.

6. *The conjunctiva or palepabral mucous membrane* covers the deep surface of the eyelid and is reflected upon the globe of the eye. It is very vascular, especially at the oculo-palpebral fold.

All the elements which enter into the structure of the eyelids are intimately united at the free border; but are more loose the further they are removed from this part.

The arteries of the eyelids are somewhat distant from the free borders, and only inosculate beyond the tarsal cartilages. We can therefore raise a semilunar flap from the free border of the lids without meeting with any considerable hæmorrhage.

Fig. 1



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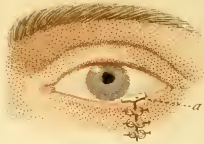


Fig 3.

Fig. 4

Fig. 5.

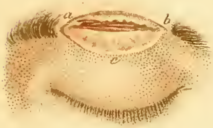
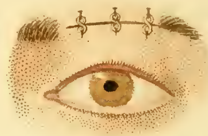


Fig. 5 bis



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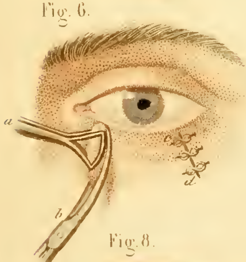

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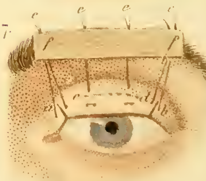

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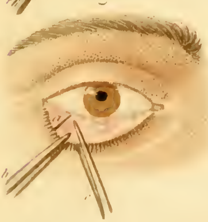

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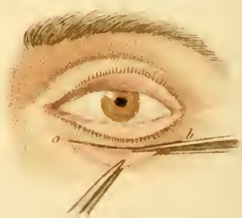


PLATE XXXVI.

OPERATIONS UPON THE EYELIDS.

Fig. 1.—*Symblepharon.—Ammon's method.*—The portion of eyelid which adheres to the globe of the eye is enclosed between two incisions, *a*, *b*, and *c*, *b*, which isolate it from the rest of the eyelid.

Fig. 2.—*Same operation finished.*—The two free edges of the incision are united by three sutures, the little adherent triangular, flap, *a*.

Fig. 3.—*Epicanthus.*—*a*, *b*, *c*, *d*, an elliptical wound, resulting from the excision of a fold of skin taken from the root of the nose.

Fig. 4.—*Blepharoptosis.—Ordinary operation.*—*a*, pressure or cross action forceps seizing a fold of skin, *b*, on the upper eyelid, which is excised with the scissors, *c*.

Fig. 5.—*Same operation.—Hunt's plan.*—*a*, *b*, *c*, form and position of the flap that is removed. Fig. 5.—*bis*, the operation completed. The edges of the wound are brought together with the twisted suture.

Fig. 6.—*Entropion.—M. Janson's plan.*—The surgeon seizes with Adams's forceps a vertical fold of skin, and excises it with the curved scissors, *b*; *c*, *d*, the same operation finished near the external angle of the eye; the edges of the wound are united by three twisted sutures.

Fig. 7.—*Entropion.—Crampton's method modified by that of Guthrie.*—*a* and *b*, vertical incisions carried through the whole thickness of the lid; *c*, *d*, transverse incision through only half the thickness of the lid. The edges of this incision are brought together with the sutures, *e*, *e*, *e*, *e*; a piece of plaster, *ff*, retaining the threads on a level with the eyebrow.

Fig. 8.—*Ectropion.—Adams's operation.*—*a*, first incision made into the lower lid; the surgeon seizes the edge of the lid outside that incision with the forceps, *b*, and with the scissors, *c*, cuts a small triangular flap.

Fig. 9.—*Same operation—Dieffenbach's plan.*—*a*, *b*, incision made in the lower lid; the surgeon with the forceps, *c*, draws the conjunctiva into this incision, and excises it with the scissors.

PLATE XXXVII.

FURTHER OPERATIONS PERFORMED ON THE EYELIDS.

Fig. 1.—*Ectropion—M. Desmarres's operation.*—*a*, *b*, first incision beginning at the external angle of the eye ; *b*, *c*, second incision beginning at the free border of the lower lid and joining the first at *b* ; *c*, *d*, and *a*, *d*, two incisions beginning at the internal extremities of the two first, and meeting at *d*, at the point of reflection of the ocular and palpebral mucous membranes.

Fig. 2.—*Same operation finished.*—Three sutures, *a*, *a*, *a*, uniting the edges of the wound.

Fig. 3.—*Blepharoplasty.*—*Jones's plan.*—*Operation finished.*—*a*, *b*, *c*, triangular flap replaced for the purpose of covering the denuded surface ; *c*, *d*, approximation of the integuments in order to fill up the wound which the removal of the flap has left behind.

Fig. 4.—*Blepharoplastic operation by displacement.*—*Method of Dieffenbach.*—*a*, *b*, *c*, triangular flap resulting from the removal of a tumour ; *b*, *d*, and *d*, *e*, two incisions enclosing a flap of skin which is reflected within in order to cover the wound, *a*, *b*, *c*.

Fig 5.—*Blepharoplasty by torsion.*—*a*, *b*, *c*, *d*, elliptical wound on the upper lid ; *c*, *e*, *f*, incision marking out a flap of skin from the forehead for the purpose of covering the wound, *a*, *b*, *c*, *d*.

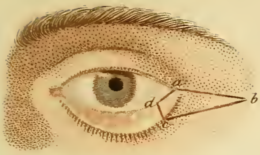
Fig. 6.—*The same operation finished.*—The flap covering the wound ; the sutures, *a*, *a*, *a*, fix it to the eyelid, while the edges of the wound that have been left behind are brought together with the twisted suture.

Fig. 7.— *Extirpation of tumours from the upper lid.*—Application of the round forceps of M. Desmarres.

Fig. 8.—*Extirpation of a tumour from the internal surface of the lower lid.*—An assistant, provided with a double grip forceps, *a*, everts the lid upon a support, *b*, while the surgeon dissects out the tumour with the forceps, *c*, and small bistoury, *d*.

Pl. 37.

Fig. 1.



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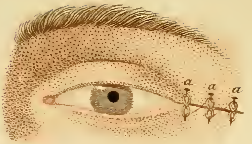

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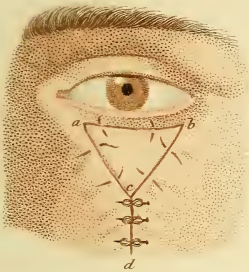

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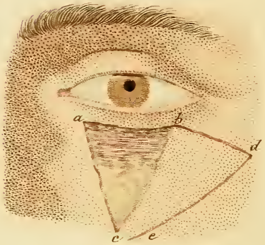

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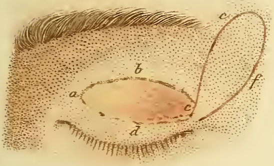

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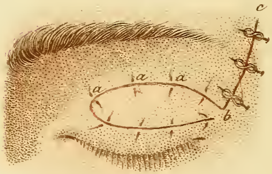

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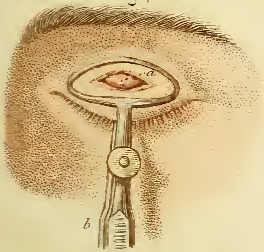

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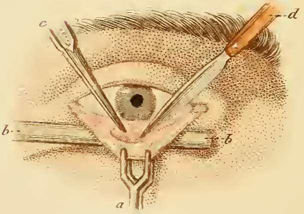

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METHODS OF OPERATING.

Coloboma.

Coloboma is a congenital or accidental division of the whole thickness of the eyelid. If the division is congenital, the edges should be pared, and afterwards brought together by means of two or three twisted sutures. If, on the other hand, it is accidental and recent, the bleeding edges of the wound should be approximated in a similar manner. The pins should be applied at a distance from the free border of the lids; they should pierce the skin and the tarsal cartilages, without, however extending through the whole thickness of the lid, so as to avoid the inflammation which would arise from their contact with the globe of the eye.

Ankyloblepharon.

Ankyloblepharon, or adhesion of the lids together at their free borders is rarely congenital. It is a frequent result of ulceration of the edges, and may be either partial or complete. If it be partial, we can, according to the extent of the adhesion, divide it either with the blunt-pointed scissors, or with a bistoury guided by a director introduced between the eye and the lids. If the adhesion is entire, we must first make a small opening at the external angle of the eye, between the two lids, and then insert into the aperture a director, which will guide the bistoury in the division of the adherent parts.

In all cases we must, before operating, be sure that the lids are not adherent to the globe of the eye. If there are any fibrous bands uniting the palpebral mucous membrane to the eye, they must be previously broken down with the stylet. Directly the operation is completed, it will be necessary to prevent the formation of fresh adhesions. For this purpose we should use an astringent lotion, place some foreign body between the edges of the lids, forcibly separate them by means of adhesive bands, cauterise them with nitrate of silver, etc. If adhesions form in spite of these measures, the cicatricial tissue must be daily destroyed. M. d'Ammon has also proposed to dissect a flap from the conjunctiva, and to fix it upon the wound.

Symblepharon.

Symblepharon, or the adhesion of the lids to the globe of the eye, is very rarely congenital. On the other hand, it is a frequent result of inflammation with loss of tissue, attacking the palpebral or ocular conjunctiva. The affection consists of fibrous bands, more or less approximated, which unite the palpebral mucous coat to the globe of the eye. These bands restrain the movement of the globe, and consequently it is necessary to divide them. If they are isolated, as in the bridle form, they can be cut with small curved blunt-pointed scissors. To prevent fresh adhesions, we must prevent the parallelism of the two little wounds resulting from the division of the bands by drawing the lid outwards by means of an adhesive fillet or band. When the symblepharon consists of numerous serrated bands, rendering the eye immovable, recourse must be had to the following operations :—

M. d'Ammon's operation (Plate XXXVI., figs. 1, 2) *for continuous adhesions.*—He encloses within two incisions, *c*, *b*, and *a*, *b*, carried through the whole thickness of the lid, that portion of it which is adherent to the globe of the eye. As soon as this triangular flap has been removed the eye will recover its usual movements. The two edges of the wound are then to be united with two or three twisted sutures.

Dieffenbach's method.—To attain the same object, Dieffenbach makes an artificial entropion. Two vertical incisions commencing at each angle of the affected lid give rise to a quadrilateral flap. The eyelashes are shaved off, the adhesions destroyed, and the four-sided flap formed by the lid is folded in such a manner that its external surface comes in contact with the wound in the eye without contracting any adhesion with it. Directly the wound in the eye is cicatrised, the artificial entropion is destroyed by bringing the lid back to its normal position.

Haynes Walton's method is to divide the adhesion centrally through its entire thickness, and unite each cut surface, which is always broad, severally by fine sutures.

Epicanthus.

D'Ammon gave the name of *Epicanthus* to a semilunar fold of skin, with its concavity externally encroaching more or less upon the inner angle of the eye (see Plate XXXVI., fig. 3). To correct this fault, a vertical fold of skin should be seized internally, and on a level with the epicanthus, at the expense of the skin of the nose. The effect of making this fold is to uncover the angle of the eye by dragging inwards the epicanthus which conceals it. The fold of skin is excised with one cut of the curved scissors. The edges of the oval wound thus produced are then brought together with sutures with the effect of removing the epicanthus. If the epicanthus is double it will be convenient to take a fold of skin between the eyes from the middle of the nose in order to remedy the affection on both sides by one operation.

Blepharoptosis (Plate XXXVI., figs. 4, 5, & 5 *bis*).

Blepharoptosis, Ptosis, Blepharoplegia, is the falling of the upper eyelid. It may arise from an elongation of the integuments, or from more or less complete paralysis of the elevator of the upper lid. The surgical treatment consists in removing the exuberant part of the lid.

Ordinary operation (fig. 4).—Seize with the pressure or cross action forceps, *a*, a transverse fold of skin, *b*, on the upper lid. The great point is to make the fold of skin of sufficient size to admit of the lid, when lowered, covering the globe of the eye. If it is made too short, a second operation will be necessary; if too long, it may lead to the formation of an entropion. The fold of skin should be excised with the scissors, *c*, the result of which is an elliptical wound, the edges of which must be brought together with two or three sutures. Some surgeons pass threads through the fold which has been seized by the forceps, and then excise it in front of the threads which are thus already in place for uniting the edges of the wound. This practice has the advantage of shortening the operation, and making it less painful.

It is recommended that the skin be removed in such a position as to take advantage of the action of the occipito-frontalis or supra-ciliary muscle.

Hunt's method (fig. 5 and 5 *bis*).—Having shaved the eyebrow, remove a semi-elliptical flap, *a*, *b*, *c*, the size of which should be in proportion to the extent to which the eyelid is relaxed, and bring together the edges of the wound in the usual manner. By this means the upper lid is elevated (see fig. 5 *bis*). The cicatrix of the wound is concealed by the eyebrow.

M. Sédillot has proposed to utilise the supraciliary muscle by dissecting its external insertion, which he causes to descend into the eyelid. By this means he would put the movement of the lid under the influence of those of the supraciliary muscle.

Entropion.

Entropion is an affection characterised by a turning inwards of the eyelids.

The indications for the surgical treatment of entropion must depend upon the nature of the causes producing it. Amongst these we may mention faulty conformations of the skin, or of the palpebral mucous membrane, contraction of the orbicularis palpebrarum, alterations of the tarsal cartilages, etc.

Entropion arising from relaxation of the skin or from spasmodic contractions of the orbicularis may be successfully treated with astringent or anti-spasmodic lotions; while bands of adhesive plaster, temporarily maintaining the lid in an everted position, are often sufficient to cure senile entropion. Should these measures prove unsuccessful, we may resort to blistering, or to cauterisation, and thus produce cicatrices, which may be effectual in restoring the lid to its natural state. The shape of the blister should correspond to that of the lid, and should be kept open several days. It has, however, the disadvantage of eaving behind a visible cicatrix.

Cauterisation is to be effected with the red-hot iron, or by means of sulphuric acid. If the actual cautery be used, we must first introduce under the lid a Beer's plate in order to steady and protect the globe of the eye; then pass a small cautery rapidly over the cutaneous surface of the lid in such a manner as to produce a transverse eschar. Cauterisation with the oil of vitriol, as proposed by Quadri, is less painful. Having settled upon the position and extent of the eschar, the globe of the eye is protected by an adhesive band applied over the palpebral opening. A drop of the acid is then to be spread transversely over the lid, with a glass rod.

After the acid has been allowed to remain on the lid for ten or fifteen seconds, it is to be wiped off. If the entropion is not corrected by this first cauterisation, several other applications of the acid may be made until the lid has assumed its normal position. It sometimes happens that the operation is carried too far, and that the entropion is followed by an eversion in the opposite direction. This risk is to be avoided by attaching the eyelashes to a thread fixed to the cheek for the upper lid, and to the forehead for the lower lid.

Excision of the skin, as proposed by Celsus.—This method is adopted in the graver forms of entropion ; and consists in excising a transverse fold of skin, the size of which should be proportionate to the degree of inversion. The operations described under blepharoptosis (see Plate XXXVI., fig. 4, 5, and 5 *bis*) are applicable to entropion.

Janson's method (see Plate XXXVI., fig. 6)—In place of removing a horizontal fold of skin, he seizes with Adams's forceps, *a*, a vertical fold, which he then excises with the curved scissors, *b*. The edges of the wound are brought together, with threads passed through the fold of skin previously to its excision, or by means of the twisted suture, *c*, *d*. Sometimes the excision of one fold is not sufficient, and it is necessary to remove two or three.

Haynes Walton dissects off with the scalpel the ciliary portion of the orbicularis muscle which lies on the edge of the eyelid, together with that amount of skin which covers the muscle, and unites the wound by sutures.

Crampton's operation modified by Guthrie (see Plate XXXVI., fig. 7).—This operation is chiefly applicable to entropions arising from a faulty condition of the tarsal cartilage ; and is performed in the following manner :—The surgeon makes with the straight scissors a vertical incision right through the lid a little to the outside of the puncta lacrymalis. A similar incision, *b*, is made near the external angle ; the enclosed flap is raised, and the two incisions united by a transverse one through the mucous membrane only. The flap is then let down, a small transverse fold of skin, *c*, *d*, is cut from the cutaneous surface of the lid, and the threads, *e*, *e*, *e*, *e*, passed through the edges of the wounds to bring them together, and fastened to the forehead, *f*, *f*. This operation, which is both painful and difficult of execution, leaves behind a deformity of the lid which has led to its abandonment.

Saunders's plan.—This consists in the removal of the tarsal cartilage. Having introduced beneath the lid one of Beer's plates, an incision is made from one angle to the other parallel with the palpebral edge, and two or three lines from the roots of the lashes. The skin is then to be dissected as far as the orbital border of the cartilage, which is to be seized with the forceps, detached from the conjunction and removed.

Trichiasis.

Trichiasis, or inversion of the eyelashes against the globe of the eye, differs from entropion in that the tarsal cartilage maintains its proper position. It may arise either from a malposition of the lashes or from the abnormal manner in which they are implanted. In the latter case there may be two (districhiasis) or three (tristrichiasis) rows of lashes.

Trichiasis is total when all the lashes of the same lid are turned towards the eye ; it is partial when only some of the lashes are thus placed. Total trichiasis, arising from a malposition of the lashes, may be treated by the same means that have been described for the cure of entropion, the measures adopted being in proportion to the gravity of the case. For partial trichiasis, M. Desmarres seizes a small transverse fold of skin close to the border of the affected lid, and excises it with a cataract knife. When the wound cicatrises the lashes are drawn into their normal position.

When these means cannot be adopted, we may have recourse to the following : (1) The straightening of the lashes ; (2) their extraction ; (3) their cauterisation ; (4) extirpation of their bulbs ; (5) excision of the free border of the lid.

The straightening of the lashes is effected by means of adhesive plaster, by which the lashes are maintained in an everted position over the cutaneous surface of the lids. We may also fix the affected lashes with a thread, restoring, and temporarily keeping them in their normal position by attaching the thread to the adjoining parts by means of a small piece of adhesive plaster· This proceeding, however, is only applicable to partial trichiasis.

Extirpation may be practised with or without cauterisation. Extirpation should be effected by removing with the hair forceps each individual lash. It is often necessary to repeat the operation, and it is to prevent the lashes from budding out afresh that cauterisation is also resorted to. M. Champmesme uses a small cautery at the end of which is a bulb, surmounted by a fine needle. The bulb, or reservoir of heat, is heated to a white heat, and the point of the needle is then introduced into each bulb of the lash. But this is a long, painful, and difficult operation. M. Carron du Villars prefers introducing into each hair bulb a long cold needle, and when the needles are all fixed, they are united into a bundle and seized with a curling iron, which is raised to a white heat. Heat is thus suddenly communicated to the needles, and all the bulbs are cauterised at once.

T extirpate the bulbs, as proposed by Vacca-Berlinghieri, a plate of ivory is introduced beneath the lid, an incision made parallel to its margin, according to the extent of the trichiasis. Two small vertical incisions are then made from the extremities of the first incision, so as to permit of a small flap of skin to be raised behind which the bulbs are brought into view, and dissected out one by one. M. Petrequin, of Lyons, removes the small flap of skin, and when cicatrisation has taken place, the border of the lid is restored to its proper condition.

Excision of the margin of the lid is done with scissors, taking care to spare the punctum lacrymale. Partial trichiasis may also be treated, after Schreger, by the excision of a small V-shaped flap, just as Adams operates for ectropion.

Ectropion (Pl. XXXVI., figs. 8--9, & Pl. XXXVII., figs. 1—2).

Ectropion or retroversion of the lids, is often produced by the same causes as those which give rise to entropion.

Diseases of the conjunctiva, deformities of the tarsal cartilage, a shrinking of the skin or affections which cause it, disease of the orbicular muscle, caries of the edge of the orbit, etc., are so many causes producing different varieties of ectropion, for each of which special treatment is required.

Ectropion occasioned by diseases of the conjunctiva.—If acute inflammation of the conjunctiva has caused a temporary tumefaction, the ectropion thus produced may be combatted by scarifications, or by the application of lunar caustic. But if in consequence of this inflammation the conjunctiva is hypertrophic and the seat of fungous granulations, cauterisation will then be insufficient, and it will be necessary to excise the swelling formed by the diseased membrane. The excision is effected by seizing the conjunctiva with the forceps or hook, and cutting off the exuberant part with the curved scissors. Care must be taken not to remove too much tissue, otherwise entropion will result. The lid is then drawn up and kept in contact with the globe of the eye by means of a bandage.

Antyllus removed from the diseased mucous membrane a triangular flap, the base of which was turned towards the free border of the lid ; but this plan has no advantage over the one above described.

Dieffenbach's operation (Plate XXXVII., figs. 3 to 6.)—To restore the lower eyelid to its proper position, by operating upon the conjunctiva, a transverse incision, *a*, *b*, is made over the cutaneous surface of the lid, beyond the adherent border of the tarsal cartilage. This incision should go completely through the lid as far as the conjunctiva. The latter should then be seized with the forceps, *c*, and drawn out through the lips of the wound, in such a manner as to turn the lid inwards. The hernial portion of mucous membrane is excised with fine scissors, and the lips of the wound are united to the lower lip of the cutaneous wound by several sutures.

Adams's operation (Plate XXXVI., fig. 8).—It must always be recollected that ectropion is due to an abnormal lengthening of the eyelid. We may, therefore, remove from the lid a triangular flap comprising its whole thickness. The base of the flap should be at the free border of the lid, and be proportioned to its looseness. The two edges of the wound are then to be brought together by means of a twisted suture, as directed in the case of coloboma.

M. Desmarres's operation (see Plate XXXVII., figs. 1 & 2).—M. Desmarres, wishing to avoid the visible and objectionable cicatrix which is always left after Adams's operation, adopts the following method :—One horizontal incision, *a, b,* is made from the external angle of the eye ; and a second, *c, b,* commencing at the free border of the retroverted lid, meets the first incision at *b.* Two other incisions, *a, d, c, d,* describe on the conjunctiva a small triangular flap, the base of which coincides with the base of the first flap, *a, b, c ;* the tissues enclosed within these incisions are then excised, while the two edges of the wound, *a, b,* and *c, b,* are united by means of sutures, fig. 2, *a, a, a ;* the resulting cicatrix is hid in the folds of the external angle of the eye.

Ectropion caused by elongation and malformation of the tarsal cartilage.—This is to be remedied by excising the cartilage. Weller first removes the fungous growths which cover the conjunctiva, and then excises about the twelfth or sixth of an inch of the tarsal cartilage, taking care to spare the external ridge of the border of the lid. The wound is then allowed to heal of itself.

Under the name of *tarsoraphy,* Walther has described a method which consists in removing within the same triangular flap the two external ends of the cartilages. The base of the flap embraces all the external angle of the eye, while the apex points towards the temple. The lips of the wound are then united by means of several twisted sutures.

Ectropion from contraction of the skin.—The cicatrisation of burns and wounds which are attended with loss of substance, is the most frequent cause of this variety of ectropion. In some cases we may resort to Adams's operation (Pl. XXXVI., fig. 8), taking care to prolong one of the incisions beyond the summit of the triangle.

If the cicatricial bridles are of small extent and have not contracted adhesions to the adjacent bones, we may cut them through transversely, and enlarge the space occupied by the cicatrisation, by keeping apart the lips of the wound by means of adhesive plaster, or we may prevent immediate union by the interposition of some foreign body, or we may follow the recommendation of M. Amussat and destroy daily the cicatricial tissue as fast as it forms at the bottom of the wound.

Should the cicatrix adhere to the ridge of the orbit, we must enclose it between two incisions, dissect freely the lips of the wound, and bring them forwards over the cicatrix on the bone.

This operation has been successfully performed by MM. d'Ammon and Desmarres.

When the cicatrices are too extensive to admit of our adopting the above measures, we must have recourse to blephoraplasty (see Pl. XXXVII., fig. 3, 4, 5, 6).

The *affections of the orbicularis palpebrarum* which give rise to ectropion are : spasmodic contraction and displacement of the fibres of the muscle. In the first case the usual medical treatment should be adopted. If that fail, we must cut across the fibres of the muscle beyond the part which adheres to the cartilage. In the latter case M. Desmarres strongly recommends cauterisation with sulphuric acid, or the excision of a cutaneous fold near the ciliary margin of the lids. By this means the fibres which are averted from the free border of the tarsal cartilage would be liberated.

TUMOURS OF THE EYELIDS.

I. *Encysted tumours.*—With respect to their seat they are: (1) sub-cutaneous ; (2) sub-muscular, beneath the orbicular muscle ; (3) sub-mucous, between the tarsal cartilage and the conjunctiva.

The surgical treatment to be adopted in these cases consists of incision, cauterisation, and excision. The tumours may be reached either from the anterior surface of the lids or from the conjunctiva ; but their situation will indicate the best plan to be adopted. Incision into and extirpation of the cysts from the conjunctiva have the advantage of not being followed by visible cicatrices, and of not exposing the lids so much to erysipelas.

Incision alone is rarely sufficient to prevent their return. It is chiefly applicable to those tumours which, being seated between the conjunctiva and the tarsal cartilage, are adherent to the cartilage, and when their dissection necessitates a loss of tissue, the cicatrisation of which would ultimately lead to an entropion.

Incision combined with the application of the nitrate of silver is more efficacious, as then adhesive inflammation is set up in the walls of the cyst.

In order to cut into and excise the cysts from the conjunctiva, an assistant keeps with his fingers or with smooth-bite forceps the lid retroverted over a small rod, or other support (see Plate XXXVIII., fig. 8). The surgeon, with a pair of forceps and a small bistoury, makes an incision into the conjunctiva which should pass a little to the right and left of the tumour, and then the cyst may be dissected and raised without being opened. To remove these cysts from the anterior surface of the lids, the lid is to be held between the fingers, and the dissection proceeded with as above described In all cases the tumour should be cautiously isolated from the tarsal cartilage.

Desmarres's operation (Plate XXXVII., fig. 7).—This has the advantage of being more easy, by tensing the lid, and stopping the hæmorrhage by maintaining pressure all round the tumour. A pair of annular forceps, one branch of which ends in a plate and the other in a ring, takes hold of the lid. The ring in being pressed towards the plate presses around the tumour so as to stop the hæmorrhage. The forceps is entrusted to an assistant, and the surgeon dissects out the tumour in the manner already described.

II. *Chalazion* is a small, indolent, and slightly movable tumour, occupying the free border of the lids. It is not unusual to meet with a series of them, forming a chaplet from one corner of the eye to another. They should be treated in the same manner as other encysted tumours.

III. *Erectile tumours.*—Compression, the ligature, and cauterisation can be successfully employed in these cases. The form and extent of the tumour will show what means should be adopted. For cauterisation, Carron du Villars transfixes the tumour with several needles, which he unites to a metallic ball. The ball is heated to whiteness and the cauterisation is followed by suppuration, which destroys the tumour.

IV. *Cancerous tumours.*—The excision of these tumours cannot be submitted to any particular rule. They may be enclosed between two curved incisions or two incisions in the shape of a V.

The lips of the wound may then be brought together with sutures, provided its extent and form permit of it.

V. Encanthis, or tumour of the caruncula lachrymalis, may be treated by cauterisation, or it may be extirpated. The latter method is to be preferred. By means of a hook, or the forceps, the tumour is drawn outwards, and is then excised either with the bistoury or the curved scissors.

Blepharoplasty (Plate XXXVII., fig. 3, 4, 5, 6).

This operation is one by which we repair, at the expense of the adjoining parts, eyelids which have undergone a partial or total loss of substance.

The measures which have been adopted in order to attain this object may be arranged under the three following methods: that of extension, that of displacement, or inclination (the French method), and that of torsion of the flaps (Indian method).

1. *Operation by extension.*—Jones's operation (Plate XXXVII., fig. 3).—Having pared the edges surrounding the lost substance, two incisions, *a*, *d*, and *b*, *d*, are to be made, beginning at the lips of the defective part, and terminating in the shape of a V on the forehead, for the upper lid, or on the cheek, for the lower lid. The base of this triangular flap will generally suffice to repair the damaged lid. This first part of the operation being finished, he proceeds to dissect the triangular flap, beginning at its apex. The lid then assumes its natural form. Sutures are then to be applied in the edges of the wound, *c*, *d*, which is left behind in consequence of the displacement of the flap. Fig. 3 represents the operation finished, the flap, *a*, *b*, *c*, having been raised in order to compensate for the loss of substance. (The line, *a*, *b*, should not be an incision as represented in the plate.)

2. *Operation by displacement.* — *Dieffenbach's operation.* — Dieffenbach, having raised a triangular flap, *a*, *b*, *c* (fig. 4), makes an incision from the external angle, *b*, and from the point, *d*, he encloses by another incision, *d*, *e*, a flap, *c*, *b*, *d*, *e*, adhering by a pedicle, *c*, *c*. This flap is to be dissected and carried inwards upon the wound, *a*, *b*, *c*, where it is fixed by sutures. It leaves behind it another wound, which very soons heals.

3. *Operation by torsion of the flap* (Græfe & Fricke, figs. 5, 6).—The morbid cicatrices may be removed by two incisions which enclose an elliptical wound, *a, b, c, d.* A flap is then cut at the expense of the fronto-temporal region of the upper lid; and of the cheek for the lower lid. This flap should be of the same shape as the wound, and nearly a quarter of an inch larger than it. It is cut by making from the point, *c*, an incision which must be carried as far as *e, f*, and brought back on a level with and outside the point, *c*. The flap, having been carefully dissected, must be twisted on its pedicle in order to place it horizontally on *a, b, c, d*, where it should be fastened by the sutures, *a, a, a* (fig. 6). The edges of the artificial wound may then be brought together with the twisted suture.

PLATE XXXVIII.

OPERATIONS ON THE LACHRYMAL APPARATUS.

Anatomy.

Fig. 1.—*Vertical antero-posterior section, showing the relations of the nasal fossæ, the mouth, and the pharynx.*—*a.* the inferior turbinated bone; *b*, Laforest's probe introduced into the nasal passage through the inferior meatus; *c*, Belloc's sound for plugging the nasal fossæ; *d*, Deleau's probe introduced into the Eustachian tube, *e*; *f*, probe introduced into the internal orifice of Steno's duct.

Fig. 2.—*Anatomy of the lachrymal apparatus.*—This consists of the lachrymal gland and its excretory ducts, the lachrymal ducts, the lachrymal sac, and the nasal duct.

The lachrymal gland is composed of two distinct portions, one overlapping the other. The larger or orbital portion is placed in the hollow on the inner side of the external angular process of the frontal bone, to which it is tolerably firmly united by fibrous bands, its anterior surface corresponding with the orbital arch. The palpebral portion, of less size than the other, is situated a little lower and to the outside; it is covered by the upper eyelid, and by a dense fibrous membrane; its inferior border being often in relation to the upper border of the tarsal cartilage.

The puncta lacrymalia are only the external orifices of the ducts of the same name, *b* and *c*, fig 2. Situated on the free border of the lids, about one-eighth of an inch outside the internal commissure, they present the form of minute gaping holes in two small conical tubercles, the lower one looking upwards and the upper one downwards. Their calibre will allow the introduction of a boar's bristle; and among southern people, in whom they are much larger, they will easily admit a small probe. According to Janin, the lower punctum is larger than the upper, a fact which we may turn to account in catheterism of the lachrymal passages.

The *lachrymal ducts*, *b* and *c*, embedded in the substance of the lids, conduct the tears into the lachrymal sac. In performing

Fig. 1

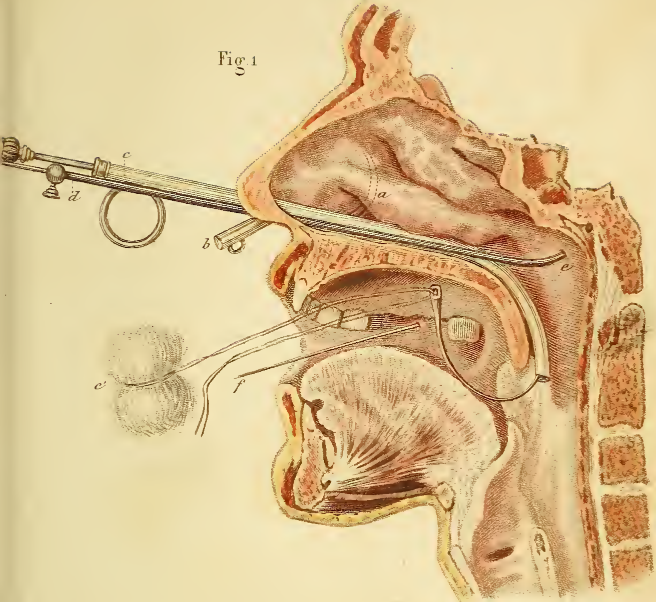


Fig. 2.

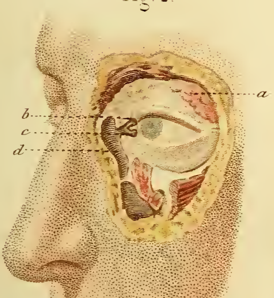
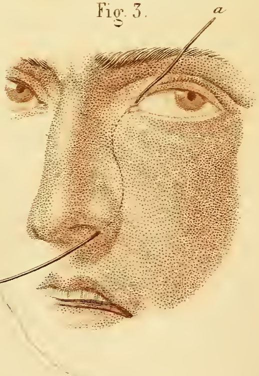


Fig. 3.



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catheterism, their angular direction should be borne in mind. Taking their departure from the puncta, they extend perpendicularly (the upper one upwards, and the other downwards) into the lid. After a short course of about the twelfth of an inch, they suddenly bend, the upper one being directed inwards, and a little obliquely from above downwards ; and the lower one in the same direction, but from below upwards. The lachrymal ducts thus meeting each other often open into the lachrymal sac by a common duct, but more frequently they are separated by a partition. Their texture is loose, and by means of slight tractions made externally over the borders of the lids, we may make their curved form sufficiently straight to admit of our introducing straight probes. Their calibre, which is considerably greater than that of the puncta lacrymalia, is maintained by the elasticity of its walls.

The *lachrymal sac, d,* and the *nasal duct* form, by their union, one channel through which the tears flow into the inferior meatus, below the inferior turbinated bone. The sac which constitutes its upper portion consists of a small oblong and vertical reservoir, into which the lachrymal ducts open. Terminated above by a cul-de-sac, it is continuous below with the nasal duct. It is lodged in an osseous groove formed behind and within by the approximation of the os unguis, with the nasal process of the superior maxilla and inferior turbinated bone. Its external half is membranous, and is covered by the tendon of the orbicular muscle, which the lachrymal sac causes to jut out both above and below. This relation is of some importance, the tendon of the above muscle serving as a guide in penetrating the lachrymal sac. The insertion, however, of this tendon is subject to variations, so that the surgeon is sometimes obliged to have recourse to other data. The upper orifice of the nasal duct is found behind the osseous ridge, which is met with on the inside of the base of the orbit, when following with the finger, from without inwards, the inferior orbital ridge. This bony projection, which limits the lachrymal groove below, is the most reliable landmark.

The *nasal duct,* which is a continuation of the lachrymal sac, is formed, as regards its bony portion, in front by the nasal process of the maxillary bone, on the inside and behind by the os unguis and the small process of the inferior turbinated bone, and on the outside by the internal wall of the antrum Highmorianum. We can, therefore, through the posterior wall of the nasal duct, reach either the nasal fossæ or the antrum.

The length of the duct varies from two-thirds to four-fifths of an inch ; its upper orifice is elliptical from behind forwards, and its diameter in the same direction may be over a quarter of an inch. The lower orifice, situated beneath the inferior turbinated bone, is wedge-shaped from within outwards, at the expense of the external wall of the nose. In front it is provided with a small valve, which is often sufficiently developed to prevent the introduction of instruments, except from behind forwards.

Fig. 3.—Catheterism of the lachrymal passages through the upper punctum lacrymale.—a, Mejean's probe ; *b,* Seton.

Fig. 1.

Fig. 4.

Fig. 2.

Fig. 3.

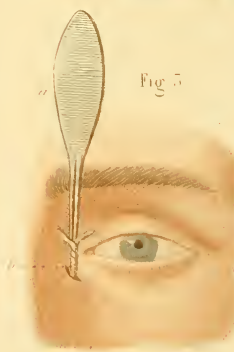


PLATE XXXIX.

OPERATIONS WHICH ARE PERFORMED ON THE LACHRYMAL APPARATUS (*Continued*).

Fig. 1.—*Catheterism of the lachrymal passages through the lower orifice of the nasal duct.—Laforest's method.*—*a*, first position of the catheter; *b*, second position; the back of the instrument is inserted in the lower orifice of the nasal duct; *c*, third position of the catheter introduced into the nasal duct.

Fig. 2.—*Temporary dilatation of the lachrymal passages.—J. L. Petit's method, modified by Desmarres.*—*a*, the fingers of an assistant pulling the external angle of the lids in order to make prominent the tendon of the orbicularis palpebrarum; while the surgeon punctures the lachrymal sac with the bistoury, *b*, and introduces into the orifice the probe, *c*.

Fig. 3.—*Third step of the operation.*—A grooved director, *a* is inserted into the lachrymal duct, and serves to introduce the piece of cat-gut, *a*, by which temporary dilatation is to be effected.

Fig. 4.—*Permanent dilatation—introduction of the canula.*—The duct opened by the bistoury, *a*, which presses against the posterior lip of the wound. The surgeon introduces the canula, *b*, with the assistance of mandrel forceps.

LACHRYMAL TUMOUR AND FISTULA.

Steps of the Operations.

The different affections to which the lachrymal apparatus is exposed may cause a mechanical stoppage of the tears, or give rise to an accumulation of fluid in the lachrymal sac, which distends it and produces a *lachrymal* tumour.

If the tumour is not removed by appropriate treatment, it increases in size, the skin inflames, ulceration takes place, and the fluid contained inside the sac runs out through a false passage, and gives rise to a *lachrymal fistula.* In the surgical treatment of these affections we endeavour to fulfil one of the three following intentions:—1. The re-establishment of the natural passage for the tears. 2. The production of new channels. 3. The obliteration of the natural channels.

1. *The re-establishment of the natural passages.*

The means employed for this purpose are : injections, catheterism, dilatation, and cauterisation.

1. *Injections.* — Often employed with success in cases of obstruction, injections at the same time permit of our conveying into the lachrymal ducts medicated fluids. An Anel's syringe is used for the purpose. The patient being seated in a chair, with his head kept in position by an assistant, the surgeon places himself in front of him, holding the syringe in his right hand for operating upon the left eye, and (unless he is ambidextrous) standing behind the patient, when operating on the right eye. The fingers of the other hand should gently evert the lower lid, so as to project forward the orifice of the inferior punctum lachrymale, which is to be chosen because it is shorter and larger than the upper one. The end of the syringe should be introduced perpendicularly to the palpebral border. It often happens that the punctum contracts, and prevents the introduction of the syringe ; but by gentle and careful pressure we may easily overcome the momentary resistance set up by the contraction of the puncta. The nozzle being introduced to a depth of one or two lines, we must depress the syringe externally so as to engage the nozzle in the horizontal portion of the duct. Once the lachrymal sac reached, the surgeon should gradually propel the fluid in order to overcome the obstruction in the duct. This will have been effected when the fluid flows pretty freely from the nostril.

2. *Catheterism.*—Catheterism is performed by means of silver probes sufficiently fine to pass through the lachrymal puncta. It is best to pass them through the upper duct. Gentle traction made externally upon the upper lid will straighten the angular direction of the duct into which the probe is introduced ; and thus we endeavour to push it into the nasal duct.

Catheterism through the inferior orifice of the nasal duct.—Laforest's metohd.—This operation is performed by means of either hollow or plain probes, the curvature of which corresponds to that of the nasal duct. The patient being seated, an assistant keeps the head in a firm position, and a little inclined backwards. The surgeon then introduces the end of the sound underneath the nostril in such a manner that it can be passed beneath the inferior turbinated bone of the nasal fossæ, by giving to the instrument a rotatory movement (see Pl. XXXIX., fig. 1 *a*). The effect of this rotatory movement is to engage the end of the sound in the lower orifice of the nasal duct ; an operation whic is carried out by gentle to-and-fro movements, for it is always from behind forwards that we must enter the inferior orifice ; *b* represents the second position of the sound. In order to make it enter the nasal duct, it is necessary to give the instrument a half turn, by which means its curve is carried inwards and downwards (*c*). Directly this third step in the operation is accomplished the sound easily reaches the lachrymal sac. Plain sounds are sufficient to remove obstructions, but once the passage is free, we must have recourse to the hollow sounds of Gensoul, with which it is easy to use injections from below upwards.

3. *Dilatation.—Mejean's operation.*—This consists in performing catheterism through the superior lachrymal punctum with a probe whose upper end is perforated and threaded with silk. The probe passes through the nasal duct as far as the inferior meatus, carrying the thread with it. Or the eyelet end of the probe may be introduced, and then, when this end has cleared the nasal fossæ, the thread may be passed and drawn through (see Pl. XXXVIII., fig. 3). By this means the lachrymal puncta will be less frayed.

4. *Dilatation by an artificial opening.—J. L. Petit* makes at first an incision into the lachrymal sac for the purpose of introducing the foreign bodies that are intended to dilate the duct. He uses a grooved bistoury, over which he passes every day into the duct a different bougie. The external wound soon heals up. *Scarpa* uses a leaden style.

Lecat opened the sac in the same manner, but in place of using a bougie, or any other solid body, he inserted in the lachrymal passages a thread, by means of which he lifted up a tent into the nasal duct. This method does not differ from that of Mejean, except that the artificial opening facilitates the passage of the thread.

Pouteau, in order to spare the patient the disfigurement of a cicatrix, enters the sac from the internal surface of the lid.

Jurine introduced at first a canula, in which he placed a curved probe, passing it out by the nostrils and carrying with it the thread to draw up the tent.

Pamard passed into the canula the spring of a watch, which in virtue of its elasticity passes outside the nostrils and then recoils upwards with the thread to which the tent is fixed.

Fournier fastened to the thread a grain of lead for the purpose of drawing it outside.

Cabanis laid hold of Mejean's probe previously introduced into the lachrymal passages by passing beneath the turbinated bone a plate with a hole in it, and with which he seized the lower end of the probe. A second plate, gliding upon the first, nips the end of the instrument, which is then easily drawn out.

M. Manec introduces into the nasal duct, from below upwards, a sound provided with a sharp point. The sharp point pushed up pierces from behind forward the anterior wall of the lachrymal sac, and admits through its eye the introductions of a thread which can then be drawn downwards and by means of which a tent can be drawn up.

M. Morel Lavellér makes use of a probe curved in the form of an arc, supporting a thread which is fixed by a small groove at the end of the instrument. The thread thus is easily seized with forceps beneath the inferior turbinated bone, and drawn out.

Such are the chief modifications of the operations of J. L. Petit and Lecat, in order to facilitate the passage of the thread through the lachrymal passages. Whatever plan is adopted, the rules of cutting into the sac are the same.

M. Desmarres' operation (see Pl. XXXIX., figs. 2 & 3).—The instruments required for this operation are a bistoury, a director, a hollow sound, and cord made of cat-gut.

First Step.—Puncture.—An assistant should keep the head of the patient still, and with his finger draw aside the external angle of the eye in order to make prominent the tendon of the orbicularis muscle, as this tendon is a guide in finding out the upper orifice of the nasal duct (see Anatomical Indications). The bistoury being held in the right hand, the little finger of which rests upon the malar bone, is plunged into the lachrymal sac from before backwards in the direction of the os unguis ; then the handle of the instrument, being depressed a little inwards and backwards, until it nearly touches the eyebrows, the blade is made to penetrate about two or three lines into the lachrymal sac and the nasal duct.

If there has been previously a fistulous opening a little distance off, the incision should be carried up to it in order to completely divide the fistulous tract.

Second step.—Introduction of a probe, over which is passed a hollow sound.—The bistoury is half withdrawn, and along its blade a probe passed and thrust into the nasal duct (fig. 2). This probe serves the purpose of conducting a grooved sound.

Third step.—Introduction of the cat-gut cord (fig. 3).—The sound being inserted in the nasal duct, the cat-gut cord, which is to effect the dilatation, is passed through the sound, which is afterwards withdrawn. This cord presents above two small wings, as it were, which prevent it from falling into the nasal duct. It should be changed every day for one of larger size, and soon Scarpa's style may be substituted for it. The introduction of the cord is often followed by a pretty active inflammatory reaction, occasioned by the swelling of the cord in the interior of the duct. It is therefore necessary to withdraw it at the end of twenty-four hours, and to introduce a very fine Scarpa's style, which can be every day replaced by other nails which gradually increase in size.

5. *Permanent dilatation.—Introduction of a permanent canula.*—Vesalius was the first to apply the canula to the treatment of lachrymal affections. This method, revived a long time afterwards by Foubert, Wathen, and Pellier, has been adopted and modified by Dupuytren. Dupuytren's operation consists of two stages : puncture of the sac and introduction of the canula. The first step in the operation is the same as for temporary dilatation described above (M. Desmarres' method). To introduce the canula the lips of the wound should be separated by pressing

upon their posterior edge with the handle of the bistoury. Then the canula should be inserted into the sac and duct ; and directly it has entered the duct the bistoury is to be withdrawn, and the canula pushed down until its upper edge disappears in the lachrymal sac. In order to ensure the proper position of the canula in the sac and duct the following experiment should be made. The nose and mouth of the patient being closed, he must be directed to make a strong expiration ; if the canula is in a proper position a little blood mixed with air will exude from the external wound. As a dressing for the wound we may apply to it a small piece of court plaster.

MM. Bérard and *Cloquet* dilate the duct with a tent before the introduction of the canula. This precaution is useful, as the walls of the duct are thus habituated to the contact of foreign bodies, and are less exposed to the inflammatory reactions which so often occur after the immediate introduction of canulas.

The form of the canula has been variously modified. That adopted by Pellier had two enlargements, one above and one in the middle. Dupuytren designed a canula with an enlargement above, in order to facilitate its extraction when required. M. Gerdy extols canulas with a projecting rim so as to prevent their rising up. For the same purpose Riterick, of Leipzic, and afterwards Mill, Petrequin, and Lenoir used cleft canulas, the lappets of which fly back directly the instrument is in place. For the insertion of this kind of canula M. Lenoir has designed a very ingenions mandrel, which closes the lappets.

Remarks.—The introduction of canulas is not always free from danger. It is often followed by accidents of an inflammatory nature, which oblige the surgeon to extract the instrument. Forceps are designed for the purpose of withdrawing canulas from the nasal duct.

Cauterisation.—*Harveng* opened the sac in the ordinary way, and cauterised its interior, either with a small cautery heated to whiteness, or by introducing from above downwards, through a canula, a small tent covered with nitrate of silver.

M. Gensoul cauterises the duct from below upwards, by means of curved catheters, armed with the porte-caustique.

M. Lallemand, of Montpellier, opens the duct, inserts a morsel of nitrate of silver, about the size of a millet seed, and closes up the wound with a piece of court plaster. An eschar is formed inside the sac and the duct, and is then discharged from above downwards. M. Lallemand has adopted this plan with success in several obstinate cases.

Haynes Walton slits up the lower canaliculus and reopens it with a probe as often as it reunites, till a canal is established, and then introduces a solid style, long enough to reach from the lachrymal sac to the end of the nasal duct. The style is allowed to remain till pus no longer escapes from the sac.

2. *The formation of an artificial duct.*

The operations we have described are often insufficient; and we must then make a new channel for the tears.

Wolhouse made a large opening into the lachrymal sac, by means of a semi-elliptical incision, and plunged a pointed stylet through the os unguis, having previously extirpated the sac. A tent of charpie or a small canula was then introduced to keep the perforation open.

Hunter made use of a punch to perforate the os unguis; but his operation requires special instruments, and is no longer performed.

Wathen made with a drill a new passage in the direction of the natural duct, and then fixed a permanent canula.

M. Laugier has proposed to perforate with a curved trocar the wall of the maxillary sinus, and to place a canula in the opening.

3. *Obliterations of the lachrymal passages.*

1. *Nannoni* destroyed the sac. To do this he made a large opening, filled it with charpie, and then cauterised it either with caustic or the actual cautery.

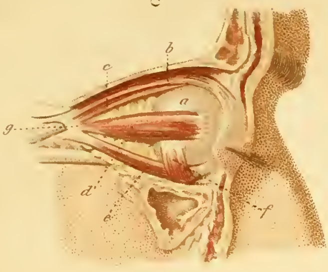
Bosche, relying upon the fact that the puncta lachrymalia may be congenitally obliterated without the patient suffering from watering of the eyes, cauterised the puncta by introducing into them a small piece of nitrate of silver.

2. *Removal of the lachrymal gland.—M. Paul Bernard* has successfully performed this operation in a case of chronic water-

ing of the eyes, which he attributed to a hypersecretion of the gland. The operation was as follows :—A vertical fold of skin is seized below the orbit, and on a level with the gland. An incision is then made from the base of the fold to its summit, with a fine bistoury, in such a manner that when it returns to its place a longitudinal wound is left of about a quarter of an inch in length, through which the orbit can be reached. It is then easy with a hook and scissors to detach and remove the gland.

Remarks.—The obliterations of the lachrymal passages, and the removal of the lachrymal gland, ought only to be resorted to after the measures described above have failed. We must therefore consider these two operations as offering the last chance of curing those cases which have proved rebellious to other modes of treatment.

Fig. 1.



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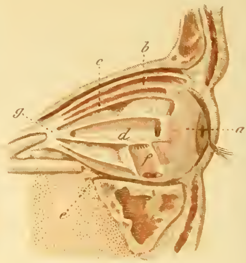

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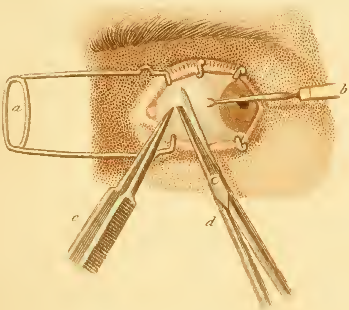


Fig. 3.

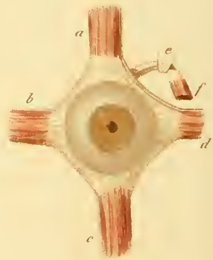


Fig. 5.

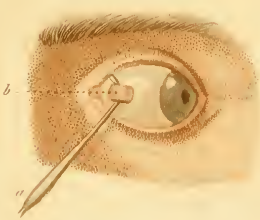


Fig. 6

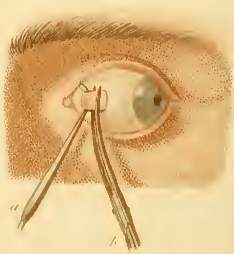


PLATE XL.

OPERATIONS WHICH ARE PERFORMED ON THE MUSCLE OF THE EYE.

ANATOMY.

Fig. 1.—*Antro-posterior and vertical section of the orbit, showing the muscles of the right eye—external view.*—*a*, globe of the eye ; *b*, the levator palpebra superioris ; *c*, the superior rectus ; *d*, the external rectus ; *e*, the inferior rectus ; *f*, the inferior oblique ; *g*, the origins of the muscles of the eye.

Fig. 2.—*Represents the auponeurotic sheaths formed by the orbital aponeurosis.*—*a*, globe of the eye ; *b*, sheath of the elevator of the upper lid ; *c*, sheath of the superior rectus ; *d*, sheath of the external rectus; *e*, sheath of the inferior rectus ; *f*, sheath of the oblique.

Fig. 3.—*The disposition of the muscles and of their insertion into the sclerotic.*—*The eye is seen in front and the muscles are lifted up from behind forwards.*—*a*, superior rectus ; *b*, external rectus ; *d*, internal rectus ; *c*, inferior rectus ; *f*, the superior oblique muscle passing over its pulley, *e*.

Fig. 4.—*The operation for strabismus.*—*M. Sédillot's plan.*—The lids are kept away by a blepharectome, *a* ; *b*, a tenaculum entrusted to an assistant ; *c*, forceps raising a fold of conjunctiva ; *d*, scissors cutting the fold in order to expose the muscle.

Fig. 5.—A blunt hook, *a*, is passed beneath the muscle, b.

Fig. 6.—*a*, the blunt hook ; *b*, the scissors cutting through the internal rectus muscle.

The movements of the globe of the eye take place around three axes, an antero-posterior, a transverse, and a vertical axis. These movements are regulated by six muscles : the four recti and the two oblique.

The four recti have a fixed point of origin behind the globe around the optic foramen, from whence they diverge and embrace the globe from behind forwards into the anterior hemisphere of which they are inserted, about two or three lines behind the circumference of the cornea—an attachment that is very favourable for those rotatory movements of the globe which they determine. These four muscles are :—

1. The *superior rectus,* situated in the upper part of the orbit beneath the elevator of the upper lid. It raises the pupil by making the eye turn upon its transverse axis.

2. The *inferior rectus,* diametrically opposed to the preceding, also moves the globe upon its transverse axis, but lowers the pupil. It passes between the globe and the inferior oblique which is inserted above its external border.

3. The *internal rectus,* situated on the internal wall of the orbit, moves the eye on its vertical axis, and carries the pupil inwards.

4. The *external rectus* placed on the external wall of the orbit antagonises the preceding muscle. Its insertion into the sclerotic is a little nearer the cornea than that of the other rectus.

The two oblique muscles move the globe of the eye on its antero-posterior axis.

1. The *superior oblique* takes its origin from around the optic foramen ; from thence its direction is forwards and inwards as far as the internal orbital margin of the frontal bone, where it is received into a fibrous ring, from which it is reflected as from a pulley. On leaving this ring it is directed from within outwards, passes beneath the superior rectus, and is inserted into the posterior hemisphere of the globe. When it contracts it carries the pupil a little downwards and outwards.

2. The *inferior oblique* from the anterior inferior angle of the floor of the orbit. It turns below the globe of the eye from within outwards, to be inserted by a large tendon into the posterior hemisphere below the insertion of the superior oblique. Three different nerves supply these muscles : the motor oculi, or third nerve, which supplies the superior, internal, and inferior recti ; the fourth, or supra-trochlea, for the exclusive supply of the superior oblique, and the sixth nerve, for the supply of the external rectus.

The orbital aponeurosis.—The globe of the eye is supported in the middle of the orbit by means of the orbital aponeurosis. Suspended in this fibrous shell, it can execute with rapidity its rotatory movements without being liable to any such displacement that might, in respect of the two eyes, destroy that simultaneous action which is so indispensable to clearness of vision. This aponeurosis, after lining the orbit and forming the palpebral ligaments, is reflected upon the globe, envelops its two posterior thirds, furnishes sheaths to the muscles, and terminates behind in the neurilemma of the optic nerve. It contracts adhesions to the anterior portion of the muscles, just as these are about to be inserted into the sclerotic. This disposition does not always permit of each muscle acting separately. It accounts for the movements which persist after the muscle itself has been cut across, since the globe of the eye is thus subject to the movement of the orbital aponeurosis.

STRABISMUS.

Operations.

Strabismus is a fault in the regular convergence of the two visual axes.

There are four kinds of this affection : *Internal* or *convergent*, strabismus ; *external* or *divergent ; superior* or *ascending ; inferior* or *descending.*

The indications and contra-indications for operating are to be drawn from the nature of the causes giving rise to the disease. We must only operate, when the strabismus is occasioned by muscular contraction, a circumstance which it is easy to determine by closing the sound eye, and making the affected eye deviate from its abnormal direction. This movement is impossible in cases of shortening or permanent contraction of the muscle ; but still such inability to move the eye is not an absolute contra-indication, for it must be determined that the opposing muscle is not paralysed. Lastly, we should not think of operating when there are amaurosis, an artificial pupil, specks upon the cornea, a tumour in the eye or orbit, paralysis of the third or sixth pair of nerves, or symblepharon.

"When the affection is owing to paralysis of the sixth pair, the eye is turned inwards, and cannot be directed outwards. It is carried in an opposite direction in the case of paralysis of the third nerve ; the upper lid has wholly or partially lost its motor power ; and there is at the same time double vision.

"Old men and young children ought not to be operated upon :

in the former case, because as a rule the affected eye has become so weak that there is no hope of its acquiring afterwards sufficient power to perform its functions ; and in the second case, because there often remain many chances of effecting a cure without an operation." (Desmarres, "Theoretical and Practical Treatise on Diseases of the Eyes."

Stromeyer's method.—The following is the simple and precise description which the author gave of his operation for spasmodic strabismus in 1829 :—

"I close the sound eye and make the patient move the affected eye as far as possible out of its abnormal direction. If the strabismus is internal, I then thrust into the internal border of the ocular conjunctiva a fine tenaculum, which should be entrusted to an intelligent assistant, who takes care to keep the eye outwards. Having raised the conjunctiva with a pair of forceps, it is to be twisted with a cataract knife by an incision made in the direction of the internal angle, and the outward traction of the eye is increased until the internal rectus is brought into view ; a fine probe is then passed beneath it, and the muscle divided with curved scissors, or with the knife that has been used for incising the conjunctiva."

Dieffenbach's method.—"The instruments required are very few : one of Pellier's elevators ; a double smooth hook to keep down the lower lid, two small sharp tenacula to lay hold of the conjunctiva ; a pair of curved scissors to cut the conjunctiva ; a plain hook to insert beneath the muscle, which is cut with the scissors that are used for the conjunctiva ; a small sharp tenaculum, which should be implanted into the sclerotic should the eye be convulsively turned in an opposite direction to that in which it should be maintained; and lastly, a sponge and a little cold water.

"Two assistants will be sufficient when the patient is restless, but more will be required if he cannot rely upon his remaining quiet. The patient should be placed as in the operation for cataract, upon a chair opposite a window with a good light, and the surgeon upon another chair a little more elevated. One of the assistants stands behind the patient, and supports his head against his chest. The surgeon places Pellier's elevator under the upper lid, to be held by the assistant behind; while the depression of the lower lid is secured by another assistant, who at the same time keeps hold of the patient's hands. The sound eye is to be kept shut. I will suppose it is the right eye which squints: it is upon that eye the operation is most simple (Internal Strabismus). The operator thrusts a small sharp tenaculum into the conjunctiva, near the caruncula lachrymalis, and draws the eye outwards; if the eye resists, a second tenaculum is to be implanted about two lines from the cornea, and the first one being confided to an assistant, the operator himself takes charge of the second. The conjunctiva being then raised into a fold by means of the two tenacula, the surgeon cuts into it with the curved scissors, and exposes the muscle. Then the scissors are abandoned; a hook is inserted between the muscle and the sclerotic; the tenaculum being no longer necessary to retain the eye in position, is disengaged, and the hand which was holding it seizes the hook beneath, while the muscle is cut through with the same scissors which are used for cutting the conjunctiva. By the section of the muscle the eye, freed from its shackles, immediately resumes its normal position. A little ablution with cold water is then all that is required.

"To operate upon the left eye the surgeon passes his left arm in front of the patient's forehead, and with his hand curved from without inwards holds the tenaculum which is inserted in the sclerotic; the assistant, standing behind the patient, holds the elevator with his left, and the tenaculum with the other hand."

When the strabismus is slight, Dieffenbach has proposed to raise with the curved scissors a small flap of the conjunctiva, and of the contracted muscle. Cullier recommends us to combine (joindre) the suture with the excision, and to divide the muscle he makes use of the boutonnés eye-scissors.

M. Phillips excises the tendinous portion of the muscle.

M. Bonnet raises the conjunctiva with forceps, and having divided it, cuts the muscle with a small scalpel inserted between the muscle and the sclerotic.

M. Velpeau seizes with a pair of claw forceps a large fold of conjunctiva along with the insertion of the muscle into the sclerotic. The surgeon can himself hold the forceps when the operation is performed upon the right eye, but must give them to an assistant in the case of the left eye. A second pair of forceps seizes and raises a fold a little distance from the first. This second pair of forceps is entrusted to an assistant. The bridle between the two instruments is then excised with either the straight or curved scissors. The operation may be finished with one snip of the scissors.

M. Lucien Boyer, having observed that after the perpendicular division of the conjunctiva the caruncula lachrymalis becomes sunken and retracted, proposes to make the incision into the conjunctiva a horizontal one, and above the tranverse diameter of the cornea.

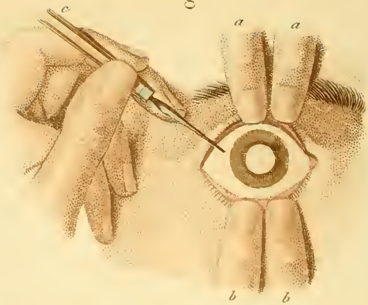
M. Sédillot's method.—M. Sédillot thus describes this method: "We seize the conjunctiva with a simple hook, to turn the eye outwards, in the case of convergent strabismus. A tenaculum is then inserted into the sclerotic, a little internal to the cornea, which is taken charge of by an assistant, while the surgeon withdraws the first. Raising with an ordinary pair of forceps a fold of conjunctiva a little inside the tenaculum, we divide that membrane with one cut of the scissors, and by cutting in succession the fibro-cellular layers as they appear, we come upon the muscle, the red body of which is well defined upon the sclerotic, and which should be carefully isolated. We then pass a hook beneath it, and gently raising it, divide it with scissors.

"In the slighter and more accidental forms of strabismus we have occasionally left untouched some of the muscular fibres, and have been quite successful, covering the sound eye for four or five hours, and compelling the patients to turn outwards the eye operated upon by making them look at objects through an opening in a small piece of diachylon, supported by a bandage."

Sub-conjunctival method.—M. Jules Guerin's operation.—Raise with tenacula a fold of conjunctiva, pierce the base of this fold with a Z-shaped myotome, which is then to be inserted between the muscle and the sclerotic. Then turn the sharp edge of the myotome from behind forwards, so as to divide the muscle with a gentle sawing movement. Such is the method by which M. Guerin proposes to keep the wound from contact with the air, and to secure, as in the case of all subcutaneous wounds, the advantage of a rapid union.

Fig. 1.

Fig. 2.



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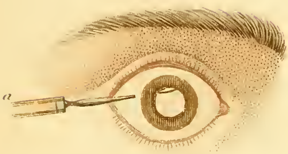

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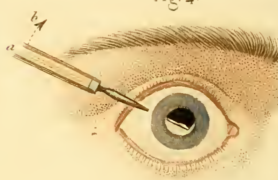


Fig. 5

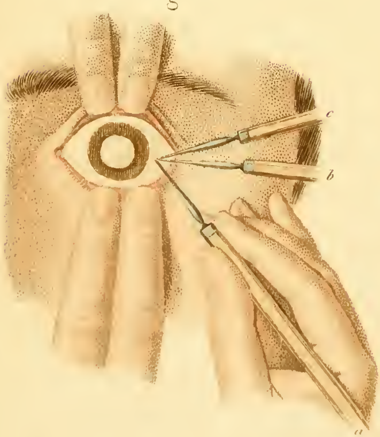


Fig. 6.

PLATE XLI.

OPERATION FOR CATARACT BY DEPRESSION.

Fig. 1.—*Antero-posterior section of the eyeball.*—*b*, cornea ; *c*, anterior chamber ; *d*, iris ; *e*, crystalline lens ; *f*, capsule of lens ; *g*, vitreous humour.

Fig. 2.—*Depression of cataract.*—*First stage* (*right eye*).—*a*, *a*, assistant's fingers raising the upper lid ; *b*, *b*, operator's fingers pulling lower lid down ; *c*, instrument held in left hand and passed through the sclerotic. The operator's third and fourth fingers are steadied by resting on the cheekbone.

Fig. 3—*Same operation.*—*Second stage.*—The needle, *a*, is passed between the lens and the iris ; the concavity of its point is occupied by the upper edge of the lens.

Fig. 4.—*Same operation.*—*Third stage.*—*Depression.*—The handle of the needle, *a*, *b*, being raised, the point is lowered, and presses the lens down into the vitreous humour.

Fig. 5.—*Same operation on the left eye.*—*a*, position of the needle in the first stage ; *b*, in the second stage ; *c*, in the third stage.

Fig. 6.—*Reclination.*—The lens, *a*, is displaced, *b*, into the vitreous humour.

PLATE XLII.

CATARACT AND ARTIFICIAL PUPIL.

Fig. 1.—*Extraction of the cataract.—First stage.—Inferior keratotomy.*—*a*, *a*, assistant's fingers raising the upper lid; *b*, *c*, middle and index fingers of operator depressing the lower lid; *d*, right hand of operator holding the cataract knife. The figure represents the instrument when it passes out of the cornea.

Fig. 2.—*Same operation.*—The inferior flap completed.

Fig. 3.—*Same operation.—Second stage.*—Opening of capsule by cystotome, *a*.

Fig. 4.—*Same operation.—Third stage.*—Expulsion of cataract. The handle of an instrument presses lightly on the upper lid, while the operator pushes the lower lid gently upwards with his finger, *a*.

Fig. 5.—*Finger armed with Desmarres' ring.*—*a*, the ring; *b*, little claws which are fixed into the sclerotic.

Fig. 6.—*Oblique keratotomy.*—The knife, *a*, is introduced obliquely from above downwards, and from without inwards.

Fig. 7.—*Superior keratotomy.*—The knife, *a*, passed transversely inwards, its edge turned upwards, cuts a superior flap.

Fig. 8.—*M. Furnari's operation.*—*a*, instrument passed from without inwards, into the anterior chamber.

Fig. 9.—*Same operation.*—Crystotrite seizing the opaque lens.

Fig. 10.—*Mulden's operation for artificial pupil.*—Crucial incision of iris, and removal of the four resulting angular flaps by angular scissors.

Fig. 11.—*Closure of pupil.—Beer's operation.*—A small incision is made in the cornea; a little hook tears the iris and draws the flap into the corneal wound.

Fig. 12.—*Closure of pupil.—Incision of iris.—M. Velpeau's operation.*—A lance-shaped knife, *a*, first pierces the cornea, and then the iris from before backwards, then, coming forwards, passes through the iris and cornea again. The edge

Pl. 42.

Fig. 1

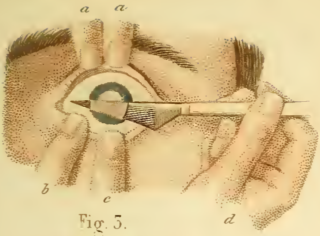


Fig. 2

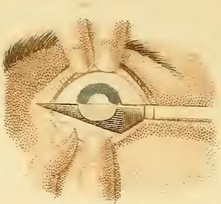


Fig. 3.

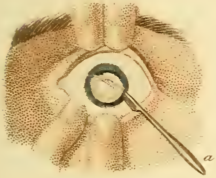
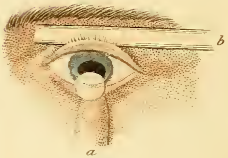


Fig. 5.

Fig. 4.



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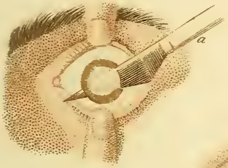

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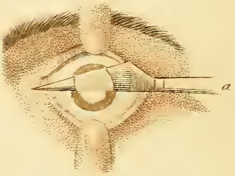

Fig. 10.

Fig. 8.

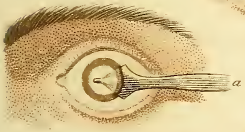

Fig. 12.

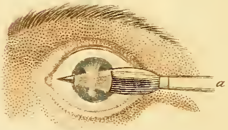

Fig. 11.

Fig. 9.

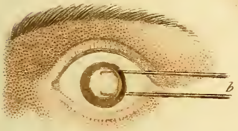

Fig. 13.

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of the instrument being brought out below forms a flap of iris and cornea.

Fig. 13.—*Detachment of iris—Scarpa's operation.*—A needle, *a*, introduced through the sclerotic, detaches the iris from above downwards.

OPERATIONS ON THE EYEBALL.

ANATOMY.

We shall confine ourselves to mentioning and shortly describing the parts forming the eyeball, which are of importance as concerning the operations performed on that organ. Passing from the circumference of the organ towards its centre, we find first—

The conjunctiva, a thin vascular membrane; which, having lined the inner surface of the lids, passes over the eyeball to invest all the visible parts of the cornea and sclerotic. At the inner angle of the eye it forms a rather deep cul de sac before passing on to the sclerotic.

The transparent *cornea* is intimately connected with the sclerotic. It is formed of successive layers, between which an instrument may easily slip, if not introduced with decision. It is hard and firm; incisions in it need to be made with very sharp instruments.

The sclerotic stretches from the nerve to the cornea. It is white and tough, resisting and elastic, and must be penetrated by a sudden and confident movement, the point of the instrument being perpendicular to the surface. The muscles of the eyeball are inserted into it.

The choroid lines the inner surface of the sclerotic, and is slightly adherent to it. The membrane is composed of two distinct parts, the inner one formed entirely of pigment, the outer essentially vascular. Between the sclerotic and choroid the ciliary vessels and nerves pass.

The long ciliary arteries are internal and external, passing forwards between the choroid and sclerotic in the plane of the transverse diameter. Hence, to avoid wounding them, it is best to pierce the sclerotic above or below the transverse diameter of the eye.

Between the sclerotic, choroid, and iris, at the level of the margin of the cornea, is the greyish ring of the ciliary body. It is essentially vascular, containing also a network of nervous, besides muscular fibres. Instruments passed into the eyeball should keep clear of this structure. *The ciliary processes*, folds formed by the inner layer of the choroid, are found behind the iris; they surround the lens, and are in contact with its equator.

The iris, the diaphragm placed between the cornea and the lens, divides the front part of the eye into two chambers—the anterior between itself and the cornea; the posterior between itself and the lens. The lens and the iris are in contact, hence the passage of an instrument between the iris and lens is dangerous to both.

These two chambers communicate by the pupil, a circular opening placed in the centre of the iris. The outer margin of the iris is connected with the ciliary circle. The iris floats freely in the eye, directly the pressure of the fluids keeping it in place is disturbed. Care is necessary to avoid wounding the membrane, as, for instance, when penetrating the anterior chamber for extraction of a cataract.

The movements of the pupil have been variously explained by different theories as to its structure. These, and the action of light and belladonna on the iris, will be alluded to in speaking of operations for artificial pupil.

The *crystalline lens* has the form of a bi-convex lens. It is made up of concentric layers varying in density, becoming more solid on approaching the centre. The external layer is nearly fluid, and is known as "*Morgagni's humour*," while the innermost part, or nucleus, is of a gummy consistence, easily crushed by the finger. The lens, under pressure, easily separates into triangles, the apices being directed to the centre; as these segments may be separately affected with cataract, or have varying degrees of opacity, in certain forms of this disease, the lens appears stellate, or marbled. The ease with which this organ splits up renders the operation of declination very difficult. The lens is surrounded by a capsule, which, by its adhesion to the hyaloid membrane, and contact with the ciliary processes, serves to keep the lens in place. The operation when performed in cases of "general cataract," viz., declination of the lens and capsule together, is rendered very difficult by these adhesions. In cases of milky or lenticular cataract, it is only necessary to lacerate the capsule, to allow the escape of its contents.

Behind the lens is the *vitreous body*, the gelatinous mass which fills the posterior four-fifths of the eyeball. An exceedingly thin membrane (the hyaloid membrane) envelopes the vitreous body, and by its numerous processes encysts the substance, in cells of various sizes and shapes. In the operation of declination it is often necessary to rupture some of these partitions with the needle.

Cataract.

Cataract is total or partial opacity of the crystalline structures. Their physical characters serve to show that there are many kinds of cataract. We will only mention such of these characters as help us in the choice of operative methods.

As regards its locality, opacity may affect—1. The enclosing membrane, as in *capsular cataract.* 2. *Morgagni's humour*, as in "milky cataract." 3. The *lens*, as in lenticular cataract. 4. *The lens* and *capsule*, as in capsulo-lenticular cataract.

Cataracts may be hard, soft, or liquid. Lenticular cataracts are usually hard and dull; they are often seen in old people, and extraction is the only treatment.

Capsular cataracts are soft, and clearer than the last. Milky cataracts are fluid, with less opacity in the upper segment than in the lower segment, the opaque particles sinking by their weight. Soft, fluid cataracts are easily re-absorbed, and therefore are those to which the operations of reclination and of solution are applicable. Young subjects are specially liable to this form; in time the opacity affects the lens, so that it is advisable to treat congenital cataracts in infancy.

The depth of the cataract is shown by the amount of shadow cast on the lens by the iris. In capsular cataract the shadow is least developed, and when quite absent, it is presumable that there are adhesions, or contact of the iris with the hypertrophied or displaced lens and capsule.

Indications for operation.—The general conditions of success are the following :—Satisfactory general state of health; soundness of the eye; absence of the slightest degree of inflammation in any one of the tissues; clearness of cornea; mobility of pupil; non-adhesion of iris; sensitiveness of retina; maturity of the cataract, as established by complete loss of sight; patiently to wait till both eyes are affected by cataract, so as not to compromise the sound eye by unforeseen and often grave accidents which may follow the operation on the diseased eye; early operations on infants; favourable climate.

Excessive heat or bitter cold are alike injurious.

Methods of Operating.

Cataract operations are designed to remove from the pupil any opaque body which prevents the rays of light from reaching the retina. The numerous procedures devised to accomplish this result can be classified under three heads: 1. *Reclination or Depression*—the opacity is only displaced; 2. *Extraction*—the opacity is removed from the eye. 3. *The mixed operation.*

General directions relative to the patient and operator, applicable alike to all cases, whatever the operation may be —The patient is to be put on strict diet for some time beforehand; all irritating causes which might bring about inflammation of the eye are to be removed; gentle purgatives are to be administered; and the evening before the operation belladonna is to be applied to dilate the pupil. If this effect is not maintained, more belladonna (or atropine) must be used an hour or two before the operation. There is no need to employ this drug except when the cataract is to be extracted.

The patient lies upon a couch, or, if no anæsthetic is employed, is seated in a low chair, the surgeon being placed on a higher seat opposite; an assistant stands behind the patient, whose head he will keep steady by putting one hand under his chin, while the other hand is pressed firmly on the forehead. The assistant keeps the upper lid raised with the first and middle fingers. This elevation requires great delicacy, as no compression must be exerted on the globe of the eye ; and yet it is most important that the lid should not slip and encumber the surgeon's instruments during the operation. Thus it will be well, according to M. Desmarres, to chalk the tips of the fingers that the lid may not slip. The means for steadying the lids indicated for strabismus may also be made use of.

If the surgeon is ambidextrous, he can operate on either eye without change of position; but in the opposite case it will be necessary for him to stand behind the patient if he is operating on the right eye.

For fixing the eye, a little double hook may be inserted into the sclerotic; but most commonly the operator obtains the necessary immobility by means of the first two fingers of the disengaged hand; the first finger depressing the lower lid, while the ring finger, placed higher and farther inwards near the lachrymal caruncle, exerts gentle pressure outwards on the globe. On this finger Desmarres wears a ring, to which are attached two little points, or claws, which he fixes in the sclerotic (Plate XL., fig. 5).

§ 1. *Depression.*—This is performed with cataract needles. Scarpa's needle is more bent than Dupuytren's, and has a projecting ridge on the concavity, which enables the operator to give more force to the point of the instrument, but is inconvenient as being more likely to break up the lens when the needle is pressing on the cataract to depress it.

Dupuytren's needle, flatter and smaller at the point, has a conical stem, which fills up exactly the wound by which it is passed in; this renders the vitreous less likely to escape. The handle of these needles is marked with a little black spot, showing the convexity of the point, and serving as a datum while moving the instrument within the eye.

Depression may be performed by penetrating the sclerotic, called *scleroticonyxis*, or the cornea, *keratonyxis.* There are varieties of these principal operations.

a.—Scleroticonyxis (*left eye*).

First stage.—Puncture.—Left eye.—The operator lowers the under lid and fixes the eye with the first two fingers of the free (left) hand, then, holding his needle like a pen, between the thumb, index, and middle fingers of the right hand, he rests the two other fingers on the cheek. The needle is brought to the sclerotic obliquely upwards, the point at right angles to the surface it is to pierce; its convexity is upwards, its two edges transverse so that the little incision they will make is parallel to the direction of the ciliary vessels. The patient is told to look inwards. The needle is immediately passed into the sclerotic, $\frac{1}{12}$ to $\frac{1}{10}$ inch behind the transparent cornea, and $\frac{1}{20}$ to $\frac{1}{12}$ inch below its equator. A puncture closer to the cornea risks wounding the iris and ciliary body; if farther from the cornea, there is danger of piercing the lens, and thus making the withdrawal of the needle behind the iris more difficult. Lastly, in puncturing below the equator, we avoid the ciliary artery which runs at this level between the choroid and sclerotic. The puncture should be made by one movement and boldly, for at this moment patients often start back and displace the needle.

Second stage.—Passage of the needle between the iris and lens.—The needle passed through the sclerotic is withdrawn most carefully, until only the curved part is left inside the globe. Then the first movement of rotation imparted by the thumb to the handle of the instrument turns the concavity of the point backwards, and brings the convexity forwards; the black spot acts as guide in this manœuvre. At the same time, by another movement, combined with the first, the handle of the instrument is slightly raised and drawn towards the temple, so that the point passing round the lower edge of the lens, without striking it, can be placed between the lens and iris. Contact or adhesion between these structures render this manœuvre one of great delicacy. The needle, now in a horizontal position, is next turned, so that the point appears in the pupil.

Third stage.—Incision of the capsule.—In most cases it is not possible to displace the capsule with the lens *en masse*. Laceration of the capsule is especially needed when the cataract is large and soft. This step has the additional advantage of shewing the real nature of those cataracts whose character is doubtful, and sometimes it furnishes indications for modifying the operation. The division of the capsule is effected with the edge of the needle, which is made to pass with a to and fro movement, first upon the lower and then the upper capsule.

Fourth stage.—Displacement of the cataract.—The capsule being divided, the concavity of the needle is applied to the upper margin of the lens, and by a careful see-sawing movement, in which the handle is raised and carried forwards, the lens is pushed downwards and outwards into the vitreous. The needle is held in this position for eight or ten seconds. The displacement must be effected gently, that the lens may not rise over the needle, which might lodge it in the anterior chamber. If that accident should happen, the lens must be speared with the needle and carried back through the pupil; and if that attempt should fail, the cornea must be cut through, to allow the lens to escape.

To obviate this difficulty M. Gerdy has devised a needle whose point is made to bifurcate after it has been introduced —the two branches, embracing the lens, enable the operator to gain a better hold and to conduct it safely to the lower part of the eye.

b.—Reclination is only a modification of the last stage of the above. The needle pushes the lens down and backwards in the vitreous, and then lays it flat, so that the anterior surface is upwards (Plate XLI., fig. 6). This kind of depression is applicable to soft cataracts, when the capsule and lens are displaced together. After the displacement it often happens that the flaps of the capsule, or the fragments of the lens, separated by the pressure of the needle, float in the centre of the eye.

These must be separately attacked and dispersed in the humours to favour their absorption. This will prevent the formation of secondary cataracts, which often result from the reunion of the flaps.

c.—Laceration is especially applicable to soft liquid cataracts. In this operation the capsule is torn, and its fluid contents escape into the humours of the eye, there being absorbed. If the cataract, though soft, is capable of being separated into pieces, these, by reduction in size, will be more easily affected by the humours.

In the case of cataracts which adhere to the iris, it will be necessary to limit the laceration to the field of the pupil. This operation is performed with a little hook slipped flat between the capsule and iris; when opposite the pupil the hook is turned towards the capsule and divides it by radiating lines.

d.—Suction is only applicable to fluid cataracts. Laugier passes into the lens a hollow needle, which has an aspirating opening near its point. The needle is mounted on a little exhausting syringe, which extracts the cataractous fluid.

Blanchet uses a hollow needle, which is furnished with an elastic india-rubber ball instead of a syringe, to exert suction.

Petit, Ferrein, and Bowen have attacked the lens from behind, dividing the capsule; the lens alone was depressed, the anterior layer of capsule being left in place.

Bretonneau and Velpeau, having passed the needle through the sclerotic, freely divide the hyaloid cellules before passing the instrument over the edge of the lens, thus preparing the way by which the lens is to descend into the vitreous.

Bergeron and Goirand detach the lens all round from the vitreous, then, having separated it from the ciliary processes, they plunge capsule and lens into the vitreous humour.

Pauli and Chégoin have proposed to raise the lens instead of depressing it, on the ground that reascension of the lens after depression is the result of its specific lightness.

Malgaigne, having observed that the lens only reascends when it has been depressed with the capsule, and that the capsule resists absorption for a very long time, and that there is no extreme inconvenience in its remaining in place, has described the following proceeding:—Pass the needle through the sclerotic, the concavity of the point being turned *upwards*, in such a way as to penetrate the lower and posterior part of the lens; the capsule is divided by carrying the needle backwards, then, by carrying the needle in a half-circle through the vitreous, it is brought above the lens, with its concavity directed *downwards;* by gentle pressure the lens is pushed down, the two flaps of capsule closing behind it. This operation will only answer for lenticular cataracts.

e.—Keratonyxis.—Corneal depression, that is by puncture through the cornea, is only now employed in those rare cases where the eyes, deep in the sockets and very mobile, cannot be easily steadied. All the movements of the needle take place in the pupil, the edges of which are constantly fretted, while the loss of the aqueous, the passage of the lens into the anterior chamber, cicatrices in the cornea, etc., are serious accidents, and the operation being difficult, they have long since led to the abandonment of keratonyxis in most cases.

First stage.—Puncture will probably lead to an opaque cicatrix, so that it should always be made towards the periphery, and preferably in the lower segment. If there were already an opaque spot, that should be chosen for the needle wound. The instrument is to be introduced with the edges upward and downward, so as to make a little vertical incision.

Second stage.—Depression or laceration.—The point of the needle being well in the anterior chamber, a rotatory movement brings its concavity towards the lens. The capsule is to be divided as usual, then the flat of the needle being carried above the lens, it is to be pushed down into the vitreous by a lever movement, raising the handle of the instrument and passing it inwards.

In laceration, the lens is pierced, and division of its substance is attempted by rotating the needle rapidly. Central laceration by keratonyxis is alone practicable when cataracts adhere to the iris.

2. *Extraction.*

The expulsion of a cataract may be effected through a corneal wound (*keratotomy*), or a sclerotic wound (*sclerotomy*). A cataract knife, or keratotome, to cut through the cornea; a needle or a cystotome to divide the capsule; a little scoop, ocular forceps, and fine scissors, complete the apparatus. Wenzel's knife is lancet-shaped, and is convenient for incising the cornea and the capsule at the same time, but it is inconvenient, as not filling up the wound made in the cornea, which favours the escape of the aqueous. Richter's knife, more commonly used, has a short triangular blade, which exactly fills up the corneal wound. The shortness of the blade lessens the risk of woundng the inner angle of the eye.

The rules for attention to the general health given in treating of depression are equally applicable to keratotomy.

The incision in the cornea forms a flap which may be inferior, oblique, or superior—the three varieties are called inferior, oblique, or superior keratotomy.

Inferior keratotomy (Plate XLII., figs. 1, 2, 3, 4). *First stage—Incision of cornea* (fig. 1).—The point of the instrument is brought against the cornea at the level of its equator at $\frac{1}{20}$ to $\frac{1}{12}$ inch in front of the sclerotic; a sharp and decided puncture is made into the anterior chamber, then a pause is made to ascertain that the iris is not wounded, after which the handle is carried backwards a little and the point is pushed from without inwards, in the equator of the globe, until a counter-opening of exit is made exactly opposite the point of entrance; the blade of the instrument is to be kept parallel to the plane of the iris all the while. When the point has passed from one side to the other of the cornea, the knife is to be handled most gently, without any sudden movement, that the flap may be cut with its edges exactly parallel to the border of the sclerotic. Too much precipitancy in this stage of the operation leads to risk of wounding the iris, and expulsion of the aqueous humour. The muscles which have contracted spasmodically at the puncture must during the completion of the flap have time to relax; the knife must exactly close the wound it gradually forms, so that it may prevent the escape of the aqueous (fig. 2). When the flap is made the lid is closed, and the patient allowed to rest a while, if not under chloroform.

Second stage.—Division of the capsule (fig. 3).—The cystotome, held like a pen, is introduced from below upwards, through the corneal wound; then the point, being turned towards the capsule, is made to divide it; this is done gently and without force enough to push back the lens. The ordinary needle can be used in this operation.

Third stage.—Expulsion of the cataract (fig. 4).—It sometimes happens that after the incision of the capsule, the lens escapes of itself, the globe being compressed by the contraction of the ocular muscles, an accident to be avoided. If this does not happen, it is enough to press the finger or handle of a knife on the upper lid, when the lens will pass through the pupil into the anterior chamber and slip out through the corneal wound. The escape of the lens can be further assisted by double pressure: one finger on the upper and one on the lower lid. There are sometimes fragments of the lens or capsule remaining in the pupillary field: these must be removed with fine forceps or a curette, lest secondary cataracts should be formed.

Oblique keratotomy.—Wenzel's operation (fig. 6).—The point of the knife is to enter the cornea at the middle point of the outer and upper fourth, and to make exit at the centre of the inner and lower fourth. This form of operation is more difficult than the last; but the cicatrisation of the wound is more rapid, the lower lid is less likely to catch under the flap, and there is less risk of wounding the nose and internal caruncle when making the corneal wound.

Superior keratotomy.—Richter, Wenzel, and Jaeger's operations (fig. 7).—This is performed just like the oblique and inferior operations. The base of the flap corresponds with the equator of the cornea, and its free edge is upwards. The difficulty of this procedure is greater than that of the two preceding operations; but it has the advantage of less frequently allowing the aqueous to escape. Cicatrisation is rapid, the flap being supported by the upper lid.

Furnari's operation.—Furnari uses a double-edged knife, ending in a point slightly curved on the flat, which is employed for opening the capsule. The anterior chamber is opened at one side by the knife, with which the capsule is then incised; then by the corneal wound a pair of fine forceps is passed in, the lens seized and removed (Plate XLII. figs. 8, 9).

Sclerotomy.—Proposed by Bell, but abandoned. An incision was made in the sclerotic, through which forceps were introduced and the lens removed. But this proceeding endangers wounding the ciliary arteries, evacuating the vitreous, and causing choroiditis, retenitis, etc.

3. *The mixed operation* (*Quadri*).

It consists in passing a needle through the sclerotic, with which the lens is broken up; fine forceps are then introduced through a corneal wound, the capsule is divided, and the pieces of lens removed. This operation is almost abandoned.

OPERATIONS FOR ARTIFICIAL PUPIL.

Cheselden first made an artificial pupil in 1728, since which the operation has undergone many modifications. The fact is accounted for by the number of different conditions calling for this treatment. The surgeon will be guided in his choice of operation by the affection he has to treat.

The various operations may be placed in four classes:—1. Incision of iris, or *iridotomy*; 2. Excision, or *iridectomy*; 3. Separation from its border, or *coredialysis*; 4. Displacement of the pupil, or *corectopy*.

For preliminary treatment, and position of the patient, surgeon, and assistants, see the chapter on Cataract Operations.

Incision of the iris (*iridotomy, or coretomy*).

Cheselden introduced a small falciform needle through the sclerotic (as in depressing a cataract). When the needle was well within the posterior chamber, he turned the point towards the iris, passed it through the membrane from behind forwards, and by little see-saw movements made an incision of $\frac{1}{8}$ to $\frac{1}{5}$ inch.

Sharp passed the needle through the cornea. Others also have attacked the iris from the front. *Jurine* passed a needle through the sclerotic and pierced the iris first from behind, then in front, uniting the punctures by an incision made in withdrawing the needle backwards. This most delicate manœuvre may wound the lens, and may tear away the iris from its attachment. *Janin*, having noticed that horizontal incision of the iris was almost always followed by reunion of the edges, cut across the fibres of the iris; he passed a small knife or fine scissors through the cornea, and made a perpendicular incision on the inner side of the natural pupil. Experience has shown that the incisions made by Janin's method have the same tendency to close as those of other surgeons.

Compound iridotomy.—Whatever the method used, simple incision of the iris is almost always followed by union of the edges of the wound. To remedy this fault, surgeons employ a mixed operation. *Guerin's method.*—To combine the advantages of the two preceding operations, Guerin opened the cornea as the first step, and made a crucial incision (perpendicular and horizontal) in the iris. *Flajani* operated in the same way. *Maunoir* also cut through the cornea at the outset; then with bent, fine scissors he cut a triangular flap in the iris, having its point at the centre, and its base at the circumference. *Carron du Villars* used Maunoir's operation, but not his scissors, preferring scissors with a spring to keep them open. This is a great help. *Velpeau* (Plate XLII., fig. 12) uses a narrow knife, double-edged, and resembling the "*serpent's tongue*" lancet. The knife is introduced through and across the cornea; the point pierces the iris backwards, entering the posterior chamber, then, after its horizontal course has continued for three or four millimetres, the point is brought again through the iris (this time forwards). The knife, being brought out, cuts a flap of iris, which rolls itself up and soon disappears, leaving a triangular pupil.

Remarks.—Iridotomy is generally easily and rapidly performed; there is less fear of inflammatory accidents than in other methods; but it is unreliable, the reunion of the edges of the wound rendering the operation useless. The same remark holds good with the mixed operation in some instances.

Excision of the iris (*iridectomy*).

Wenzel's operation (Plate XLII., fig. 12) only differs from Velpeau's operation (described above) in that Wenzel cuts off and removes the little triangular flap which Velpeau cuts and leaves in the eye. *Sabatier* made a corneal flap as in cataract, drew the iris out through the wound, and cut off a portion with scissors curved on the flat. *Mulder* first made a crucial incision in the iris (Plate XLII., fig. 10), and then with scissors cut off each of the triangular flaps. *Physick* used forceps with a punching blade. One of the blades is passed behind the iris, the other in front; when closed the forceps will cut out a circular piece of iris. *Leroy d'Etoiles* operates on the iris *in situ*, using a little instrument whose mechanism resembles that of the tonsillotôme. A little turning hook seizes the iris and draws it between two rings, which, sliding one on the other, cut off the seized portion of iris. *Beer* makes a small incision in the cornea through which he passes a small hook; with this he seizes the iris and brings it out through the wound, and cuts off a suitable portion with the scissors. This latter mode of operation has been modified by *Gibson* and others. *Desmarres* pierces the cornea with eye forceps, draws out a portion of iris, and cuts it off.

Remarks.—Iridectomy has the simple advantage over incision that reclosure of the pupil is not likely to follow; but it is more difficult, requiring much endurance on the part of the patient, and much confidence and steadiness of hand on the surgeon's part.

Tearing of the iris (coredialysis).

The ease with which the iris can be torn from its ciliary attachment was first utilised in making artificial pupils by *Assalini* and *Buzzi*. *Scarpa* organized the method and brought it into usage.

Scarpa's operation (Plate XLII., fig. 13).—A needle, *a*, is passed through the sclerotic as in depression of cataract, the point of the needle, being directed towards the upper and inner edge of the iris, passes through that membrane from behind forwards, and by a lever movement tears the iris from its attachment to one-third of its circumference.

Leveille's operation only differs from the last in the depression of the lens, performed beforehand in order to avoid injuring it during the operation.

Himly, *Flajani*, and *Beer* pass the needle through the cornea, so that the iris can be operated upon at any point. *Assalini* opened the cornea freely, and passed forceps through the wound to tear the iris. *Bonzel* used a small hook for the detachment of the iris.

Langenbeck's operation adds enclosure in the corneal wound to separation. An opening $\frac{1}{12}$ to $\frac{1}{6}$ inch in length is made in the cornea with an ordinary keratotome, through which is passed a small hook enclosed in a movable sheath; the hook is disengaged, made to seize the iris and draw the separated flap into the corneal wound, where it forms adhesions which prevent the newly-made pupil from closing. *Jungken, Græfe,* and *Reisenger* have altered the instrument, but retain the operation.

Luzardi devised an instrument consisting of two sliding bars, kept together by a spring. The needle is easily passed into the eye, through the cornea or sclerotic, no incision having been previously made; when it has reached the iris, one of the bars of the instrument is drawn back, which exposes the hooked extremity of the other bar, and the iris is seized with this latter; a spring sends back the sliding bar, which secures the iris on its hook and enables it to be drawn into the wound.

Donegana adds incision to separation. A little falciform needle, the concavity sharp, is introduced through the cornea or sclerotic; the iris is separated with the blunt convex margin, and cut through to the centre with the concave edge.

Huquier, having noticed that the iris when detached is hard to incise properly, yielding before the instrument, begins by cutting from the centre outwards, and then separates each of the lips of the wound.

Remarks.—All operations by scleroticonyxis expose the lens to danger; further the needle hidden by the iris is guided with difficulty, and may be misdirected. In operating by keratonyxis these dangers are avoided, and all points of the circumference of the iris are easily approached.

Separation alone is not always successful for any length of time: the separated iris may unfold and obliterate the new pupil. It is therefore best to enclose the separated iris in the external wound. Langenbeck and Luzardi's operation are suitable to the great majority of cases. The process of de tachment is especially adapted to all cases where the iris adheres to the capsule, where there is anterior synechia, or where there is extensive corneal opacity.

Displacement of the natural pupil (corectopy).

This operation is applicable to cases in which the pupil is veiled by a central nebula of the cornea. The end in view is placing the pupil behind a clear part of the cornea.

Adams made a little incision in the cornea, into which he drew the edge of the iris, in order to displace the pupil. When healing, the corneal wound formed adhesions which kept the pupil in its new position. *Himly* performed a similar operation.

Guepin and Desmarres have devised a kind of punch which takes a small piece out of the cornea, into which the iris prolapses if it does not take the required position of itself; a little pressure on the eye will cause it to do so. As the corneal wound heals, the iris is maintained in its new position.

Remarks.—Corectopy is easily performed, and is less liable to cause inflammations than the other methods. But it is not applicable to cases in which the pupil or iris has undergone any morbid change.

Corneal Spots, or Opacities.

Corneal spots are usually the result of ulcerating keratitis. They are kept up, in many cases, by an inflamed state of the cornea, which may be detected by the opacity being situated in the midst of a vascular network. Following this indication, it has been suggested that the division of these vessels should lead to the resolution of nebulæ. Still, the surgeon ought not to make incisions in the cornea until he has exhausted the simpler modes of treatment. The operative measures about to be described require great prudence and great dexterity on the surgeon's part. They are attended with some danger, and may lead to loss of the eye.

Scarifications were first used by Demours, who operated with the point of a lancet or fine bistoury, with which he made four or five deep incisions across the opaque spot. *Holscher* succeeded in rendering a portion of the cornea transparent by this means; and then made an artificial pupil behind it. *Richet* passed the point of a cataract knife round the opaque spot, or even around the whole cornea, obliquely through half the thickness of the cornea. The little circular flap thus formed was then dissected off.

The Seton.—Pellier, and Delarne have published some observations made by them on the results of passing a thread between the layers of the cornea, by means of a fine flat needle. It was exceedingly difficult to accomplish, and full of danger; and though successful in some cases, has been abandoned, as have also trephining, and resection of the opacity.

Abrasion of the cornea.—This operation, which replaces an opacity by an ulcer, is condemned by most surgeons. Malgaigne employed it successfully in the case of his daughter. Yet it should only be tried when the sight is quite lost, and then not until all other means have failed.

The lids being separated, and the eye fixed either with forceps or hooks fixed into the sclerotic, the operator holds the cornea with mouse-toothed forceps, and raises the superficial layer with a cataract knife. In this tedious and painful operation the anterior chamber is often wounded. It should be reserved for the metallic stains produced by the excessive use of badly prepared collyria containing lead or silver.

Pterygium and Pannus.

The former is a kind of excrescence appearing on the cornea, almost always of a triangular form, seated in the inner angle of the eye. The latter, of no regular form, may appear in any part of the cornea; the same operative measures are applicable to both forms of disease.

The little outgrowth is seized with a double hook, or with rat-toothed forceps, and is cut off with a fine scalpel, or with scissors curved on the flat; nitrate of silver is then applied to the wound. These affections often recur, and are apt to leave an opaque spot on the cornea after their removal.

Hypopyon.

Accumulations of pus in the anterior chamber are soon reabsorbed in most cases, so that an operation is rarely called for. If it should be necessary, puncture of the cornea is performed with a simple cataract knife at the lowest point.

Acute Phlegmon.

In cases of this disease, the pain caused by purulent accumulation becomes intolerable, and an outlet must be made for the fluid. *Scarpa* cut the cornea at its centre, and raised a circular flap—a tedious process. It is better to open the cornea at its lowest point, by a straight incision with a cataract knife. There is then a chance of preserving the transparency of some part of the cornea.

Hydrophthalmia

may distend the ocular globe to such a degree, or be attended by such intense inflammation, that it calls for puncture. The liquid may be partly or wholly let out, by making an incision through the cornea or sclerotic. Desmarres, for puncturing the sclerotic, makes use of an instrument like a short lancet, having near the point two shoulders, which prevent the blade from entering too deeply. The blade has a longitudinal furrow by which the fluid can escape.

Extirpation of the Eye.—Ordinary Operation.

If there is a tumour connected with the eye, prolong the external angle of the commissure of the lids by an incision of necessary length; raise the lids, cutting them away from the ball, which is seized with a hook or Museux's forceps; pass a bistoury in at the inner angle of the eye, and make it sweep the under surface of the eyeball, or of the tumour, from within outwards; then repeat this manœuvre on the upper surface, to completely circumscribe and separate the tumour; then with curved scissors divide the pedicle at the bottom of the orbit: such is the quickest and simplest operation. Instead of the bistoury, the muscles of the eye may be cut through with the curved scissors.

Dupuytren began by detaching the tumour from the upper orbital wall, then cut off the pedicle, and turning the tumour out, finished the dissection of its under surface.

If the lids are to be removed with the ball, the first incisions must be carried through them and not through their mucous lining.

When no tumour is connected with the eye the incision in the lids is unnecessary. The conjunctiva should be carefully dissected up from the globe in order to cover the stump; then, seizing the eye with the hook, or forceps, cut through the muscles, either with the curved scissors or with the bistoury, finally severing the optic nerve.

Fitting an Artificial Eye.

The stump left after an extirpation having completely healed, a well-fitting enamel eye is obtained. The upper lid is raised while the most convex part of the enamel eye is passed underneath it; then the lower lid is drawn down till the lower edge of the eye slips over it. It should not be left in place for a long time at first; the stump becomes in time accustomed to its presence. If the orbit holds it too loosely, it must be replaced by a larger one.

The enamel eye is removed by means of a blunt gold or silver probe bent into a hook; the instrument is passed between the eye and the lid (drawn down at the time); a gentle lever movement raises the eye and makes it glide out of the orbit.

PLATE XLIII.

OPERATIONS ON THE EAR.

Fig. 1.—*Section showing the (angular) relative direction of the Eustachian tube and external auditory passage.*—*a*, inferior turbinated bone; *b*, middle turbinated bone; *c*, opening of the Eustachian tube at the level of the attachment of the lower bone; *d*, first angle in the Eustachian tube which from this point turns more directly outwards; *e*, membrana tympani; *f*, external auditory canal, which, passing from within outwards, completes in the horizontal plane the arc of the course of the Eustachian tube; *g*, internal carotid.

Fig. 2.—*Perforation of the lobule of the ear.*—*a*, trocar; *b*, cork applied behind the lobule to make counter-pressure.

Fig. 2, *bis.*—*Trocar for this operation, and for introducing the rings.*

Fig. 3.—*Extirpation of a polypus of the external ear.*

Fig. 4.—*Perforation of the membrana tympani.*—*a*, *b*, Deleau's perforator; *c*, membrana tympani.

Operations on the External Ear.

Perforation of the lobule.—This operation, of which the object is to attach earrings, may be performed with a lady's stilette or other pointed instrument. It is customary to use a small trocar (fig. 2, *bis*), whose canula bears a small movable point; a cork is also required. First deaden sensation in the lobule by pinching it sharply with the finger; then place the cork behind the lobule, holding both with the left hand, and pass the trocar through the ear into the cork. The cork is then removed with the point of the trocar in it; the canula is withdrawn after it has received a lead wire or silk thread, which is thus drawn through the wound, tied in a loop, and left until the opening has healed and become a permanent one.

Wounds of the external ear, and otoplasty.—Simple wounds unite very well by first intention with the support of sutures carried through the whole thickness of the ear.

Otoplasty is seldom applicable except when wounds of the

Fig. 1.

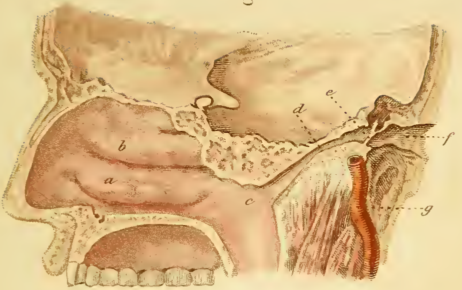


Fig. 2.

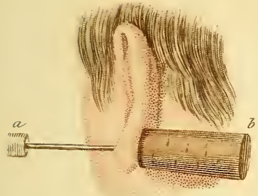


Fig. 3.

Fig. 2.bis

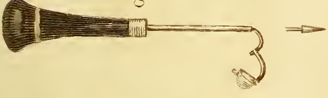
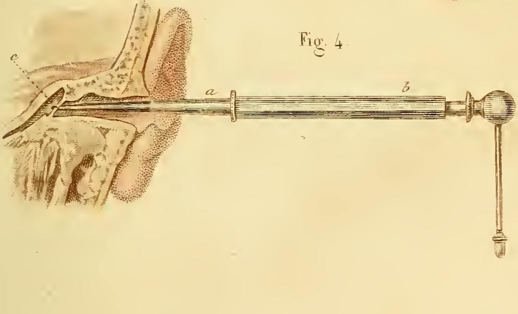


Fig. 4.



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ear have been attended with much loss of substance (see Blepharoplasty). In all cases the repairing flap of skin will be so arranged that its dermal surface is outwards.

Foreign bodies in the auditory canal.—It would be hard to name all the foreign substances which may be found obstructing this canal, but they come under two classes:—1. Those which form in the ear, hard or soft wax, pus, blood clots, etc.; 2. Bodies from without.

Extraction of foreign bodies may be effected by curettes, or forceps, whose curves and whose sizes are suitable to the direction of the auditory canal. The surgeon will choose his mode of proceeding according to the form, hardness, or softness, etc., of the foreign substance. By drawing the external ear (with the left hand) upwards and outwards the curves of the canal are somewhat straightened, and the entrance of instruments rendered easier. The canal should also be well oiled, and the introduction of a speculum will help to dilate the soft parts and facilitate the use of instruments for breaking up the impacted body more easily. It is well to remember that in the adult the vertical diameter of the canal is greater than the transverse. We must, therefore, pass instruments along the floor to insinuate them more easily under the foreign body. In children, on the other hand, the horizontal diameter is greater than the vertical. In the second place, the tympanic membrane slopes downwards and inwards, which must be remembered, that the drum may not be wounded, and that the foreign body be not pushed back into the angle which the membrane makes with the anterior wall of the passage.

Thickened wax and similar substances can be softened and expelled by injections of lukewarm water. Solid bodies are often removable by this means, the reflux of the injected water carrying them out. If all these methods fail, it would be well to try the plan of Paul d'Egine, who made a small incision behind the concha of the ear, through which he passed a stylet, which was to pass inside the foreign body and expel it.

Polypus of the auditory meatus.

Polypi may be removed or destroyed by ligature, excision, torsion, and cauterisation. The nature, colour, and size of the polyp will indicate to the surgeon which proceeding to adopt.

Ligature can be done directly or by means of Desaute's ecraseur, a slip-knot being passed over a pedunculated polypus.

Torsion is suitable to most cases; steel forceps are used. The hæmorrhage, which is often free, is easily arrested by cauterising. Nitrate of silver, or Vienna paste, is the means usually employed; great care is needed, and it is better to pass a little plug of cotton wool to the bottom of the canal to protect the tympanic membrane from the caustic.

Absence and obstruction of the auditory meatus.

Congenital absence of the canal resulting from contact of the bony walls is beyond the surgeon's powers to relieve. But when a membrane (of variable density), situated more or less deeply in the canal, obliterates it, the obstacle may be removed by puncture, incision, or cauterization. It will always be prudent to begin with an exploratory puncture, to prove the presence of a canal behind the membrane; if then the hearing is improved by that puncture, it should be enlarged by a crucial incision and the flaps dissected off. Some dilating body, or sponge tent, should be afterwards passed into the artificial opening, to keep it from closing while the wound heals.

Itard and Bonafond have successfully used cauterisation with nitrate of silver to destroy deeply-placed membranes.

If the duct be stopped up by the thickness of the lining membrane, it should be opened by dilators, such as catgut, sponge, and tangle tents, etc., which are subsequently replaced by a gold or ivory tube, to keep the canal properly expanded.

Whatever method be used, let the surgeon proceed with care and avoid injury to the middle ear.

Operations on the Middle Ear.

(Plate XXXVIII., fig. 1, and Plate XLIII., fig. 1 & 4.)

Perforation of the membrana tympani.

This operation is intended to admit air to the middle ear when deafness is caused by permanent stoppage of the Eustachian tube. It may be performed by puncture, excision, or cauterization.

1. *Puncture—A. Cooper's operation.*—A small curved trocar is passed along the floor of the external meatus, up to the tympanum. When the point has reached the membrane it is pushed sharply through it, about $\frac{1}{16}$ of an inch, and the patient recovers his hearing at once.

Buchanan's operation only differs from the preceding in the form of the trocar, which is square. When the membrane is punctured, the opening is enlarged by rotating the trocar.

2. *Excision.—Himly's operation.*—Puncture as performed in the above ways is liable to close up again. To avoid this failure, Himly punctured the membrane and excised a portion by means of a punch, which has since been improved by Falrizi and Deleau. Deleau's perforator consists of a canula, whose extremity has a circular cutting edge; the canula encloses a point whose base has also a cutting edge. A spring when turned causes the point to protrude, and perforate the membrane; directly afterwards another spring causes its return, a circular piece is cut out of the membrane by the contact of the cutting base of the point, and the cutting edge of the canula (Plate XLIII., fig. 4, shews the application of this instrument).

3. *Cauterization*, as proposed by Richeraud, is now almost abandoned.

Perforation of the mastoid cells.

The communication which exists between the mastoid cells and the tympanic cavity has suggested to surgeons the idea of opening a passage to the external air by perforating the mastoid process. The operation can be done with a little trephine, a trocar, or a perforator. The most favourable spot is a little in front of the process, $\frac{2}{5}$ to $\frac{4}{5}$ of an inch above its point (Malgaigne).

Perforation of the mastoid cells is not only indicated in certain forms of deafness, but is sometimes of use to afford an outlet to pus and other fluids contained in the cells or the middle ear, resulting from abscess or organic lesions of the process.

This operation does not always afford good results; it is not absolutely free from danger, and is sometimes fatal.

These considerations, and the fact that the cells are sometimes atrophied (when puncture is useless), make surgeons cautious in using it.

Catheterism of the Eustachian tube (Plate XXXVIII., fig. 1).

This duct is about one inch and a half long, with an opening (shown at *c*, Plate XLIII., fig. 1) looking downwards, inwards, and forwards; the aperture being behind the inferior turbinated bone, *a*. The orifice can therefore be reached either through the mouth or through the nasal fossa. Fig. 1 in Plate XXXVIII. shows Deleau's probe, *a*, lying on the floor of the nasal fossa, its point within the Eustachian tube at *e*. The object of this procedure is to clear the tube, which result is obtained by injecting air or medicated fluids.

Guyot, postmaster at Versailles, in 1724, was the first person who successfully attempted to catheterise this passage. He passed his probe through the mouth. Many followed his example, but in 1741 *Cléland* reached the opening and passed his catheter through the nose, and since then Guyot's method has been given up.

Ordinary method.—A silver probe of small size, and bent like a uterine sound is used.

The patient is seated, his head slightly thrown back and kept in position by an assistant standing behind him; the operator holds the probe (well oiled) in his right hand, and passes it through the nostril of the side affected, slipping the probe along the floor of the fossa, till it has reached the level of the soft palate. In this first stage of the operation the point of the sound is turned downwards and slightly outwards. When the point of the sound touches the soft palate, it gives the patient a disagreeable sensation and provokes a sudden act of swallowing. The point must then be turned slightly outwards and upwards by rotating the shaft of the sound, which is to be kept all the time close to the outer wall of the nostril. Gentle to and fro movements of the sound or catheter are then to be made until the point is caught in the orifice of the Eustachian tube. Success is shown both by the fixedness of the instrument and the peculiar sensation which it gives in the ear of the patient. To inject the passage, the catheter is kept steady by pinching the nostril through which it has been passed, and the jet of a syringe is placed in the external opening of the catheter.

Deleau's method (Plate XXXVIII., fig. 1).—Instead of a silver probe, Mr. Deleau uses a flexible tube, which can be passed deeper into the Eustachian duct without cutting in its windings. A stilette inside this tube gives it steadiness and imparts a convenient curve. The end of this stilette is made to project from the catheter, and passes easily into the nasal opening of the duct ; it serves then as a guide along which to pass the catheter as far as possible, and the former is then withdrawn. The outer end of the catheter is somewhat expanded, and is fitted with a bent wire, acting as a spring, and retaining the instrument in the nose by pinching the nostril.

While thus fixed it is easy to use the apparatus for injections. Air is chiefly injected by Deleau, by means of a caoutchouc ball syringe, squeezing which causes a current of air in the duct.

These air douches afford in certain cases valuable means of diagnosis. The operator applies his ear to the ear of the patient, and easily detects the fact when the air enters the tympanic cavity and returns between the tube and the Eustachian tube. In this case the obstruction is incomplete. If the air current passes through the middle ear and out at the external ear, there is a perforation of the tympanum. And rattling or gurgling sounds heard in the above described manner indicate the presence of pus or other fluids in the middle ear.

When the nostril of the same side as the obstructed tube is itself affected, catheterism may be practised through the *other* nostril, taking care that the instrument has a longer curve, and that the length of the bent part is proportioned to the greater distance to be traversed, to reach the opening of the canal. To assist the introduction of the catheter it will be well to turn the tip backwards a little, on the convex side of the curve.

Gairal passes the sound along the nasal fossa till the point no longer rests on the floor, then makes it turn a quarter of a circle upwards and outwards: after this, it is only necessary to push the sound a little further to make the point enter the opening of the Eustachian tube, at the same time gently rotating outwards to pass the catheter further into the duct.

The mouthpiece of Gairal's sound is graduated to show the degree of rotation practised.

OPERATIONS ON THE LIPS.

A fold of *mucous membrane under the upper lip* is seen in some persons while laughing, like a cushion stretching across, and, as it pushes forwards, lifting the lip and everting it. To cure this deformity, it is enough to seize the fold with forceps, and cut it off with scissors curved on the flat. Compresses, soaked in cold water or alum lotion, tucked in between the lip and the alveolar process of the jaw, usually suffice to arrest the slight hæmorrhage which sometimes follows.

Hypertrophy of the upper lip.—If hypertrophy of the lip co-exists with a scrofulous habit, it is necessary to direct treatment against the strumous condition, and to abstain from any operation. But when the swelling appears in a healthy individual, we may have recourse to the operation practised by Paillard. This consists in reducing the lip by taking a strip of mucous membrane from its whole extent. To accomplish this an assistant seizes one of the labial commissures and inverts the lip, drawing it slightly forwards, while the operator takes hold of the other commissure with his free hand, and then with a bistoury he raises a mucous flap from the whole length of the lip, and about half its width. The same after treatment is employed here as in the last operation.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4

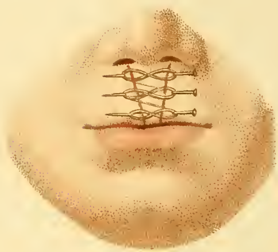


Fig. 5.

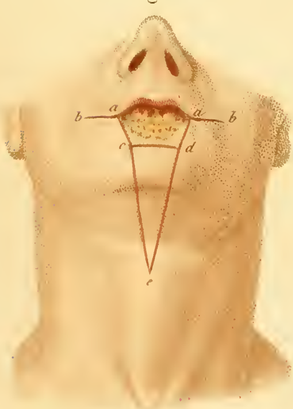


Fig. 6.

PLATE XLIV.

HARELIP, CHEILOPLASTY.—CONTRACTION OF THE BUCCAL ORIFICE.

Fig. 1.—*Simple harelip.*

Fig. 2.—*The same after operation.*—Three points of twisted suture unite the edges of the wound.

Fig. 3.—*Double harelip.*

Fig. 4.—*The same after operation.*

Fig. 5.—*Cheiloplasty.*—The cancerous mass, *a, c, d, a,* is contained between two incisions, *a, c, e,* and *a, d, e.* The commissures are extended by two incisions, *a, b,* and *a, b ;* the two edges, *a, d, e* and *a, c, e,* will be opposed and united in the median line by points of suture.

Fig. 6.—*Chopart's method.*—Two incisions, *a, e* and *d, f,* bound a quadrilateral flap, *a, e, f, d,* from which the diseased structure is cut away by the incision, *b, c.* The flap, *b, c, c, f,* should be raised to the level of the commissures *a* and d.

PLATE XLV.

HARELIP, ETC. (*Continued*).

Figs. 1 & 2.—*Malgaigne's method of treating harelip.*

Fig. 1.—Two incisions, *a* and *b*, detach two little flaps from the edges of the fissure, which are turned down, that their open surfaces may be opposed, the object being to prevent the little gap which remains after the ordinary operation, at the edge of the lip.

Fig. 2.—*The two flaps turned down before the application of the sutures.*

Figs. 3 & 4.—*Method adopted by M. Mirault, of Angers.* —A flap, *a*, on one of the borders of the fissure, is preserved. This little flap is intended to fill up the gap at the edge of the lip.

Figs. 5 & 6.—*Contraction of the buccal orifice.—Dieffenbach's method.*

Two incisions, *a*, *b*, and *c*, *d*, through half the thickness of the lip, form two sides of a triangular flap, whose base is the contracted mouth orifice and whose apex is at the labial commissure.

Fig. 6.—The flap is raised, the mucous membrane, *a*, alone remains, and forms the floor of the wound.

Fig. 7.—The mucous membrane is divided horizontally; the two membranous flaps, *a* and *b*, will cover the raw surfaces and form the mucous covering of the new lips.

Fig. 8.—*A diagram showing the mode of introducing the suture, which is to be done before dividing the mucous membrane.*

Reproduction of the buccal orifice.

This operation is performed in cases of adhesion of the lips or of contraction of the orifice. If the abnormal adhesion is congenital, and complete, the opening must be made at once by cutting through the closing membrane. In order to do this, a puncture with a straight bistoury must be made at a point answering to one of the commissures of the lips; a

Fig 1.

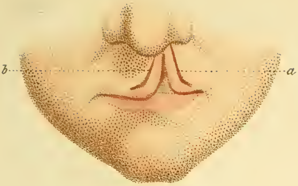


Fig. 2

Fig. 3

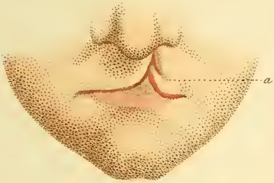


Fig. 4

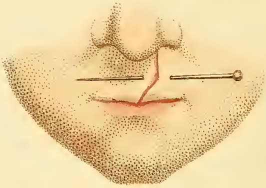


Fig. 5

Fig. 6.

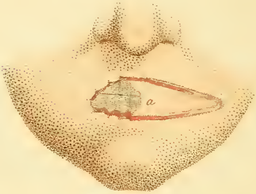
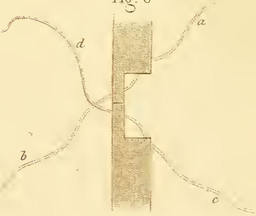


Fig. 7.

Fig. 8



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director is passed through this opening to guide the cutting instrument (bistoury or scissors) in order to form the new mouth. The two raw surfaces are to be then covered with linen and simple cerate, to prevent contact during cicatrisation.

When the contraction of the buccal orifice is produced by vicious cicatrices, resulting from burns or ulcers, it is more difficult to obtain a good result than in cases of abnormal adhesion. The process of cicatrisation brings about new adhesions which re-establish the contraction. To prevent this re-establishment of the deformity methods have been devised which we are about to describe.

Berger's method.—The buccal orifice being formed by two incisions carried as far as requisite—but in all cases ceasing inside the labial arteries—the two commissures are pulled apart by two blunt silver hooks, acting in opposition to one another. A suitable bandage fixes the two hooks at a proper distance from one another while the lips cicatrise. This procedure has been successful in some cases.

It has also been proposed to make a trocar puncture at the site of each commissure, then passing a leaden wire through each puncture, to twist up the ends day by day until the included skin, etc., are cut through by the gradual tightening. But there is danger that the divided tissues will cicatrise and unite behind the wire loop.

Krügen Hansen's method.—The leaden wire is here not intended to *cut* the tissues, it is left in place without being tightened, and when the little holes first made are cicatrized and converted into permanent apertures, the buccal orifice is completed by the bistoury, the two cicatrised perforations forming the commissures. By this procedure the results of the healing process are less to be feared than in the former case. Instead of the leaden wire a little silver canula might be used, or Scarpa's leaden style, the head of the style being in the mouth, and the bent point outside on the skin.

Dieffenbach's operation (Plate XLIV., *bis.*, figs. 5, 6).—To prevent the reunion of the edges of the wound this surgeon devised a mode of operation by which the buccal mucous membrane is preserved, so as to re-cover the raw surface of the newly-formed lips.

The operator passes into the patient's mouth the index finger of the left hand, to fix the cheek, the other hand, carrying a sharp-pointed pair of scissors, or better, a straight and very sharp bistoury, introduces the point of the instrument a little above the intended labial commissure ; the blade must not perforate the cheek, but be passed from without inwards, halfway through the tissues, till it reaches the contracted buccal orifice. When the point appears, turn the blade with its edge forwards, and cut at once from behind forwards the entire superficial half of the tissues. A second incision is made in exactly the same manner just below the first, and these two incisions are connected by a semilunar cut just at the point where the new commissure is to be. It only remains to cut out the triangular flap *a*, *b*, *c*, *d*, contained between the incisions, taking care to avoid cutting the mucous membrane which forms the floor of the wound.

The second step of the operation consists in utilising the said mucous membrane. It is to be separated as much as possible from the other tissues, then divided horizontally up to $\frac{1}{4}$ inch from the commissure. The two flaps serve to cover the raw surfaces and are fastened to the skin by points of suture.

Velpeau's operation.—Before dividing the mucous membrane horizontally, M. Velpeau introduces the threads destined for the sutures. Each thread, with a needle attached, passes through the skin and mucous membrane from within outwards. A series of threads for each lip being in position, the mucous membrane is divided and the sutures are tied.

Operation of M. Serre, of Montpellier.—M. Serre divides skin and mucous membrane at the same level, then he brings the two membranes together and connects them by sutures. This method is simpler than the preceding, but it has not the same chances of solidity.

Harelip.

The operation of harelip has two chief stages.

1. *The preparation of the edges of the fissure.*—The patient

if an adult, may be operated on while sitting in a chair, his head slightly thrown back, and supported by an assistant. If the patient is a young child, he must be wrapped in a sheet and entrusted to an assistant who holds him on his knees. The assistant, whose duty it is to support the head, should press the patient's cheeks as much forward as possible, and compress the facial arteries on the upper jaw in front of the masseters. The operator begins by raising the upper lip to divide with a bistoury or scissors the frænum which binds it to the gum. The angle of the left edge of the fissure is then seized with forceps or with the fingers and drawn downwards and forwards; then, with strong and yet slender scissors, the whole red margin of the fissure on one side is removed at one cut, extending to $\frac{1}{12}$ of an inch above the fissure. The right margin is then excised by a similar cut, which is made to meet the upper extremity of the first incision. These two incisions then form an inverted V, whose limbs enclose the harelip. Both lips should be freely severed from their deep attachments, to enable them to be brought together without tension.

2. *Union.*—The two raw surfaces of the wound are next brought together and joined by two or three points of twisted suture in this manner: the lower angle of the left flap is seized as before the first incision, and is transfixed obliquely from below upwards, and from without inwards, by a pin which passes in at the mucous edge of the lip, and out at the raw surface. The pin should appear at a point between the two anterior thirds and posterior third of the thickness of the lip, entering $\frac{1}{8}$ of an inch external to the fissure, and making its exit in the wound $\frac{1}{8}$ of an inch above the mucous edge of the lip. The angle of the other flap is next pierced by the pin, but from above downwards, and from within outwards, entering at the wound and coming out on the mucous surface of the lip.

The first pin describes a curve whose concavity is below, in order to make the two angles of the fissure project downward—to prevent, as much as possible, the little gap which almost always remains in the edge of the lip. Some surgeons instead of passing the first pin through the mucous edge of the lip, pass it through the skin a little above.

The first pin being in place, and the apposition of the flaps maintained by the help of a thread applied like the figure 8, the second pin is passed horizontally at a little distance above the first. Then the third pin is placed a little above the second (see Plate XLIV., fig. 2). Between the pins it is well to place slips of plaster to draw the cheeks forwards and support the sides of the wound. Lastly, the points of the pins are cut off and the skin protected by small strips of plaster from contact with their ends (see Plate II., fig. 6). A simple dressing of simple cerate on linen and a little lint will complete the affair.

During the first few days the patient should be kept as much as possible alone, to prevent any tendency to excitement, either to crying or laughing, which by traction on the flaps would endanger the union of the wound. Fluid nourishment should be allowed only; and if the patient is an infant, it should be fed with a spoon. The wound should also be carefully watched in the case of an infant who might suck in and swallow blood, and thus hæmorrhage might go on unsuspected.

From the third to the fourth day the lowest pin may be taken out, taking care to do it by a twisting motion, to avoid all painful traction on the flaps, which might separate the newly united parts. On the next day take out the middle pin, and on the day after take out the top one. Let the plaster stay on till the ninth day. Many surgeons remove all the pins after about fifty-four hours, leaving the plaster and the silks, which still remain glued to the part by the blood.

Malgaigne's operation (Plate XLIV., *bis.*, figs. 1, 2).—After operations conducted in the usual manner a gap remains in the edge of the lip, even when the pin is introduced, so as to make the two angles project. To remedy this defect, M. Malgaigne has proposed the following procedure: "The preliminaries being arranged as in the usual operation, the edges are to be made raw, either with scissors or bistoury, carried downwards from above, describing a curve, and ending $\frac{1}{12}$ to $\frac{1}{8}$ of an inch from the real edge of the lip, at the spot where the lip becomes horizontal. These flaps are only held by their pedicles, which allow them to be inverted, being turned down till their raw surfaces are in contact. The first pin, which should be a strong one, is passed at the base of the lip, to bring into contact at once the two retreating angles produced by the turning down of the flaps. Then one or two pins are placed above the first. The body of the lip is thus united, and it remains to give its edge a suitable form.

"To accomplish this press together the pedicles of the two flaps. Sometimes the incision has not gone low enough; the flaps, when turned down, do not lie in the same horizontal line as the edge of the lip; the incision must then be prolonged until a good line of lip is obtained. Then, with scissors, cut off all unnecessary length of the flaps, leaving only that which is essential to filling the gap up well; it is as well to keep a little too much to allow for retraction of the cicatrix. They are fastened together either with entomological pins or with interrupted sutures. If the harelip do not extend the full height of the lip, it will be well to prolong the incisions towards the nostril, to make exact adaptation at the upper end of the wound. If the labial frænum comes down too low, it should be divided."—*Manual of Operative Surgery.*

Operation of M. Mirault d'Angers (Plate XLV., figs. 3, 4).—One of the edges of the fissure is completely stripped; but on the other side a pedunculated flap is left at the lower angle. When the edges are brought together, the said flap comes in to prevent any notch.

Mr. Francis Mason, in an interesting and full article on Harelip in the *St. Thomas's Hospital Gazette* for 1875, remarks:—"It is of importance thoroughly to free the lip from the jaw on each side, so that the edges of the wound may be brought into contact without any strain on the pins or sutures, and in doing this the surgeon should remember to apply his knife quite close to the maxillary bone, for in so doing the risk of hæmorrhage is diminished. Moreover, a sufficient quantity of the edge of each cleft should be taken away. As a rule too little is removed; hence an unsightly vertical dip is left. Then the incision should be made somewhat concave, with the concavity directed towards the fissure, and a sufficient amount of the prolabium should be taken away, which obviates the V-shaped dip so often noticed after the operation."

Double harelip (Plate XLIV., figs. 3, 4).

When the central tubercle is so small as to be removable without inconvenience, it is simpler to excise it, and complete the operation as in simple harelip. But if the median tubercle must be kept, then its edges must be pared as well as those of the outer borders of the fissures. Apposition is obtained by pins passed through the outer flaps and central tubercle. The cicatrix has the form of a V or a Y. It may be that the central piece is too large for a single pin to go through both wounds at once, in which case twisted sutures may be used in each branch of the V. The notch remaining in the edge of the lip is larger in these cases than those of simple harelip; and modifications of Malgaigne's and Mirault's operations may be employed to meet this defect.

Complicated harelip.

The most common complications of harelip are :—1. The presence of teeth protruding in front; 2. Considerable prominence of the intermaxillary bone; 3. Malformation of the median tubercle and irregularity of the lip; 4. Cleft palate.

1. *Protruding teeth* are to be pushed back and drawn into position by threads fastened to the neighbouring teeth; if replacement cannot be effected, the teeth must be extracted.

2. *Intermaxillary protrusion* is a complication for which different modes of treatment may be tried. If the bone is movable, push it back; if it is fixed, cut it out.

Desault has replaced the osseous tubercle by the aid of a tight bandage passing over the prominence and fastened behind the head. The patient is to keep the bandage on until the malposition of the bone is rectified enough to allow the operation to be performed.

M. Gensoul has corrected projection of the piece of bone by breaking it and bending it into position. Whatever thod be adopted, the harelip operation must be delayed until the intermaxillary bone is set aright.

Blandin, with strong scissors, cut out a triangular piece from the base of the septum nasi. The intermaxillary, deprived of its support, could then be pushed back into place.

3. *Abnormal connection of the labial tubercle* (attachment to the tip of the nose) occurs often, with projection of the osseous tubercle supporting it. In this case the labial tubercle is to be utilised to form the division between the nostrils.

Dupuytren with a bistoury divided the adhesions which united the labial tubercle to the osseous tubercle, removing from this latter all that projected beyond the upper jaw. Then the cutaneous tubercle has its edges pared, the edges of the fissure are also pared, and the treatment proceeds as in simple harelip. The cutaneous tubercle is then bent up, and kept in position under the nose by suture.

4. *Cleft palate.—Phillips* has operated as follows where the bony fissure has interfered with the treatment of a harelip. He passed a silver wire through the base of the nose behind the alæ, small plates of cork having been placed on each side of the nose, and being traversed by the silver wire. The wire is then bent over the corks, which serve as points of support, and the nose is thus fixed between two buttons, which throw together the parts whose separation hindered the process of union.

Removal of cancers of the lip and cheiloplasty.

Cancroid excrescences and superficial tumours growing from the free edge of the lip may be cut off with scissors curved on the flat. The little tumour is seized and raised with forceps, and then cut off, care being taken that some sound tissue is removed with it. The wound generally heals readily.

Cauterisation may be employed as well by covering the wound with arsenical paste or other caustic.

Larger tumours, involving a greater depth of tissue, should be limited by two incisions, made with scissors or the bistoury, in the shape of the letter V. After the ablation of the tumour, the edges of the V-shaped wound are brought together by suture. This operation is, however, only suitable for tumours of a moderate size. It may happen that difficulty is found in bringing the wound together; in that case it will be necessary to dissect up the edges of the wound from the subjacent parts in order to oppose them more easily. Large and irregular tumours will demand special ingenuity and skill on the part of the surgeon. The removal of these tumours will involve loss of substance, which can only be made up by cheiloplastic processes.

Cheiloplasty of the lower lip.

The Italian and Indian methods are now abandoned. Whatever method may be used, a most important indication is to keep as much mucous membrane as possible to cover the new lip.

Chopart's operation (Plate XLIV., fig. 6).—The tumour is isolated by two parallel vertical incisions commencing at the fore edge of the lip, and going down to the sub-hyoid region.

These two incisions are the boundaries of a quadrilateral flap which is to be dissected downwards. This dissection accomplished, all the diseased tissue is removed from the flap by a horizontal incision. To make up for the loss of substance incurred in the ablation of the tumour, it is necessary to proceed thus: lower the head of the patient while the upper edge of the flap is raised to the level of the labial commissures, or of the portion of lower lip which has been preserved. The flap is fixed in position by sutures in the vertical incisions. If it has been possible to save any mucous membrane, that will be used to cover the new lip. In cases where the free edge of the lip is sound, it should be preserved by cutting through the skin between it and the diseased part; and, finally, the upper edge of the quadrilateral flap is to be fastened to it by sutures.

Operation of M. Roux.—The tumour being removed by a semilunar incision, passing from one commissure to another, M. Roux dissects the integuments downwards, isolating them from the lower jaw: he carries the dissection as low as the sub-hyoid region, the extent of the wound being proportioned to the loss of substance which must be made up. The skin of the chin forms, in this case, a mobile pouch in front of the lower jaw—a veritable apron, which can be raised to the level of the lip; it is to be kept in position by adhesive strapping and bandages until cicatrisation is complete. If the tumour extends to the cheek, the buccal opening is extended by cutting the angles of the mouth, and bringing one of the extremities of the semilunar incision up to meet it.

Morgan's operation.—To render the dissection of the flap which is to be raised easier, Morgan has modified the preceding operation by cutting through the integument vertically downward from the centre of the semilunar incision. We thus have two flaps, easily dissected up, and which can be brought up to the level of the commissures, and united in the middle line by suture.

M. Malgaigne's operation.—All the diseased parts should be taken away at once, either by a V-shaped incision or by two vertical incisions descending as low as the lower edge of the maxilla, connected there by a transverse incision. In the first case the lost substance is in the shape of a triangle; it will then be convenient to prolong the angles of the mouth on each side by a transverse incision, and to dissect up two triangular flaps. The vertical edges are then to be brought together in the middle line by means of sutures; the upper edge of the flaps is disposed of thus: part is wanted for the lip, and the remainders on each side are to be stitched to the upper edge of the horizontal incisions.

" In the second case the lost structure is four-sided, and to the incisions springing from the commissures two others must be added, extending down to the lower edge of the jaw. We can thus dissect up two four-sided flaps, which are joined in the middle line, and to the edges of other incisions, where suitable points can be found.

" The result of this proceeding is that the cheeks alone contribute the tissues for the lip, whose free border is formed by the raw surface of the horizontal incision. Consequently the new lip contains muscular fibres belonging to the orbicularis and its antagonists; it is covered behind by natural mucous membrane, and sometimes the free edge of the lip is covered with mucous membrane by Diffenbach's method."—*Manual of Operative Surgery.*

It is rarely necessary to practise cheiloplasty of the upper lip. Losses of tissue are made up by flaps borrowed from the cheeks: the nature of the case will indicate the operative measures needed.

Genoplasty.

"When the operation is called for by inconsiderable lesions, the surgeon confines himself to paring the edges of the wounds and dissecting them up from the surrounding tissues, then bringing them together with sutures."—*Roux.*

If the loss of substance is too great to be repaired in this way, it will be necessary to borrow a flap from the cervical region, and restore the cheek by the Indian or French method.

The operation must depend on the size and situation of the diseased parts; and the surgeon will be guided by the general principles laid down in treating of blepharoplasty and cheiloplasty.

PLATE XLVI.

OPERATIONS ON THE NOSE AND NASAL FOSSÆ.

Rhinoplasty.

Rhinoplasty originated in India, where the Brahmins sometimes employed it to remedy the deformities which had been caused by punishments for crime. About the fifteenth century it was introduced into Italy, and established as a regular operation by Branca and Tagliacozzi. In 1813 it was performed in England; later by Græfe in Germany; then by Delpech in France.

The object is to repair partial or total loss of the nose. Three principal modes of operation are now adopted; those which consisted in borrowing a nose, or portions of integument, from another person are not now used.

1. *The Indian method.—Common operation* (Plate XLVI., fig. 1).—It consists in taking from the patient's forehead sufficient skin to repair the loss of tissue. The first step is to make a

Fig. 1

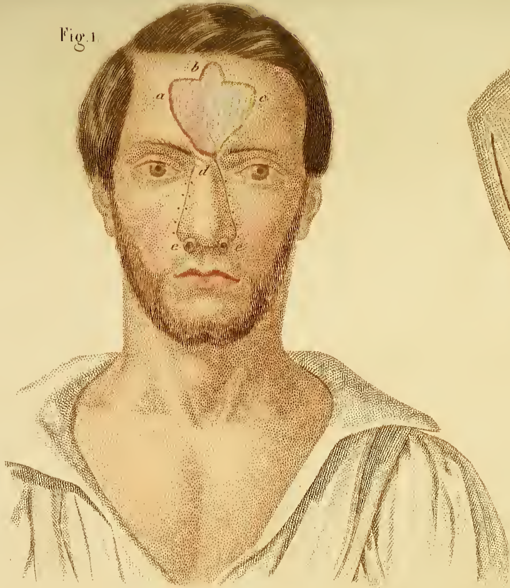


Fig. 2.

J. B. Baillière et Fils, Editeurs
Paris

pattern of the lost nose with wax or paper. This pattern is next laid on the forehead, base upwards; its exact outline is traced with ink on the skin, and the operator dissects up that skin, $\frac{1}{4}$ of an inch outside the tracing. The dissection is to be carried as far as the root of the nose, taking great care that the pedicle, *d*, is left large enough for the nutrient vessels not to be compressed. The flap is twisted on its pedicle in such a way that the raw surface is towards the nasal fossæ, and its edges are stitched to the previously pared edges of the lost nose. To keep the nostrils open, and support the new structure, may be inserted in the nostrils some plugs of lint, or pieces cut from a gum elastic band, *e*, *e*. When union has taken place the sutures are removed, and the pedicle cut through on a director, to remedy the torsion. The wound in the forehead will cicatrise, and only calls for the simplest dres sings.

Delpech's method.—This consists in cutting a flap with its base, as represented in fig. 1, with three points, *a*, *b*, and *c*. The two lateral parts form the alæ nasi, and the median point, *b*, constitutes the separation of the nostrils.

Lisfranc, wishing to avoid twisting of the pedicle, which might lead to gangrene of the flap by interfering with the circulation, advised that one of the incisions should be carried lower than the other, and twisted the flap to the side of the longer cut. But the advantages to be obtained from this step do not always make up for the inconveniences which may arise from carrying incisions too near to the injured part whose substance is to be restored.

2. *The Italian method.—Græfe's operation.*—This is but a modified form of the operation described and performed in Italy by Tagliacozzi. As the new nose has to be borrowed from the skin of the arm, the patient should be accustomed for some time before the operation to the fatiguing position which must necessarily be maintained during cicatrisation.

The second figure in Plate XLVI. shows the kind of bandage which the patient will have to bring his mind to endure while the arm is kept up to the face.

A flap, nearly six inches long by four broad, is marked out on the arm, and dissected up in such a way that the root of the nose and the lateral parts can be fixed directly by sutures to the edges of the facial wound, while the base remains adherent to the arm. Union in the opposed edges having taken place, the base of the flap is cut across and the arm released. This base of the flap is then to be cut into the three-pointed shape directed in Delpech's operation.

Tagliacozzi dissected up the flap, and let it suppurate before he fixed it to the face. He thought that the suppurative process caused the flap to become more fleshy, and rendered it more suitable for the purpose in view.

3. *French method.*—This consists in making up for lost tissue by borrowing new substance from the adjoining parts. It has been already described under the head of Blepharoplasty (Plate XXXVII).

The steps of this operation, which is especially adapted for the repair of partial loss of the nose, cannot be described with exactitude. The alæ nasi can be restored by a flap taken from the cheek; the cartilaginous septum by skin from the upper lip, care being taken not to use more than half the thickness of the lip, and to leave the mucous membrane intact.

Remarks.—Rhinoplasty is always a serious undertaking. It rarely affords encouraging results, and noses formed in this way often shrivel up and form tubercles which sometimes result in a deformity more hideous than that which it has been intended to cure. Nowadays such successful noses have been made of wax and pasteboard, and cleverly attached by means of spectacles, and by adhesive materials, that it is only in extreme cases rhinoplasty is employed, and the surgeon should not yield to his patient's request until he has warned him of the dangers to which the operation will expose him. Few people will endure the Italian operation. In most cases the Indian plan is preferable, and Delpech's method is perhaps the best.

Contraction and occlusion of the nostrils.

The operations already described for the treatment of other occlusions are applicable in this case; incision or excision must be supplemented by the introduction of tubes adapted to prevent the return of the deformity during cicatrisation, or else mucous membrane and integument must be approximated.

Foreign bodies in the nostrils.

Two routes are open for extracting or expelling foreign substances—the one in front through the nostrils, the other backwards into the pharynx. The size and character of the body and the depth at which it lies in the nasal passages will tend to indicate what course to pursue. Forceps may be employed as in the extraction of bodies from the auditory meatus, or it may be practicable to push it into the pharynx. In cases where simpler treatment fails, we may bring it forward to the nostril by means of a pledget of lint (used as in plugging the nose from behind).

Polypus nasi.

The surgical treatment of these polypi depends on their nature, seat, and form. Classified according to their nature we have:—1. Soft, or mucous polypi. 2. Vascular polypi. 3. Hard, fibrous, cartilaginous polypi. 4. Fungous or cancerous.

1. The *mucous polypi* are commonest and of least importance; they are formed of greyish matter, sparingly vascular, and often consisting of vesicles containing serous fluid. They are generally pediculated and non-adherent, and are therefore easily removed by twisting. They generally spring from the upper or outer walls of the nasal fossæ.

2. The *vascular polypi* are rich in blood-vessels. They are often very large, and push out the bony walls which confine them and oppose their expansion.

3. The *hard fibrous polypi* are less common than the preceding, and consist of a dense tissue almost devoid of vessels. They may absorb the bony walls, and they may have tough pedicles of some length, the point of origin being at a distance from the bulk of the tumour.

4. Under the names of *fungous* or *malignant polypi* are described the sarcomatous tumours.

The *operative measures* usually employed at the present day are:—1. Cauterisation; 2. Torsion; 3. Evulsion; 4. Excision and Ligation.

1. *Cauterisation.*—Solid or fluid caustics of all kinds may be used. Sulphuric acid, acid nitrate of mercury, butter of antimony, etc., may be applied with a brush. A small specu-

lum should be employed to protect the sound tissues from contact with the caustic, and the applications must be repeated more or less frequently, according to the extent and nature of the malady. Under the name of *Kusck's* caustic a mixture of sulphuric acid, butter of antimony, and nitrate of silver has been highly thought of in Germany. Nitrate of silver and the red-hot iron are sometimes efficacious; the latter is especially applicable to mucous polypi, which are to be reached in the pharynx, but it is not to be passed into the nose without extreme care, as inflammatory results may arise, and may extend to the brain.

2, 3. *Torsion and evulsion* are often combined. They are accomplished by means of polypus forceps. It is advantageous to use very strong forceps, the blades of which are armed with teeth from the joint to the tips, so as to seize firmly the bulk of the tumour. Curved forceps are employed to reach polypi from the posterior nares. The patient is seated in a chair opposite a window, the head being thrown back and supported by an assistant; the surgeon opens the nostril with one hand and with the other introduces the forceps with the blades closed up to the polypus; on reaching it the forceps are opened and passed on in such a way that the tumour is enclosed by the blades. Then the torsion is begun by turning the forceps several times on its long axis; this often suffices to disconnect the polypus. A peculiar sensation indicates to the surgeon that his object is attained. The forceps must then be withdrawn with the blades firmly closed to remove the whole or part of the tumour. Sometimes a single operation of this sort completely clears the nasal fossa; but in the great majority of cases it is necessary to introduce the forceps again for a fresh torsion to crush the remainder of the polypus, and by successive evulsive attempts to remove all obstruction from the passage. During the operation much blood may be lost, and the patient must have a few moments of rest between each attempt.

Some polypi are so soft and so slightly adherent that they can be turned out with the fingers; in other cases the pedicle is so distinct that a thread may be passed round it and the removal effected by strangulation.

Hard and large-sized polypi often require such forceps as can be disjointed, each limb being passed separately; sometimes to effect extraction the orifice must be enlarged by an incision into the edge of the nostril or upper lip; or sometimes the soft palate must be cut through.

When polypi are approached by the posterior nares the tumour must be pushed back by the little finger passed through the nostril, and the forceps used must necessarily be bent.

Hæmorrhage will perhaps occur after the operation. Astringent injections are usually sufficient to meet this difficulty; if not, then plugging must be resorted to.

4. *Excision* is chiefly applicable to pediculated polypi situated near the nostrils. Fibrous polypi, with large pedicles, and inaccessible to the ligature, should also be excised.

This operation is performed either with scissors or with a probe-pointed bistoury. The polypus having been seized with forceps or a vulsellum is drawn as near as possible to the nostrils and firmly held in position while the cutting instrument divides the attachment.

Wately succeeded in removing a large and deep-seated polypus by first passing a ligature round the pedicle; one of the threads served to guide a sheathed bistoury, having an eye near its point, through which the thread was passed. The instrument, thus led up to the pedicle, excised the tumour. In all cases we make choice of such scissors or knife as by its shape will best suit the case in hand.

5. *Ligature.*—Ligation has three principal steps:—1. To pass a loop of thread, silk or wire, through the nostril into the pharynx, or *vice versâ*. 2. To place the loop round the pedicle which it is to strangle. 3. To complete the constriction by means of a knot fastener.

First Proceeding.—A properly curved forceps can be passed through the nostril backwards into the pharynx, where the two ends of the wire or thread, passed into the mouth, will be seized by the jaws of the forceps and by them withdrawn from behind forwards through the nostril. Or a sound with an eye carrying a loop of thread can be passed through the nostril into the pharynx, where the thread may be taken by the fingers or a pair of forceps.

Or, lastly, Belloc's canula (Plate X., fig 15) affords a more sure and prompt means than the preceding. It is to be used as in plugging.

Second proceeding.—The loop of thread or wire is to be passed round the pedicle in such a way as to prevent it from slipping, using either the fingers or a fitting instrument so constructed as to expand the loop to such a size as will allow it to pass easily over the tumour.

Third proceeding.—The loop being well placed and drawn tight, the operator removes the last instrument to make use of the knot-fastener. The thread is tightened every day until the separation of the polypus, which usually happens on the eighth or tenth day.

Plugging the nose (Plate XXXVIII.).

This operation should only be used in case of hæmorrhages which resist ordinary means. Cold or astringent injection, cold affusions on the back and head, foot and hand baths, should all be tried first. If the bleeding persists, we must plug. The operation does not procure direct compression on the bleeding point, but it closes behind and before the points of issue by which the blood escapes, and thus forms a clot which stops the hæmorrhage.

Franck's method.—He makes use of a piece of pig's intestine dried; it is moistened and then tied at one end and passed into the nose by means of a probe. Water is then injected into this bag and the free end tied up.

Martin St. Anger employs an apparatus similar to that of Franck, under the name of *Rhinobyon.* A little bladder is fixed to one end of a silver tube which has a tap, the bladder is passed to the back of the nasal fossa, blown up and kept distended by turning the tap. The distended bag plugs the pharnyx, a dossil of lint is used to close the nostril, and the canula is kept in place by a clamp which slides in it and fits against the nasal opening. Indiarubber bags are now made.

Martin Solon has simplified the last operation by using a gum elastic tube in place of a silver one; a double thread attached to the tube where the bladder is tied on is left hanging out of the nostrils, and serves to keep in place the pledget of lint after the insufflation of the bladder; a little peg stuck into the tube prevents the escape of air and keeps the bladder distended.

The ordinary operation is commenced by making a plug with a roll of lint which shall block up the posterior nases. It is then tied in the middle of a piece of strong silk about 18 inches long. Belloc's sound is then passed through the nostril (or else a very flexible gum elastic catheter is used). The instrument having reached the pharynx, the button is pushed in, or the end of the catheter is seized with forceps and drawn forwards through the mouth, and to the end protruding from the mouth the threads attached to the plug are tied; next the instrument is withdrawn from the nose, and in drawing the thread through the nose a small plug is first pulled into the posterior nares, completely closing it, and then the thread in front is used to tie a plug into the anterior nares. The nasal openings are thus effectually stopped up, both behind and before, and the arrangement may be left for two or three days.

The anterior fastening is then cut, and the posterior plug may be either seized by curved forceps passed through the mouth or pushed back into the pharynx by means of a probe passed through the nose.

OPERATIONS ON THE FRONTAL AND MAXILLARY SINUSES.

Perforation of the frontal sinus.

Trephining of this part may be required in cases of fracture, caries, necrosis, abscess, foreign bodies, and polypi. A semilunar incision whose concavity looks upwards and inwards is made at the level of the upper edge of the eyebrow; the flap is raised, a small trephine applied. The operation is always a serious one, and to heal the fistula which frequently results we have recourse to compression, or to autoplasty.

Catheterism and perforation of the maxillary sinus.

Catheterism.—The opening into the sinus is situated above the inferior turbinated bone, *a* (Plate XLIII., fig. 1), and below the middle bone, *b;* to reach it one uses a little curved probe, slipping it under the middle bone, and about half-way along it the probe will reach the opening into which it is to be passed.

Jourdain has succeeded in curing retention of mucous by means of emollient injections. If the orifice of the sinus cannot be found, or if it is stopped up, an artificial opening may be made with a curved trocar, perforating the bony wall of the sinus under the middle turbinated bone, from within outwards. Jourdain's method is not often adopted.

Perforation of the sinus is the treatment generally adopted, and there are three or four methods of doing it. *Lamorie* entered the sinus between the zygomatic process and the third molar tooth. *Desault* operated in the canine fossa after cutting through the cheek. Desault's operation has been modified; the gum is incised and the perforation is made $\frac{1}{3}$ of an inch or so above the gingival margin. The wound bears no visible scar. *Cheselden* opened the sinus through the mouth. All these proceedings have their advantages and inconveniences; certain special cases may call for their employment, but the following proceeding is that which is generally preferred:—

The ordinary operation is attributed to Meibomius. It leaves no visible scar, and it consists in perforating the alveolus and entering the sinus at a low point, easily accessible by instruments. All the molar teeth correspond to the sinus, and it is through the socket of one of them that the cavity is reached. If a tooth is wanting, its alveolus is made use of; if a molar is carious, whichever it is, it is to be extracted (Malgaigne). If all the molars are sound the second is extracted.

The operation can be done with a punch, or a trocar, or a small trephine. The nature of the disease will decide the size of the opening to be made. Belloc put a wooden peg into the opening to prevent the admission of food. Other operators have left a canula in the passage.

It is difficult to determine the relative value of these procedures; but perforation through the tooth-socket is usually easy, and appears to be the method adopted by nature, since, in certain cases, fluids escape from the sinus by a socket which a tooth extraction has left empty.

Pl. 47

Fig 1.

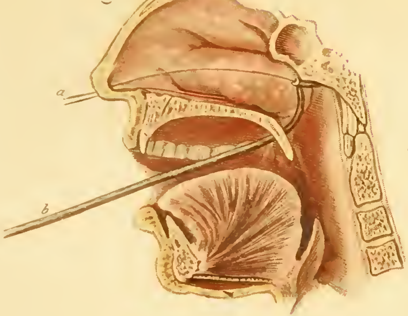


Fig 2.

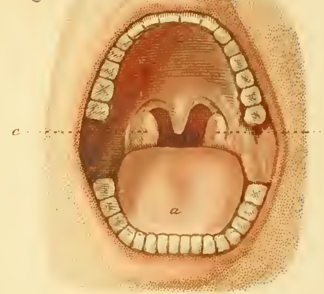


Fig 3.

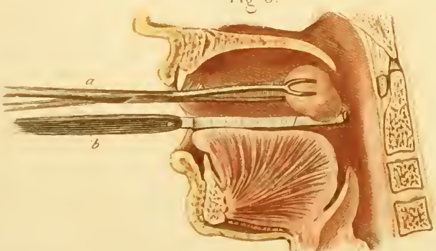
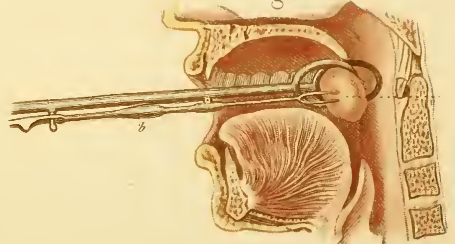


Fig. 4.



Pl 48

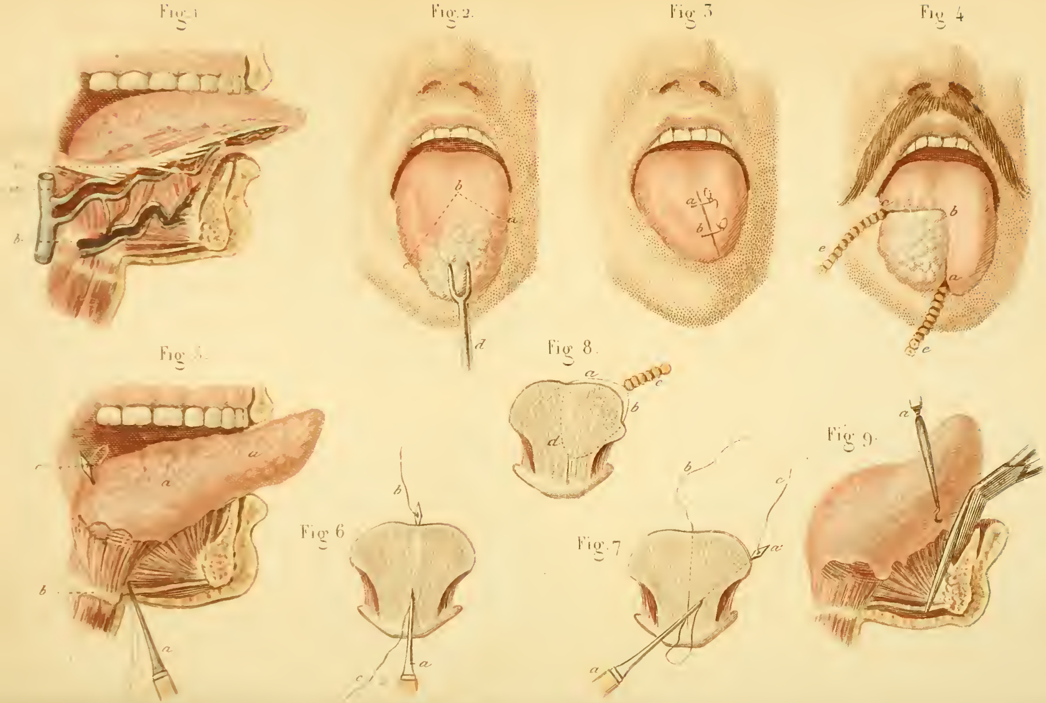


Fig 1
b.
Fig 2.
b
a
c
d
Fig 3
a
b
Fig 4
c
b
e
a
e
Fig 5.
a
a
b
a
Fig 6
b
a
c
Fig 7
b
c
a
a
Fig 8.
a
c
b
d
Fig 9.
a

PLATE XLVII.

LIGATURE OF A NASAL POLYPUS.—REMOVAL OF TONSILS.

Fig. 1.—*Vertical section of face from before backwards.*—*a*, loop of thread passed round a nasal polypus by means of M. Chaussier's *porte ligature.*

Fig. 2.—*Anatomical position of the tonsils between the pillars of the fauces.*—*a*, tongue ; *b, c*, tonsils.

Fig. 3.—Tonsil seized with vulsellum forceps, *a*, is cut off with a probe-pointed bistoury, whose cutting edge is covered with tape.

Fig. 4.—*a*, tonsil removed by the guillotine, *b*.

PLATE XLVIII.

CANCER OF TONGUE AND OPERATION FOR STAMMERING.

Fig. 1.—*Anatomy.*—Arrangement of lingual arteries, *a* and *b*. Hypoglossal nerve, *c*.

Fig. 2.—The cancerous portion is seized with clawed forceps, *d*. Two incisions, *a b, c b.* forming a V, whose apex is in the middle line, bound a triangular flap which bares a wound whose edges are brought together by two sutures (fig. 3), *a* and *b*.

Fig. 3.—*Sutures.*

Fig. 4.—The cancerous portion is comprehended between two ligatures, *b, c*, and *b, a*, which are drawn tight by means of two beaded ecraseurs, *e, e*.

Fig. 5.—*M. Vidal's operation.*—A straight needle, *a*, mounted in a handle is passed in above the hyoid bone, *b*, and transfixes the tongue from below upwards ; *c*, loop of thread carried up by the needle.

Figs. 6, 7, 8.—*Same operation.*—*Transverse section of tongue to show the courses the needle ought to take.* Fig. 6.—*a*, needle. One end of the thread, *b*, pulled out—the other end, *c*, hangs down outside. Fig. 7.—The needle, *a, a*, has been withdrawn and passed into the tongue again, laterally, so that the point appears at the edge of the diseased organ; the extremities, *b*, *c*, of the thread are drawn out. Fig. 8.—The two ends of the thread, *a* and *b* (whose loop, *a*, embraces half the tongue), are drawn together by the ecraseur, *c*.

Fig. 9.—*Section of genio-glossi.—M. Baudens' operation.*—A tenaculum, *a*, is fixed in the mucous membrane, and the maxillary origin of the muscles cut through with scissors carried on the flat.

CANCER OF THE TONGUE.

Operative Measures.

Before having recourse to such operations as remove part or the whole of the tongue, the surgeon must remember that certain tumours are wholly superficial, and that it is then sufficient to decorticate the tongue to take away the morbid tissues—that in other cases encysted tumours seated in the substance of the organ can be easily extracted by enucleation. But some affections call for ligature or excision.

Excision.—In excision it is necessary to remove a certain portion of sound tissue, about $\frac{1}{12}$ of an inch beyond the edges of the tumour. Corks placed between the teeth keep the mouth open; the tongue is held with vulsellum forceps, and drawn as far as possible out of the mouth. The incision is to be made according to the form and seat of the cancer, sometimes straight across the tongue, sometimes in a curve. If the diseased part cannot be removed by a single cut, it is best to begin on the under side of the organ, not to be hampered by the hæmorrhage when operating on the upper surface. *Boyer* included the tumour between two incisions (fig. 2, *a*, *b*, *c*, *a*), meeting like the letter V. Two or three points of suture draw the edges together.

Ligation.—Mayor's operation.—This consists in separating the diseased tissue from the sound parts, by means of threads carried through the whole thickness of the tongue.

For a cancer only affecting half the organ, Mayor transfixed the organ near its base, with a bistoury, which was then carried forwards, splitting the tongue. The diseased part was then strangulated by means of a ligature. One could, without any incision, include the diseased tissue between two ligatures. (fig. 4).

M. J. Cloquet's operation.—In a case of cancer which had affected the whole of one side of the tongue, and had so extended about the base that ligation could not be performed by the mouth, Cloquet adopted the following mode of operating. A curved needle in a handle, having the eye at its point, was passed in at the middle line of the neck, above the hyoid bone, and transfixed the tongue from below upwards.

The eye of the curved needle—by means of a rocking movement imparted to the handle—is made to appear in the mouth; two ligatures are then passed through the eye. The operator then withdraws the needle, and with it the threads, so that one end of them remains in the mouth, and one end is hanging out of the wound in the neck.

The needle is passed again through the neck wound ; but this time it is made to issue at one side of the tongue instead of penetrating it, where the eye receives the ends of the first threads which had remained in the mouth. The needle, again withdrawn, brings out these last threads through the neck wound. The ligatures thus introduced are employed, one to constrict half the tongue (transversely), the other, received into a vertical slit in the middle of the tip of the tongue, completely isolates and strangulates the cancerous tissues.

The operation of M. Mirault d'Angers is a modification of Cloquet's. The needle is passed first upwards through the tongue, and then downwards at one side of the organ.

Vidal's operation (figs. 5, 6, 7, 8).—This is the author's own description of his operation:—" I use a large straight needle in a handle (fig 5, *a*). It has a spear-headed point, with an eye. If only half the tongue is to be removed, a single very strong thread is used. The tongue being held by its tip and drawn forward as far as possible, the needle is introduced just above the hyoid bone, *b*. The farther back the disease has gone, the farther back the needle must go. Having passed it upwards through the tongue—the point appears in the mouth with the loop of thread it carries, *c*, the two ends hanging out of the neck, held by an assistant. The surgeon takes the needle handle in his left hand, and with forceps draws one-half the loop out of the mouth, giving it to another assistant (fig. 6, *b*). There is now one thread in the neck wound, *c*. The needle is then half withdrawn until the point has reached the base of the tongue, when it is pushed upwards and outwards, and the spear-head appears between the anterior pillar of the fauces and the edge of the tongue (fig. 7). With the forceps, the end of thread which had hung from the neck is drawn out of the needle-eye, and the instrument is completely withdrawn. The two ends of the thread are tied or passed through a *serre nœud*, *c* (fig. 8). If the cancer occupies the whole tongue, a double ligature is made to encircle both halves of the organ. Then two threads are passed through the needle eye—one black and one white—the difference of colour rendering the constriction of each side more easy of accomplishment."

Stammering.

Operative surgery furnishes several procedures by means of which stammering was supposed to be remedied. Experience has shown that most of these operations are not only useless but dangerous; we will, therefore, only describe such as give some chance of success, and as are free from danger.

Baudens' operation (fig. 9).—The patient is seated in a chair, his head supported by an assistant, who draws back the commissures of the lips; the operator, with a hook held in his left hand, raises the mucous membrane lying over the edge of the genio-glossi muscles, and then with pointed scissors, bent on the flat (passed half open to a depth of an inch close behind the symphysis), cuts the insertion of both muscles at once. A little plug of sponge or lint is then put into the wound, and left until the hæmorrhage is no longer to be feared. The wound usually heals quickly.

Bonnet's operation.—Subcutaneous division of genio-glossi.—The patient in seated with his head thrown back; the surgeon puts a finger of his left hand in the mouth just above the genial tubercles; then, with a sharp tenotomy knife in his right hand, he pierces the skin, in the middle line under the chin, and passes the knife through the inter muscular space of the digastric and mylohyoid. The sharp knife is then replaced by a blunt one, which is carried through the wound, its edge turned forwards, until the finger in the mouth feels the point of the blade; then turning the edge to each side successively, the surgeon cuts through the attachment of the genio-glossi. Before completing this step, he should be sure that the knife is between the tubercles, and not touching the buccal mucous membrane. After the operation a considerable effusion of blood may take place, causing some trouble in deglutition for three or four days.

The results of these operations have been so often disappointing that physicians prefer to try *gymnastic* exercises, as those of Colombat Serres, and others.

Section of the Frænum Linguæ.

If it extends too far forward the frænum is troublesome to the new-born infant in sucking, and in later years it impedes speech. Before cutting the frænum, it should not be forgotten that the ranine veins run under the tongue on each side. The infant is placed on the knees of an assistant, who holds the child's head back, and pinches his nose to make him open his mouth ; the surgeon lifts the tongue with the thumb and finger of the left hand to stretch the membrane ; then with scissors, curved on the flat, he makes the incision, as far as possible from the tongue, and with the points of the scissors turned downwards, away from the ranine veins. To raise the tongue the split flat end of a director may be used. The wound requires no special attention.

Two accidents are to be feared in this operation :—(1) The tongue being turned back into the pharynx, which might cause suffocation ; (2) hæmorrhage, when the vessels are wounded. In the first case the index finger can set the tongue right ; in the second case, one has recourse to astringents or cauterisation by wire heated to whiteness, or the wounded vessel may be closed with a ligature.

We sometimes see in young infants sublingual tumours in the form of a fleshy pad. They may be removed by excising them with curved scissors.

Abnormal Adhesions of the Tongue.

These may be congenital or acquired. In the first instance they appear as bridles of cellular tissue, easily divided with scissors ; in the second they are often the result of suppuration ; they are then extensive, and sometimes are very tough.

The patient is seated in a chair, the head thrown backwards, the mouth kept open by a cork between the molar teeth ; the operator, standing behind the patient, separates the buccal wall and the free parts of the tongue, and then with a bistoury divides the adhesions. The operation is stopped now and then to allow the patient to use astringent gargles.

The wound cicatrises of itself. To avoid fresh adhesions, the patient is advised to move the tongue frequently, and to pass the finger between the cut surfaces.

Excision of the uvula.—The patient being seated in a chair, and held as in the operation for removal of tonsils, the operator seizes the uvula with polypus or torsion forceps, and cuts it off with one stroke of the bistoury or scissors.

The hæmorrhage is usually trifling ; and to check it, it is only necessary to squeeze the cut-end with the forceps, or touch it with lunar caustic.

OPERATIONS ON THE TONSILS.

Abscess of Tonsils.

When quinsy ends in suppuration, the collection of pus may require to be let out ; pass the index finger of one hand up to the tonsil, and with the other hand slip a sharp bistoury, its blade wrapped in linen nearly to the point, along the finger parallel with the cheek, and puncture the tumour where the fluctuation is most evident.

Excision of tonsils (Pl. XLVII.).

Chronic inflammations often bring about hypertrophy of these glands, interfering with deglutition and respiration. Scarification, cauterisation, and ligation have been employed at different times in the treatment of this affection; but they have almost entirely given place to excision. It is done either with tonsil forceps and a probe-pointed bistoury, or with guillotines invented for the special purpose.

Excision.—The patient being seated opposite the light, with his head leaning against the chest of an assistant, who keeps the jaws open by means of a wedge-shaped cork placed between the teeth; if the assistant is in front of the patient, he will keep the tongue down with a spatula or handle of a spoon. The operator stands before the patient, and seizing the tonsil with the vulsellum forceps, draws the gland from between the pillars of the fauces, and slightly forwards, thus making it more prominent, and at the same time farther from the carotid artery. In the disengaged hand he holds a probe-pointed bistoury, whose edge is protected by being bound with tape to within an inch and a half of its extremity. Bringing the blade parallel to the wall of the mouth, under the tonsil with the edge upwards, the operator cuts off the hypertrophied gland. As a rule, it is best to remove as much of the tumour as possible. The operation is rarely followed by much hæmorrhage, and astringent gargles, or powdered alum placed on the wound, will stop it, if it occurs.

Should there be any reason to fear bleeding, on account of the large size of the gland, or of any abnormity of growth, the operator must take the precaution to have an iron heated to whiteness, in readiness to apply to the wound. It has been said that deep inspirations help to check bleeding from these parts.

Should the carotid artery be wounded in the operation, the operator will at once compress the common carotid with his fingers; at the same time a plug of lint fastened to one blade of straight forceps is applied to the bleeding spot, and the other blade is placed outside the cheek to form a point of support; the two rings in the handles are then securely tied to each other, thus exercising pressure sufficient to stop a slight bleeding, or control a more severe one while the artery is tied.

It is unnecessary to describe here the instruments specially devised for this operation. By Fahnestock's tonsillotome modified by Velpeau the tonsil is made to pass through its two rings, and fixed by a sliding prong (single or double), or by a twisted claw; it only remains to make the rings slide one over the other, in order to cut off the redundant gland. These instruments, which are certainly very ingenious, will be used with advantage in the case of infants; but have the inconvenience of not being applicable to all cases, and effect only an incomplete excision. The bistoury operation is therefore generally preferred (Pl. XLVII., fig. 3, *a*, *b*).

PLATE XLIX.

OPERATIONS ON THE SALIVARY APPARATUS.

Fistula of the Parotid Gland and Steno's Duct.

Anatomy.

Fig. 1.—*The parotid gland, a,* whose shape is almost pyramidal, is bounded above by the zygomatic process and maxillary articulation; behind by the sterno-mastoid muscle; it lies over the mastoid process and the digastric muscle. It surrounds the internal maxillary artery, and sends glandular processes into the condyloid fossa and beneath the temporal bone, its deep or reflected part being traversed by the carotid artery, and the facial nerve, whose relations with the glands we will consider farther on.

In front, the gland is thin; it spreads over the outer service of the masseter muscle, in irregular processes, whose inner service lies upon the *transverse artery of the face* and some branches of the facial. It also has on its outer surface some lymphatic glands (occasionally lodged in its substance); usually, however, they are found in the meshes of the fascial capsule of the gland. These glandulæ may be the seat of morbid affections (abscess, etc.), while the parotid itself is perfectly healthy.

Fig. 2.—The deeper relations of the parotid are of great surgical interest. The gland has here been removed, and the nerves and vessels connected with it are shown.

The facial nerve, a, buries itself in the gland, and then divides into branches, the chief of which are almost horizontal, which must not be forgotten when opening abscesses in this region.

Incisions made at right angles to the course of the nerve

Fig. 1.

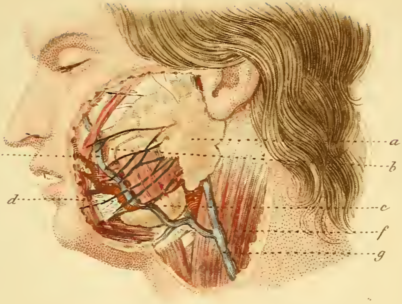


Fig. 2.

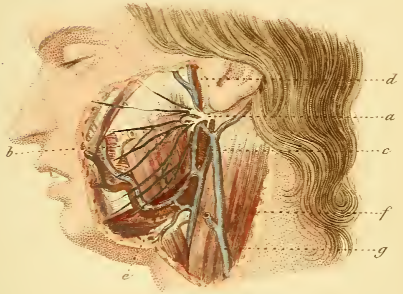


Fig. 3.

Fig. 4.

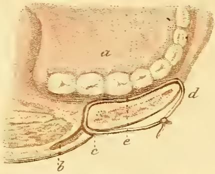
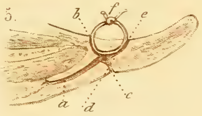


Fig. 5.



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Paris.

have often caused facial paralysis by dividing branches of the nerve.

The external carotid artery, c, almost always runs up through the deeper part of the gland.

The temporal artery, and its important veins, also pass through the gland in different directions.

Do not these anatomical data show how difficult and dangerous an operation is extirpation of the gland?

Steno's duct, b (figs. 1 & 2), passes horizontally forwards upon the masseter, in a line drawn from the *tragus* to the angle of the mouth; at the anterior edge of the masseter, it changes its course and passes perpendicularly into the substance of the cheek, going through the buccinator; and after a short oblique course between this muscle and the mucous membrane it opens in the mouth almost exactly opposite the separation between the first and second molar. This canal is accompanied by branches from the transverse facial artery, and by a branch of the facial nerve.

The submaxillàry gland, c (fig. 1), is placed under the body of the lower jaw, in relation with the fossa which bears its name; it is covered below by the cervical fascia, and the platysma. Within it is related to digastricus, mylohyoideus, hyoglossus, and the lingual nerve. The most important of its relations is with the facial artery, *d* (fig. 1), which passes through a groove on its upper and inner surface.

Wharton's duct, b (fig. 1), arises in the gland, and opens by the side of the frænum linguæ.

Fig. 3.—Morand's operation.

Fig. 4.—Horizontal section of fig. 3.—a, upper row of teeth; *b,* Steno's duct; *c,* fistula; *d,* angle of mouth; *e,* seton tied outside the mouth.

Fig. 5.—Deguise's operation.

Operative Measures.

Salivary fistulæ are of two kinds; some, affecting the *parotid* directly, are situated over the gland itself, or over the branches of the salivary duct, while others are caused by lesions of the *duct.*

§ 1. There are various modes of treating parotid fistula :—

1. *Irritating injections*, proposed by Louis, with astringent or caustic fluids.

2. *Cauterisation* with the red-hot iron, or with caustics.

3. *Vesication* has been successfully used by M. Velpeau.

4. *Compression*, proposed by Desault, with the intention of causing atrophy of the parotid. M. Malgaigne, instead of this, attempts to prevent the flow of saliva and favour cicatrisation, by the application of a piece of gold leaf covered with a patch of Burgundy pitch.

5. *Excision.*—Which consists in making two elliptical incisions to remove the edges of the ulcer, and then uniting the raw surfaces by means of sutures.

6. *Extirpation* of the parotid is nowadays seldom attempted on account of its danger.

§ 2. *Fistulæ of the duct* may be treated in many ways; the operations are classed according to their object, *e, g* :—

1. Cicatrisation of the fistulous opening. 2. Dilatation of the natural opening. 3. The formation of a new buccal opening. 4. Procuring atrophy of the gland.

First Class.—1. *Compression* exerted on the fistulous opening, or on some point in the duct—between its opening and the gland—favours cicatrisation of the wound by hindering the passage of saliva which helps to keep the fistula open. This procedure is indicated specially in cases where the buccal orifice is large, and the fistula is susceptible of rapid cicatrisation.

2. *Cauterisation* may be employed here as well as in fistulæ of the gland.

3. *The twisted suture* may be successfully employed after the edges of an old fistula have been pared.

Second Class.—1. *Re-establishment of the natural passage.*—*Morand's operation* (figs. 3 & 4).—A seton is passed through the buccal opening by means of a small probe, and made to come out through the fistula, or *vice versâ*. When the canal is sufficiently clear to allow a free discharge of saliva, the seton is withdrawn, a short piece being left for a time in the duct. Then the edges of the fistula are pared, and cicatrisation assisted by common methods.

Third Class.—The formation of a new canal.—To accomplish this end, *Deroy* passed a red-hot iron through the cheek, just in front of the masseter. The operation has been modified by later surgeons, and at present the following method is usually adopted.

Deguise's operation.—Fig. 5 represents a horizontal section of the cheek, showing the disposition of the parts concerned; *a* is Steno's duct, *c* the fistulous opening. A trocar is passed into the fistula, and as far as possible along Steno's duct, and then backwards and inwards through the cheek in the direction of *c, b*. Two fingers passed into the mouth keep the cheek steady, and enable us to know the point of perforation. The trocar is withdrawn, the canula remaining, and through it a lead wire is passed (*c, b*); then the canula is taken out, and with the trocar passed in an opposite direction to the first puncture (*d, e*). Then a silk thread is put in through the canula, which is next withdrawn. The silk is intended to be tied to the end of the leaden wire, in order to pull the wire into the mouth in the line, *d, e,* that its two ends may be fastened into a ring, *f,* which encircles the soft parts at the bottom of the fistula. It only remains to pare the edges of the fistula, and bring them together with sutures. When the wound has healed, the leaden ring is cut, and the saliva runs through the artificial opening into the mouth.

M. Rona modifies this operation by using silk instead of lead wire. M. Malgaigne uses a strong silk thread with a needle at each end. The first needle is passed into the cheek in the line, *c, b,* the second in the line, *d, e.* The silk loop then encircles the soft parts, when its ends are tied in the mouth. This operation is as speedy as it is easy.

Fourth Class.—Desault extolled compression to atrophy the gland. *Viborg*—for the same purpose—ligatured the duct. But the result of experience has gone against these procedures, and those of the third class are preferred.

Extirpation of the submaxillary gland (see explanation of Plate XLIX.).

Operation.—A crucial or semi-lunar incision is made through the skin covering the gland. The vessels are tied with two ligatures, and cut between. The gland is seized, drawn out, and isolated from the hypoglossal nerve and lingual artery, by careful dissection. After the operation immediate union may be tried, if the wound allows, or dressing with lint may be employed, leaving the parts to heal by second intention.

RANULA.

Ranula is a tumour developed on each side under the tongue, between the jaw and the tongue, above the suprahyoid muscles. Surgeons are not agreed as to the nature of these tumours ; they are seated either in the sublingual gland, or are produced by dilatations of Wharton's duct, or are encysted tumours of the duct (Jobert). Whatever their origin may be, they sometimes are of such size as to interfere with deglutition, and to call for surgical aid.

Puncture and incision.—The original modes of treatment are nowadays rejected as insufficient.

Cauterisation with the hot iron was employed by Ambrose Paré ; liquid caustics and injections of iodine have been employed successfully, but the resulting inflammation is often severe.

The *seton* has been used with the view of bringing about adhesive inflammation of the walls of the cyst. The canula, first tried by Lecat, was modified by Dupuytren, who incises the tumour and inserts a double button, which is allowed to remain, in order to favour a continual flow either of saliva or of the fluids secreted by the cyst. This treatment has often been successful.

Excision is often adopted at the present day. The upper wall of the tumour is raised by forceps or a tenaculum, then that wall is cut away with a bistoury or scissors ; the tumour empties itself, and cicatrisation soon takes place. This is the quickest and simplest of all the operations performed for the treatment of ranula ; Malgaigne's practice of cauterising the part after the excision renders the result more certain.

Jobert, under the name of *batrachosioplasty*, has described a modified mode of excision. The flaps produced by a longitudinal incision of the tumour are turned back, and fixed to the mucous membrane of the mouth by sutures. The operation is delicate and takes time.

Fig. 1.

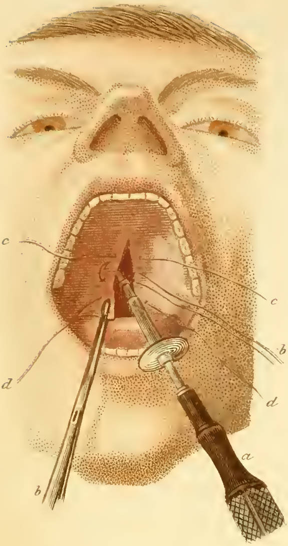


Fig. 2.

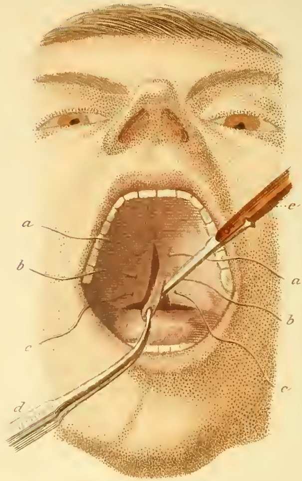


Fig. 3.

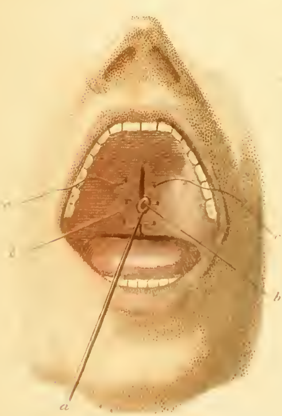
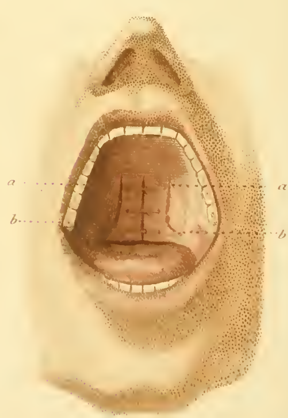


Fig. 4.



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Pl. 51

Fig. 1.

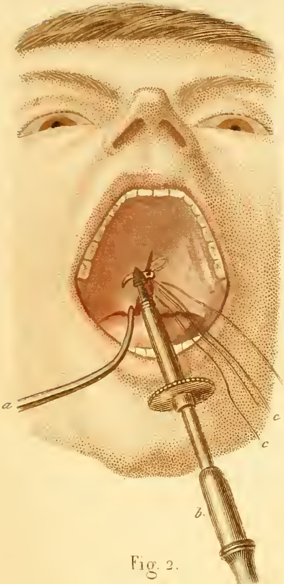
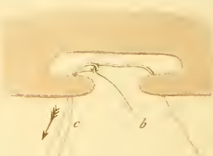


Fig. 3.

Fig. 4

Fig. 5.



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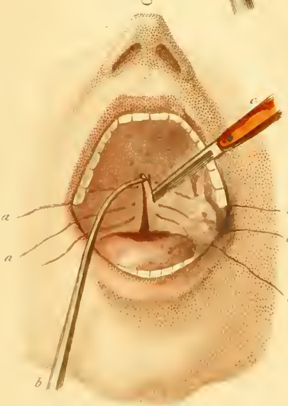


Fig. 6.

Fig. 7.

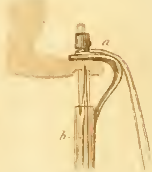


Fig. 8.

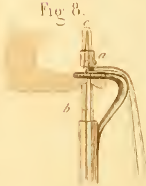


Fig. 9

PLATE L.

STAPHYLORAPHY.

Fig. 1.—*Roux's operation.*—The first and second sutures, *d*, *d*, and *c*, *c*, having been put in, the third is placed half-way between them. The free edge of the cleft is held with the forceps, *b*, and the needle held in the needle-holder, *a*, is passed from behind forwards through the margin of the cleft.

Fig. 2.—The three threads, *a*, *a*, *b*, *b*, *c*, *c*, being in position, the operator pares the edges of the fissure with a probe-pointed knife, *e*.

Fig. 3.—Tightening the knots, *c*, *c*, *b*, *b*, with the instrument, *a*, *a*.

Fig. 4.—*Staphyloplasty.*—*Dieffenbach's operation.*—*a*, *b*, and *a*, *b*, longitudinal incisions made parallel to the edges of the fissure.

PLATE LI.

STAPHYLORAPHY.

Figs. 1, 2, 3, 4, 5.—*Bérard's method.*—Fig. 1.—The operator seizes one edge of the fissure with a pair of forceps, *a*, and passes a loop of thread, *c*, from before backwards with a needle-carrier, *b*.

Fig. 2.—The ligatures, *a*, *a*, *a*, being in position, the surgeon pares the edges of the fissure with a bistoury, *c*.

Fig. 3, 4, 5.—*Diagrams of the above operation.*—Fig. 3.—Passage of the first single thread, *b*, *b*, through one lip of the fissure, *a*, *a*.

Fig. 4.—Passage of the loop of thread, *c*.

Fig. 5.—The loop of thread, *c*, drawing forwards the end, *b*, of the first thread, *b*, *b*.

Fig. 6, 7, 8, 9.—*Pierri's method.*—Fig. 6.—*Application of the instrument behind one lip of the fissure.*—*c*, movable cap holding a loop of thread, *a*; *b*, hooked needle contained in a canula.

Fig. 7.—*The canula pushed up to the front of the fissure.*—*b*, the sliding-needle at the moment when it is about to pass through the edge of the fissure.

Fig. 8.—The needle, *b*, pushed on by the operator after having traversed the lip and pushed back the cap, *c*, receives in its hoo the loop of thread, *a*.

Fig. 9.—The needle drawing the loop of thread, *a*, forwards.

CLEFT-PALATE.

OPERATIONS (Plates L. & LI.).

Cleft-palates are almost always congenital, and appear in three forms.

1. *Simple Cleft-palate*, affecting only the velum palati, is a median fissure without loss of substance, and limited to soft parts.

2. *Incomplete fissure of the palatine arch*, with some osseous separation.

3. *Complete fissure of the palate*, in which the bones and soft parts are completely separated the whole length of the palate. The fissure may reach the lips, and be complicated with harelip (Plates XLIV. & XLV.).

The surgical operations by which these deformities are remedied are:—1. *Staphyloraphy*, in simple cleft-palate. 2. *Staphyloplasty*, a modification of the last, applicable to incomplete fissures. 3. *Palatoplasty*, or *uranoplasty*, for the repair of loss of structure in the palatine arch.

Staphyloraphy was practised in the last century by a French dentist, Le Mounier; in 1817 Graefe tried it unsuccessfully. Roux, in 1819, organised the operation, drew up rules, and practised it successfully. Staphyloraphy is always a long and delicate operation, requiring endurance and docility on the part of the patient: hence the practice of postponing the operation until the patient knows what he is about.

The operation consists of three stages. 1. Paring the edges of the fissure. 2. Passage of threads intended to unite the edges. 3. Tying the threads.

Roux's operation.—The apparatus consists of:—1. The sutures formed of two or three waxed threads. 2. Six little flat-bent needles; the suture threads have a needle at each end. 3. A needle-holder. 4. Dressing forceps. 5. A probe-pointed bistoury. 6. Roux's bent scissors.

First stage.—Introducing the sutures (Pl. L., fig. 1).—The patient is seated opposite the light, the head leaning and back supported against the chest of an assistant; the mouth is kept wide open by a cork between the molar teeth; the surgeon in front of the patient, with forceps in his left hand, seizes the right lip of the fissure, and by a needle-holder, *a*, held in his right hand, passes the point of the needle behind the velum, to bring it forwards through the soft-palate, $\frac{1}{4}$ to $\frac{1}{3}$ of an inch from the edge of the fissure. The needle, passed as far as its eye, is loosened by the needle-holder, and its point seized by a pair of forceps drawing it forwards, with the end of thread which is in its eye. After some moments (to rest the patient), the same manœuvre is performed on the left lip with the other needle on the first thread, the two ends of which are now in position. When three sutures are used, the lowest is put in first, then the highest, and, lastly, the third is put in the middle. Fig. 1 shews the introduction of the third suture.

The ends of the threads, *c*, *c*, *d*, *d*, being drawn outside, and the loop which each forms being drawn down in the pharynx, the next stage of the operation is begun.

Second stage.—Paring the edges (fig. 2).—To pare the surfaces which are to be opposed, each margin is seized with the forceps, *a*, held in one hand, while with bent scissors, or a probe-pointed bistoury in the other hand, the edge is cut off from behind forwards, keeping clear of the sutures, *a*, *a*, *b*, *b*, *c*, *c*; then with a probe-pointed bistoury the fragment is separated by an incision carried a little beyond the angle terminating the fissure. The other edge is next treated in the same way, the second incision being made to meet the first, a little beyond the angle of the fissure.

Third stage.—Tying the knot (fig. 3).—M. Roux begins by drawing up the hindmost thread with his fingers, and after a simple knot he hands the threads over to an assistant, who keeps the thread, *b*, *b*, in place with ring forceps, ; while the second thread is made tight, and then the third is treated. The sutures must not be drawn closer than is necessary to keep the edges well in contact, and avoid any separation of the intervals. When all this is done (fig. 4) the threads are cut off near the knots. The patient must be kept quiet and silent, *and abstain from* *solid aliment for two or three days!!!* Anything tending to stretch the velum palati may compromise success. The sutures are not taken out till the third or four day. The lowest had better remain twenty-four to forty-eight hours longer than the others. There are certain faults in this proceeding of M. Roux. The surgeon needs much dexterity, or he will find several inconveniences. It is necessary that the sutures be placed at equal distances apart, and that each suture passes through the palate at the same level—on each side—and that the distance from the margin of the fissure is uniform. Unless these conditions are observed, it is useless to hope for perfect apposition without lapping or irregularity in the wound. And it is easy to understand the difficulty there must be in passing sutures from behind forward, when it is impossible to see the point at which the needle is going to pierce the palate. Paring the edges is difficult when performed from behind forwards with the bistoury; and when using scissors there is risk of cutting the threads. For these reasons the operation has been modified in the methods to be described.

Berard's operation (Plate LI.).—Two chief alterations are to be here noticed:—1. The sutures are passed from before backwards, so that the point of perforation by the needle can be seen. 2. The edges are pared from before backwards. The margins of the fissure can be made tense, and the incisions are cleaner. The following instruments are required:—Rat-toothed forceps, to hold the palate; dressing forceps, as needle-holder; slightly curved needles, $\frac{3}{4}$ inch in length, $\frac{1}{16}$ of an inch wide, and an eye $\frac{1}{50}$ inch from the end.

The patient is placed as in Roux's operation (fig. 1). One edge of the fissure is held with forceps, *a*, while the needle-holder, *b*, is made to pass the first thread backwards through one of the margins; the needle is brought out of the mouth, and the two ends of thread hang over the lower lip, *c*, *c*. Fig 3 shows this first stage of the operation. A thread, *b*, *b*, passes through one lip, *a*, of the fissure. A second needle is passed through the other lip of the fissure on the same level, but with the difference that the second needle has a *loop* of thread in its eye. Fig. 4 shows the loop, *c*, passing through the edge of the fissure. This loop is made to receive the end of the first thread, *b*, and draw it back in the direction of the arrow, *c*, as is shown in fig. 5. The other two sutures, being placed in position in the same manner as the first, the surgeon proceeds to pare the edges from below upwards. Fig. 2.—The edge of the cleft is seized with, *b*, the forceps, and the paring is accompanied with the bistoury, *c*.

Velpeau begins by paring the edges before placing the sutures. Other modes of operating are similar to Berard's, but the instruments used are different. To detail all the devices for passing the sutures, or paring the edges more easily, would be wearisome ; but their mechanism explains itself to the surgeon. We will, therefore, only allude to the more established instruments.

Bourgongnon has devised a needle with a movable point with which the puncture can be made from behind. Other needles of the same kind straight and curved have been effectively used for perforating from the front.

Smidt has devised a needle consisting of a steel rod in a handle, curved towards the point in a half circle of about ½ inch radius. The point has not an eye, but is a little expanded, and has a notch in the side to catch a suture in. The thread being attached, the needle is passed from behind forwards through the palate, and when the loop of thread (in the notch) appears in front it is seized, and the needle is drawn back ; the other end of the thread is then attached, and passed through the other lip of the cleft.

Leroy d'Etioles has devised an instrument which makes the three punctures at once and pares the edge at the same time.

Foraytier and *Pierri* use needle-holders, which retain the edge of the fissure while a needle pushed from before backwards through the palate conducts the suture or brings it back. For a description of Pierri's instrument see Plate LI., figs. 6—9.

Staphyloplasty.

The loss of substance which constitutes cleft-palate is often so great as to render it impossible to bring the edges together by staphyloraphy. We then have recourse to staphyloplasty, which has three varieties.

M. Roux's operation.—In order to make the parts easier of approximation Roux made two transverse incisions on each side of the fissure the length of the palate bones. The rest of the operation is as usual.

Dieffenbach's operation (Plate L., fig. 4).—Dieffenbach made a longitudinal incision on each side, *a*, *a*, *b*, *b*, about ⅓ of an inch from the cleft.

Bonfils cut from each side a flap, which he dissected from before backwards, turned it on its pedicle, and applied over the solution of continuity. The operation, derived from the Indian method, is not so easy as the two former.

Palatoplasty.

When the palatine arch is divided by a considerable fissure, we may have recourse to M. Roux's plan of dissecting up the soft parts outside of each set of sutures, separating them from the bones, and thus easily drawing them together. For this purpose M. Roux used little two-edged knives, straight in the blade, but with the blades bent at right angles or nearly so to the shaft.

Krimer detached two lateral flaps, reversed them, and brought them together across the cleft with points of suture. It is difficult to estimate the value of these various modes of operating; the case will suggest the operation most suitable.

Dieffenbach's method.—The method proposed by Dieffenbach in 1826 is available in some cases, and is thus described by that surgeon:—"The edge of each palate bone is pierced with a strong, straight, three-cornered punch, and a thick, soft silver wire put through the opening, the ends of which are twisted together. The mucous membrane is divided near the part where the palate bone joins the alveolar processes; a thin, smooth, concave chisel is applied to the bone, and it is cut through on both sides. The wires are then twisted again till the edges of the bony cleft approach each other a little, or altogether. The first alone can generally be done. The ends of the wire are then cut off. The effect of the closer approximation of the edges of the cleft in the bone is immediately perceptible in the soft palate. The side slits in the bone, which are at first filled up

Pl. 32

Fig 1

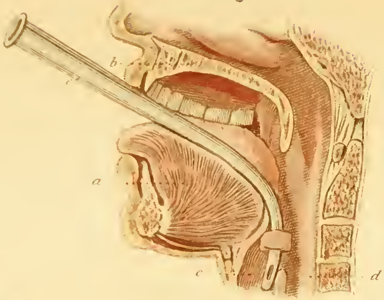


Fig 2.

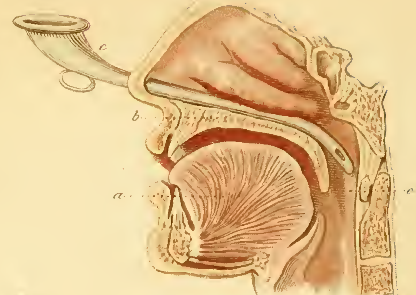


Fig 3

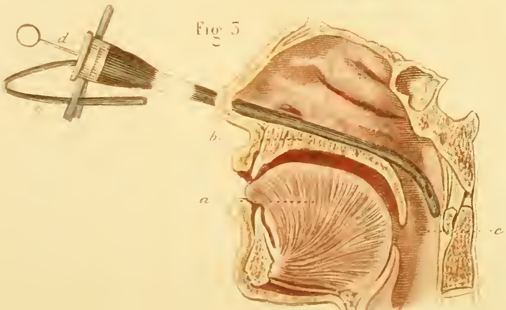
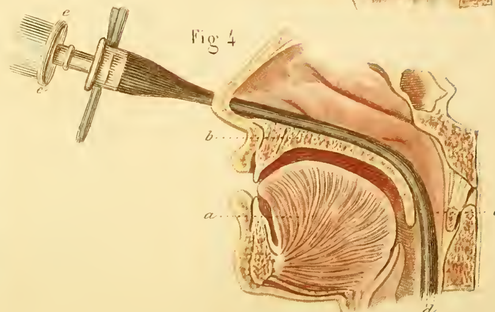


Fig 4



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with lint, close themselves by means of granulations, according to the same process. When the space in the bone is either closed or diminished so much that the cleft in the soft part is considerably lessened, the sewing of the palate may then be undertaken according to the direction already given, and side incisions made in the soft palate before the sutures are put in. The operation may be continued from time to time until the cleft is removed." The late Sir William Fergusson, without being aware that this procedure had been previously resorted to, employed it with considerable success. It is, however, frequently followed by necrosis of the palate bones, which may to some extent be obviated by making a series of small holes with a brad-awl in the line of division of the bone prior to using the chisel, after the manner suggested and practised by Mr. Francis Mason, of St. Thomas's Hospital. The "muco-periosteal" operation attributed to various surgeons is, perhaps, the best, provided the complete thickness of the soft parts be stripped off freely from the bony palate in the direction from the alveolar border towards the fissure. A properly made raspatory should be used, and its edge should not be too sharp, hence it is preferable to the rectangular knives employed by some surgeons.

PLATE LII.

CATHETERISM OF THE AIR PASSAGES AND OF THE ŒSOPHAGUS.

Figs. 1, 2, 3, 4 *represent antero-posterior vertical sections, showing the anatomy of the parts concerned.*

Fig. 1.—*Catheterism of the air passages.—Chaussier's method.* —*a*, tongue ; *b*, floor of nasal fossa ; *e*, laryngeal tube, whose end is in the larynx, *c ; d*, œsophagus.

Fig. 2.—*Catheterism of the œsophagus for feeding the insane.* —*a*, tongue ; *b*, floor of nasal fossa ; *c*, tube with upper end expanded into a funnel ; *e*, pharynx.

Fig. 3.—*Catheterism of the œsophagus.—Baillarger's method.* —The point of the instrument is passed into the upper part of the pharynx, *e ; d*, iron stilette ; *e*, whalebone stilette.

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Fig. 4.—*Same operation.*—The instrument, *d*, passed into the œsophagus *c*; *e*, *e*, *e*, the end of a syringe to inject fluid nourishment.

CATHETERISM OF THE ŒSOPHAGUS.

Anatomy.

The œsophagus is a long muscular tube extending from the pharynx to the stomach, flattened from before backwards, and an inch and a quarter across. This canal lies on the spine; in front lies the trachea, slightly to the left, so that the left side of the neck is usually selected for œsophagotomy. The pharyngeal end is at the level of the cricoid cartilage, and at this point there are often spasmodic contractions which interfere with the passage of bougies, etc.

Operative Measures.

Catheterism of the œsophagus is used for artificial feeding, or for evacuating the stomach; it is also employed to recognize the presence of foreign bodies in the passage, to extract them or push them down into the stomach.

The stomach is evacuated in poisoning cases. In these instances the first thing is to inject a quantity of tepid water, or of some other liquid, to dilute the toxic matters. After this previous measure the fluid is to be pumped out with a suitable sized pump.

The operation may be done through the nose or mouth.

Catheterism by the nose.—Desault's method.—A gum-elastic catheter with an iron rim stilette is used; a slight curve is imparted to the point of the instrument, which is held like a pen, the concavity downwards, and passed with the point sliding along the floor of the nasal fossa. When the point encounters the posterior wall of the pharynx the stilette is withdrawn with one hand while the catheter is passed on with the other. The point of the instrument being then in the upper part of the pharynx, it is only necessary to push it on in order to make it descend the œsophagus as far as the stomach. When certain of the position of the sound, and when the catheterism has beed done with a view to inject food into the stomach, a syringe is fitted to the outer opening for the purpose (fig. 4). Should the tube have slipped from the pharynx into the larynx, it is indicated (1) by the convulsive cough and suffocative spasm which immediately follow ; (2) the purpling of the face, jugular dilatation, and violent spasms, and the impossibility of articulating a single word on the part of the patient. The last symptom is the most valuable, because it is the only one which does not appear more or less when instruments are passed into the œsophagus. Therefore, let it be a rule to make a patient say some words before any alimentary matter is injected through the tube.

Baillarger's method (Plate LII., fig. 3).—This is especially applicable to the insane, because it allows us to direct the end of the sound with more certainty in a class of patients whose opposition may cause mistakes on the part of the most skilful. This surgeon uses a catheter with a double stilette. One stilette is of iron wire, *d ;* the other, *e*, is of whalebone. The two stilettes passed into the catheter take the curve given to the tube itself ; but the iron wire keeps its curve, while the whalebone tends to become straight. The catheter is passed through one of the nostrils, and when the end touches the posterior wall of the pharynx (fig. 3) the wire stilette, *d*, is withdrawn ; then the whalebone stilette, *e*, acting alone, pushes the bent end of the catheter against the vetebral column by straightening its curve. This action on the part of the whalebone stilette keeps the end of the catheter from the laryngeal opening, and consequently saves the patient from the dangers of a slip.

Blanche's method.—To attain the same end with a more simple apparatus, and one more under the surgeon's control, M. Blanche uses a jointed stilette, in which there is a central stem ending in a ring, in which the operator puts his thumb ; in two other rings the index and middle fingers are placed ; the central stem, being either pushed in or drawn out, imparts to the jointed stilette all the curves necessary for passing the catheter. This very clever instrument enables the surgeon to act with rapidity and precision, and thus spares the patient much peril and distress.

Falert and Ferrus's method.—In the great majority of cases of obstinate lunatics it suffices to convey aliments into the pharynx, when the sensation they produce excites instinctive movements and deglutition is completely effected. Falert and Ferrus have succeeded in feeding unruly patients by means of a female catheter, whose orifice is expanded into a funnel. The instrument is passed through the nose (fig. 2), and fluid nourishment, poured spoonful by spoonful into the funnel, reaches the pharynx through the catheter, and descends into the stomach.

Stricture of the Œsophagus.

The causes which may bring about stricture are numerous, and we cannot here detail them all. When the disorder is discovered, the first thing to be done is to facilitate the passage of alimentary matters into the stomach. Catheterism is then employed with a larger or smaller catheter, which may be left in if necessary. Several forms of dilators have been devised, and cauterisation with nitrate of silver has been used. These measures may be applied to cases in which the malady has been clearly made out.

Dilation obtained by bougies of gradually increasing size, as is usual in treating urethral strictures, affords a convenient and safe method to be used in strictures of this tube when resulting from duration or chronic inflammation. Cauterisation is not always applicable, and it is a difficult procedure in that it is almost impossible to determine the exact point of the stricture.

Extraction of foreign bodies.

Foreign bodies which may become lodged in the œsophagus are of two kinds, those which are capable of being softened by digestion, and thus will gradually go into the stomach, or by passing an instrument can be pushed down; other bodies, which are hard, angular, or pointed, and may stay for an indefinite time and bring about most grave accidents. In all cases the passage of a sound will furnish valuable information as to their nature, form, and situation, and the simplest means will often determine their removal. Swallowing oily and mucilaginous fluids facilitates the passage of firm and rounded substances. Bodies of large size and soft, like bread crumbs, a plum without its stone, etc., expand the canal as they pass down, and may take with them little irregular and pointed things, like fragments of bone or fish-bones. But it is often necessary to use a sound of some sort to make them pass into the stomach; either a bougie or an ordinary probang may be employed.

Extraction by the mouth.—This may be done:—1. When the foreign body is impacted in the pharynx or commencement of the œsophagus; it may then be seized with the fingers or with long curved forceps. 2. When the foreign body is arrested lower down, but from its form or its nature cannot be pushed on without danger. The instruments invented for extracting foreign bodies are too numerous to be described here. We shall therefore confine ourselves to showing their mode of action, and to enumerating the most valuable kinds. They are all intended to act from below upwards, and to bring the body into the mouth; such as hooks which can be introduced, closed between the foreign body and the œsophagus. When below it they are opened in such a way that when drawn up the substance is withdrawn also. In this category may be placed probangs, whose sponge tips are contracted and dry when introduced, which are allowed to remain below the foreign body till they have swollen and then are pulled up. Delahaye's bundles of tow; Ollenroth's chaplets; Baudens' umbrella, etc., etc. Dupuytren's prehensive sound is employed in France; it has at one end a loose hook, which can be easily passed down. Drawing it back, the wings of the instrument fall and catch the foreign body. It is impossible to estimate the relative value of these contrivances in particular cases; the surgeon will be guided by the nature of the case, and will use the usual simple methods, or will devise something new.

When the methods now described have failed, and by its presence the foreign body is causing inflammation of the œsophagus, the surgeon must resort to œsophagotomy.

PLATE LIII.

LIGATURE OF VASCULAR TUMOURS.

Ballard and Rigal's method.—The figures shew a section of the base of the tumours, to indicate the course of the needles.

Fig. 1.—*A long and strong thread with three needles.*—*a*, straight and sharp-edged needle ; *b*, straight and round needle ; *c*, curved needle.

Fig. 2.—*a*, base of the tumour ; *b*, skin. A vertical roll of skin has been raised from the level of the upper third of the tumour ; this fold, pierced by the cutting needle and its thread, and then let go, will encircle the upper third with the thread, *c*, *d*, *e*, whose extremities protrude from the skin at the punctures, *e*, *e*. The round straight needle remains for the present outside the tumour.

Fig. 3.—The round needle transfixes the tumour at its base, entering at the point, *e*, and, issuing at *b*, it brings with it a loop of thread, *g*.

Fig. 4.—The loop being cut the needle, *f*, is removed.

Fig. 5.—The upper third of the tumour is thus surrounded at its base by the thread, *c*, *d*, *e*, whose ends hang out of the same puncture, *c*, and, further, a second thread, *f*, *g*, having its ends free, is placed above the middle third.

Fig. 6.—With a second thread the same manœuvre is practised for the lower third of the tumour, by which means the middle third is comprised between two parallel threads, *f*, *g*, and *f'*, *g'*, each of these threads being threaded on a curved needle, *c* (fig. 1), one of the needles is passed in at *j*, and under the skin, and out at *j'*. So also the end of thread, *g*, similarly treated, is made to come out at *g'* ; and at this point, *g'*, the two threads, *g* and *g'*, are to be firmly tied, thus forming a loop which will encircle the middle third of the tumour, as is shewn in fig. 7.

Fig. 8.—The ends of the ligatures are passed through a bead ecraseur, and tied over a small piece of wood.

Pl. 55

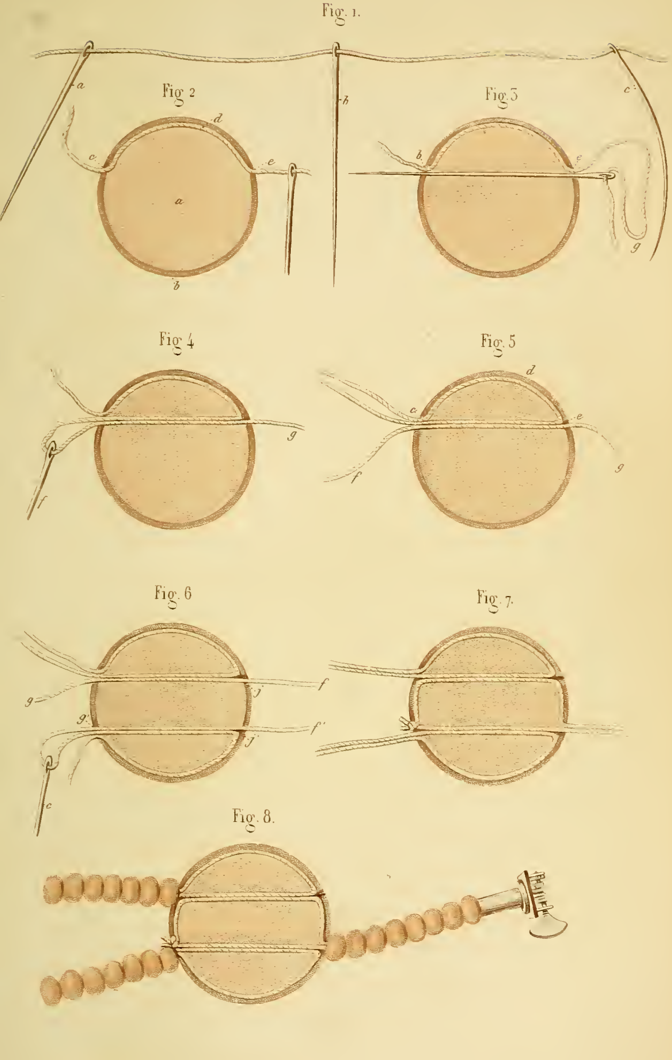
Fig. 1.
a
b
c
Fig 2
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b
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Fig. 3
b
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Fig 4
f
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Fig. 5
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Fig. 6
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Fig. 7.
Fig. 8.

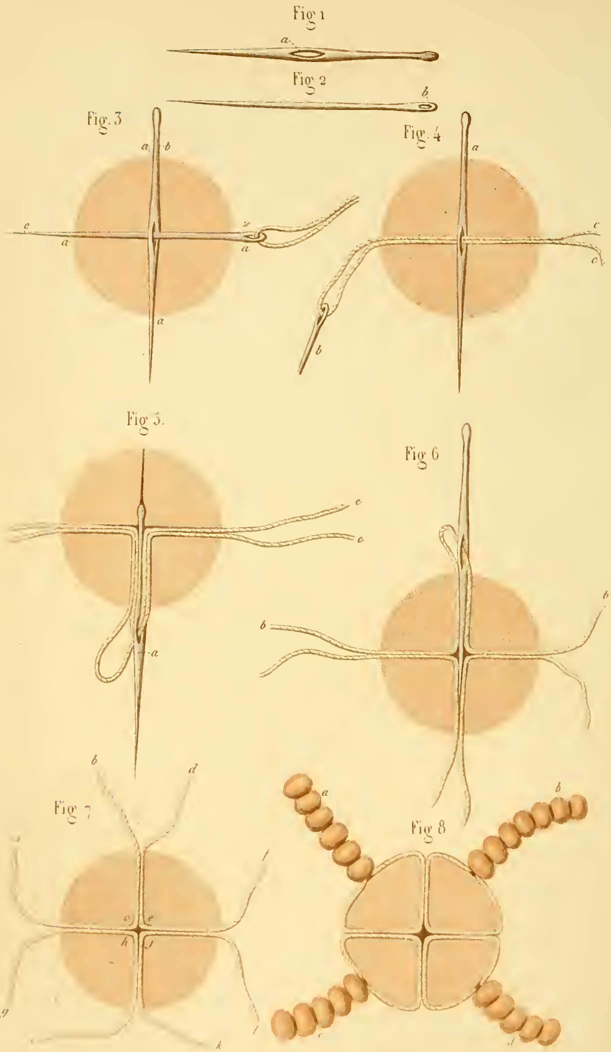
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PLATE LIV.

GOITRE LIGATION.

Manec's Operation.

Fig. 1.—Female needle, having an eye, *a*, near its centre.

Fig. 2.—Male needle, with an eye, *b*, at one end to receive a very strong double thread.

Fig. 3.—*a*, *a*, *a*, *a*.—Section passing through the base of a tumour to show the disposition of the needles. The female needle, *b*, is put in first; the male needle, *c*, passes through the tumour and the eye of the female needle.

Fig. 4.—The female needle, *a*, in place. The male needle, *b*, has passed right through the tumour, and the double thread, *c*, *c*, remains engaged in the eye of the needle, *a*.

Fig. 5.—The female needle, *a*, pushed from above downwards, brings the double thread, *c*, *c*, out of the tumour. One of the threads is then cut, and removed from the eye of the needle, *a*.

Fig. 6.—The female needle is pulled back, bringing with it the loop of the thread, *b*, *b*, which is cut, and the needle completely removed from the tumour.

Fig. 7.—The tumour is thus divided into four parts, isolated by four loops of thread, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l*, whose ends are drawn up by four bead ecraseurs (fig. 8, *a*, *b*, *c*, *d*).

Goitre.

The name Goitre, or bronchocele, denotes enlargement of the thyroid body. It often acquires considerable size, and hinders respiration and swallowing.

In the great majority of cases goitre is only produced by hypertrophy of the thyroid; but it may also consist of erectile, tuberculous, calcareous, cancerous, etc., tumours. Before having recourse to operation, then, it is most important to make out the nature of the disease, that suitable treatment may be first tried.

In general, iodine preparations are of use in simple or recent hypertrophy; puncture would be indicated in the case of serous or purulent cysts. But when the tumour is solid, the operations to be described are called for. Cauterisation, setons, ligation of the thyroid arteries, extirpation, and ligation of the tumour *en masse* have all been employed.

Cauterisation.—This measure alone could never be successfully used in the case of very large goitres ; but combined with other operative measures, it can render good service. Caustic potash is preferable to other agents ; but the surgeon must use it with great care, lest important organs near the tumour be injured.

Setons have been successfully used by Monro, by Adisson, by Flajani, Maunoir, and Dupuytren ; but they should only be used in the case of certain tumours whose nature is clearly defined. Setons set up suppuration, which causes the tumour to contract. They would be dangerous if the tumour were cancerous. When used they should be passed through each lobe of the tumour, and the thread withdrawn when the tumour begins to diminish.

Ligation of the thyroid arteries.—This is especially suitable in erectile tumours, in simple hypertrophy, and in cases where development of the thyroid has rendered the arteries superficial. Both sides must be tied, for any prospect of success. Carlisle and Chelius have employed this treatment.

Ligature en masse was first performed by Moreau in 1779. Mayor of Lausanne has since described the operation more fully.

Mayor's method.—The tumour is laid bare by a double elliptic incision, which permits the skin to be turned back right and left ; then a ligature, consisting of two threads of different colours, is passed through the base of the tumour ; the two ends of each thread are then drawn tight, to strangulate each half of the tumour. If the goitre is of large size, and lobulated, a ligature could be applied to each lobe by traversing the tumour in different directions with long needles armed with double threads, so as to strangulate each lobe separately.

Ballard and Rigal's method.—Three subcutaneous ligatures were applied to the base of a large goitre. To give an idea of this proceeding, a series of diagrams are given in Pl. LIII., to show the courses of the needles, and the disposition of the threads.

Manec's method (Pl. LIV.).—By a shorter and simpler plan than the last, Manec has tied the pedicle of a large tumour by means of four ligatures acting from the centre of the tumour towards the circumference.

The apparatus needed consists of two straight needles, whose length should be some centimetres greater than the larger diameter of the tumour. One of these needles, called "the female," for simplicity's sake, should be flat, sharp-edged, and pierced at its middle with an eye large enough to be freely traversed by the other, "the male" needle. This last needle has an eye at one end which receives two threads of different colours. The tumour is first transfixed at its base by the female needle, so that the eye of the needle is in the centre of the tumour, and the needle stays there while the tumour is transfixed afresh by the male needle carrying its threads in a direction perpendicular to the direction of the female needle, and through its central eye. Having ascertained that the male needle has passed through the female, the male is removed, leaving the threads running across the base of the tumour and protruding on each side of it.

The female needle is then pushed on until one of the threads in its eye can be seized and cut. Half the tumour is thus divided into two parts, each comprised in a loop of thread. The same proceeding is repeated in the opposite direction to form loops of thread for the other half; and the tumour will thus be strangulated at its base by four ligatures acting from the centre towards the circumference.

Extirpation.—This operation, one of the most serious in surgery, ought not to be attempted except in an extreme case, as when the patient is threatened with suffocation.

The surgical anatomy of the thyroid region shows the perils which attend extirpation of goitres, such as hæmorrhage, and entrance of air into the veins. Few successful results have been recorded; and only under great pressure should the surgeon attempt the operation. Careful attention to the anatomical relations of the thyroid (Plate LV.) will enable the surgeon to avoid some of the vessels and nerves, and thus lessen the danger. The combination of ligation with extirpation as employed by Mayor is the safest.

Catheterism of the Air Passages.

(Pl. LII., fig. 1.)

The object of this procedure is to keep up respiration, either by insufflation or with the tube left in, to keep the laryngeal passage open. It is used in œdema of the glottis, in asphyxia, and most of all in the newly-born. The instrument can be used by the nose or mouth.

1. *Introduction of the tube through the nose.—Desault's method.*—A gum elastic catheter, of large size, with a stilette suitably curved, is introduced through the nasal fossa as far as the pharynx. The jaws of the patient are kept open by means of corks, to enable the operator to seize, with his fingers or forceps, the end of the catheter. The stilette is withdrawn, and the end of the catheter is held against the tongue while the catheter is pushed on well into the larynx. When the operation has succeeded, the hand holding the instrument feels that an obstacle has been overcome ; the patient has a sudden cough, and there is spasmodic raising of the larynx ; air comes out of the open end of the catheter at each expiration. All these signs are wanting when the catheter is in the œsophagus. Withdraw it a little, and pass it again. The nose operation is only used when the catheter is meant to be kept in. For new-born infants the following proceeding is better.

2. *The mouth operation.—Chaussier's method* (Pl. LII., fig. 1).—Chaussier used a silver tube, eight inches in length, bent near the end, and pierced with two lateral holes for the passage of air. Above the holes is a piece of sponge or of agaric, which is intended to completely obliterate the upper orifice of the larynx above. Depaul has substituted one terminal opening for Chaussier's two lateral ones.

The child lies on its back, the chest higher than the pelvis, the head leaning back, the neck bent in front. The operator begins by clearing the mouth and throat of any mucus which may be present ; then slips the little finger of the left hand over the tongue as far as the epiglottis ; then taking the laryngeal tube in the right hand, he passes it along the left finger as far as the epiglottis. Moving the point of the tube about, the epiglottis is raised, and the instrument is passed on until it is well in the larynx, and then the disk of sponge closes the laryngeal opening around the tube.

If the tube is in the glottis, the chest is at once dilated by blowing in; but if in the œsophagus, the abdomen will be inflated first. To ensure success, we are counselled to firmly press the child's lips round the tube with the thumb and forefinger of each hand, while the second and third fingers compress the nostrils and close the nose. First of all, the operator should suck out all mucus from the trachea and bronchi; then blow in air with the mouth, imitating the equal periods of natural breathing. After each insufflation, the free end of the tube is left open. The insufflations must be made gently—not to rupture the air cells, by the sudden and violent ingress of a quantity of air. Twelve or fifteen insufflations a minute are enough. After each of them the hands are pressed gently on the chest, to give the walls the movement of natural expiration.

It is often not till the expiration of an hour that the artificial respiration re-animates the infant and stimulates the heart. It must therefore be continued gently and patiently. The operation should not be given up until the heart beats 120 to 130 times in a minute.

PLATE LV.

ŒSOPHAGOTOMY.

Figs. 1, 2.—Anatomy.

Fig. 1.—The œsophagus diverging a little to the left, it is chiefly on the left side of the neck that operations are undertaken.

Under the skin and cellular tissue we find the sterno-mastoid, *g*, and the hyoid muscles, *e, f;* the external jugular vein, *h, h*, which crosses the sterno-mastoid is scarcely ever found within the area of the incision. At the level of the hyoid bone, *C*, in the cellular tissue between the inner edge of the sterno-mastoid and the hyoid muscles, we find the laryngeal nerve, and the lingual, *b*, and thyroid, *d*, arteries. Thus the incision should not be carried higher than a point from ½ to ¾ of an inch below the hyoid bone.

Fig. 2.—Beneath the sterno-mastoid, *g, g*, we find the carotid artery, *j*, and the jugular vein, *i*, contained in a cellular sheath. These vessels cross the œsophagus, *L*, in a line passing from behind forwards and without inwards. Drawing the laryngeal muscles forwards, we find the trachea, *G*, which is in front of the œsophagus ; lower down is the inferior thyroid artery, *f*. The lowest point of the incision must not come nearer the sternum than two or three fingers' breadths, on account of that vessel. Above, at the level of the hyoid bone, *C*, are found the facial, lingual, and superior thyroid arteries mentioned in fig. 1.

Fig. 3.—*Œsophagotomy.*—*a, a*, incision following the line of the anterior border of the sterno-mastoid. The left hand of the operator, *b*, pulls the edge of the sterno-mastoid outwards and backwards, with the carotid vessels, *c* and *d;* the muscles of the larynx and trachea are pulled aside by the blunt hook, *f*, and the operator opens the œsophagus with a bistoury, *h*.

Operation.

The patient lies on his right side, his head turned to the right and thrown back, the neck slightly raised and supported.

Fig. 1.

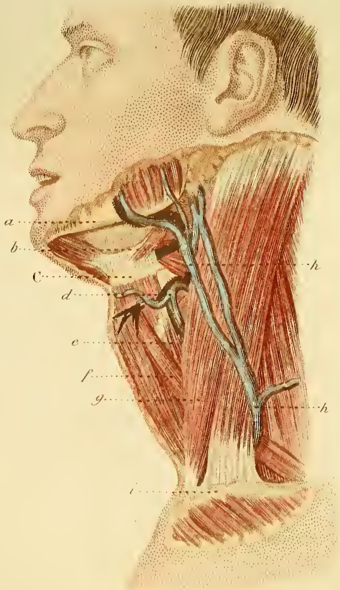


Fig. 2.

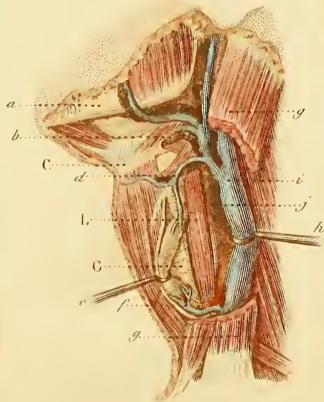
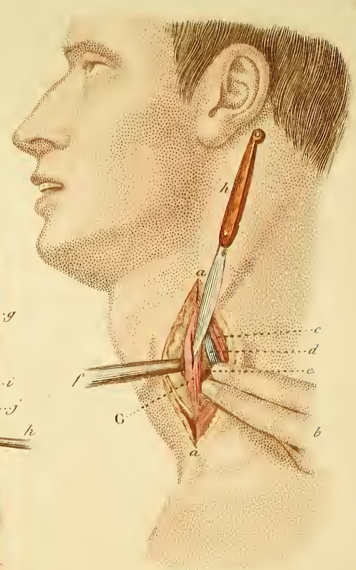


Fig. 3.



The operator stands on the patient's left, so as to be able to make the incision with the right hand, while the left hand separates and protects the structures which have to be avoided.

An assistant on the patient's right side, supplied with blunt hooks, draws aside the right edge of the wound, the hyoid muscles, and the trachea.

The operator then with a convex bistoury makes an incision three inches long, parallel to the trachea, and in the groove which separates the sterno-mastoid and thyroid muscles. The incision will pass through the skin, cellular tissue, and cervical fascia; the cellular tissue in the intermediate groove will be carefully divided on a director; the inner border of the sterno-mastoid muscle will be kept out of the way by the fingers of the left hand, while the assistant gently presses aside the laryngo-tracheal mass.

The trachea must be handled carefully not to interfere with the respiration. Accessions of dyspnœa will cause sudden movements which are dangerous to the patient. The omo-hyoid muscle crosses the wound diagonally; when it does not interfere with the operation seriously, it is to be moved out of the way upwards, otherwise it must be divided on a director.

At the bottom of the wound and behind is the cellular sheath of the great vessels, which must be pulled away from the œsophagus; in front the assistant removes the trachea with a blunt hook. The œsophagus then appears at the bottom of the wound in the form of a broad muscular band lying on the cervical vertebræ. The foreign body oftens helps to distinguish the organ by the swelling it causes. The patient may be made to swallow, which will make the muscular band contract and become firmer.

The œsophagus, being clearly defined, the bistoury is used to make a puncture, which will serve to begin an incision at first of small extent, but afterwards enlarged with a probe-pointed bistoury to give exit to the foreign body.

If the operator cannot distinguish the œsophagus in the wound a tube or probang must be passed down to assist in defining it. This step is especially necessary when the foreign body is below the wound, and cannot therefore give any indication of the gullet by expanding it. A bougie is enough to serve as an index of the position of the tube, and to act as a point of resistance for the incision. *Comes*' dart sound may be employed ; making the dart puncture the point selected, a passage is procured for a probe-pointed bistoury. But the most convenient instrument is Vacca's. This is a catheter penetrated in part of its length ; a channelled stilette is made to protrude from the opening, when a button is turned. The bulging caused by the protrusion of the stilette will guide the operator in making the incision.

The incision made ; the foreign body is to be extracted; polypus forceps, tenacula, hooks, etc., will be useful for this purpose. No general rules for extractive manœuvres can be given. The nature and form of the foreign body, the depth at which it lies, will help to indicate what course is to be pursued. After the operation the edges of the wound are brought together by simple dressing. Union by first intention is not to be tried. If the incision in the œsophagus is sufficiently extensive it will be prudent to leave a hollow sound in the canal for some days, to conduct the food to the stomach, and avoid its escape into the wound.

Fig. 1.

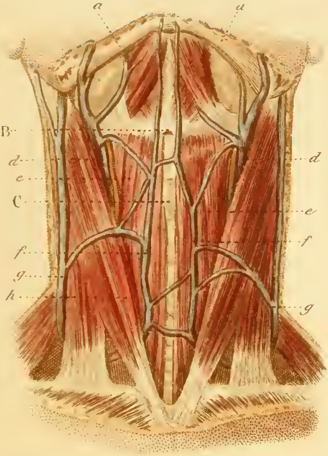


Fig. 2.

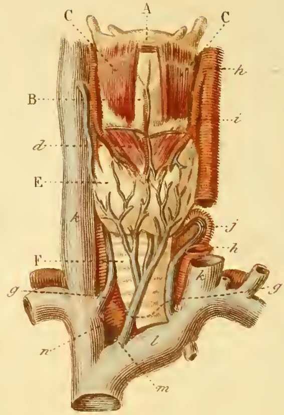


Fig. 3.

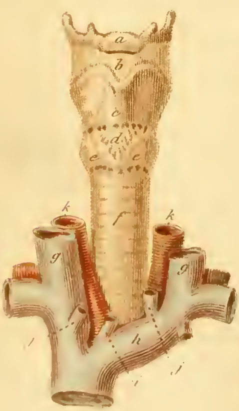


Fig 4.