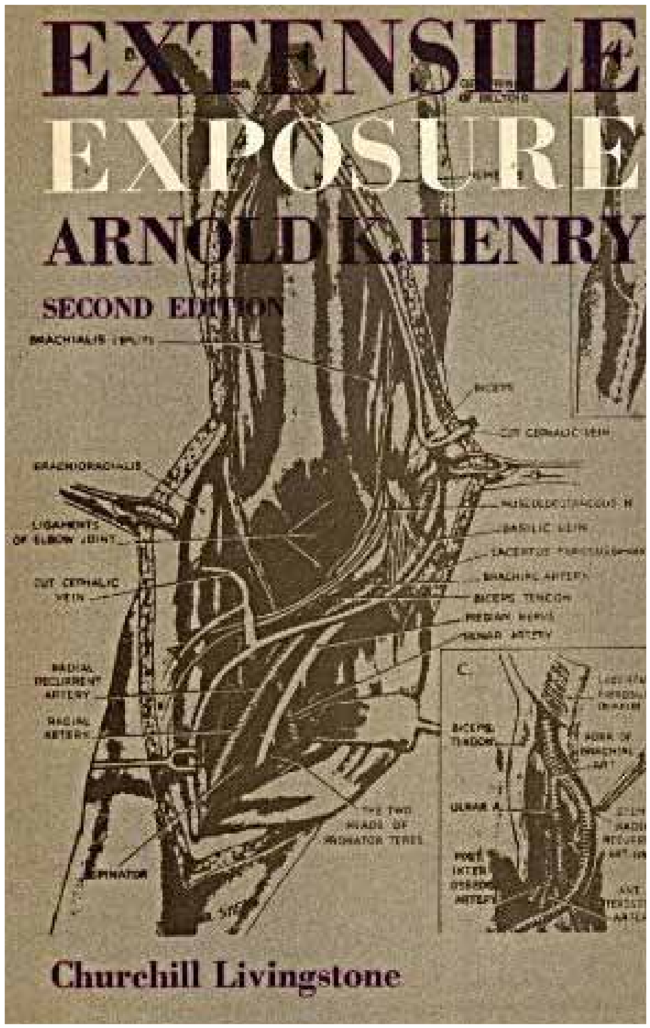
Extensile Exposure

[2nd Edition]



Arnold K. Henry

GLOBAL HELP
Health Education using Low-cost Publications

SECTION II

ACCESS AT THE SECOND LEFT COSTAL ARCH

SINCE 1922 I have used this arch in the following sequence of exposures :—

I. Resection of a *posterior segment* gave access to

A. The stellate ganglion (1922).

B. The first stage of the left subclavian artery (1923).

(By removal of a transverse process in *A* and *B* the operation became a costotransversectomy.)

II. Resection of an *anterior segment* gave access to

A. Pulmonary emboli (1940).

B. Upper thoracic ganglia, sympathetic and spinal, plus relevant nerve roots. (This last with T. P. Garry in 1949.)

Exposure of the stellate ganglion from behind achieved a certain currency when Adson adopted it at the Mayo Clinic (*Proceedings of Staff Meetings*, 1928, **3**, 266), where I had the privilege of seeing him use it. The sole important modification of the method came later with the transverse muscle-splitting incision through trapezius, devised by J. C. White. Description, therefore, of the stellate exposure—the first, Professor Leriche tells me, designed to reach the ganglion from the back—would be redundant. The other three I shall describe ; they, like certain features they present, have gained no current recognition.

A METHOD OF LIGATING THE FIRST STAGE OF THE LEFT SUBCLAVIAN ARTERY FROM BEHIND [1]

While investigating a posterior approach to the stellate ganglion, I came on a simple method of exposing and tying the first stage of the left subclavian artery.

After demonstrating this method on several occasions in the School of Anatomy of the Royal College of Surgeons in Ireland,

[1] *British Journal of Surgery*, 1923, **10**, 367.

I found that another posterior approach had been used by Sherrill in 1910 and published by him in 1911.[1]

Only twenty-one cases of ligature of the left subclavian artery in its first stage were on record when my paper appeared in 1923, and of these, seven had been performed since Sherrill's operation, which was then the solitary other instance of a posterior approach to this forbidding vessel. But in February 1925 I received a letter from the late W. A. Hailes of Melbourne, which is still a cherished memory, for it described success with the method I had published, giving me my first experience of what in bishops' parlance might be termed *translation* from dissecting room direct to theatre.

The aneurysm in Hailes' patient had the size of a cricket ball, and the ligature was placed about $\frac{3}{4}$ in. above the aortic arch. In his letter Hailes expressed the belief that the case would have been inoperable from in front "even with resection of the clavicle and sternum."[2]

This belief of Hailes reflected the sinister repute of anterior access to the first stage of the *left* subclavian artery. Thus, in spite of Halsted's successful case in 1892, and others since, ligation of the first stage—right or left—got no mention in the 1934 edition of Carson's text-book, nor was it dealt with in Thorek's *Modern Surgical Technique* (1938). A place was therefore clear for the simple means on which I chanced in a quite unescapable "marriage of observation upon accident."

During an approach to the left stellate ganglion of a hunch-backed cadaver, after a costotransversectomy at the level of the second left rib followed by depression of the pleural dome, the first stage of the left subclavian artery stood out in the field. Further depression of the pleura exposed the artery from its point of origin at the aortic arch to the first rib, and definition of all its branches except the thyrocervical trunk was easy. These structures were rendered surprisingly superficial by the kyphotic deformity of the back. Examination of normal subjects showed that in them the left subclavian artery and its branches are farther from the dorsal surface of the trunk. The first stage of the artery,

[1] Sherrill raised a flap of skin and muscle and removed about 3 in. of the second, third, and fourth ribs. After pushing aside the pleura, the artery was exposed at the level of the fourth dorsal vertebra as it left the aorta. *Transactions of the Southern Surgical and Gynecological Association*, 1911, **23**. Quoted by W. S. Halsted in *Johns Hopkins Hospital Reports*, **21**, fasc. 1.

[2] The case was later published by R. J. Wright-Smith, then Medical Registrar in Melbourne Hospital (*Medical Journal of Australia*, 21st May 1927, p. 754).

however, is just as easily tied in spite of the depth at which it lies, for once the lung and pleura have been depressed, the artery, except for a delicate sheath, lies naked in the thoracic cavity, and is immediately accessible. There is no barrier of vein or nerve; the vessel is directly under the finger. With a suitable needle it is easy to pass a ligature round the artery, and at my request this was done by students who had never previously tied any vessel in the body. Before describing the steps of the operation, certain anatomical points must be dealt with.

ANATOMY

The muscular planes.—The part of the second left rib which is removed lies between the scapula and the vertebral spines: it is

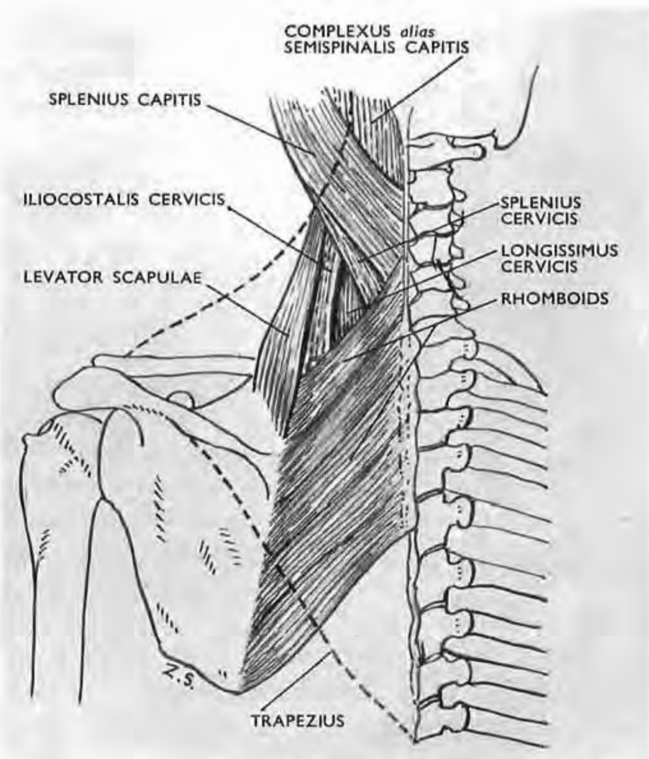


Fig. 82
Showing the muscles that lie deep to the trapezius, which is indicated by the dotted line.

concealed by muscles which anchor the scapula to the vertebræ. The trapezius is spread over the rhomboids, which cover the upper serratus posterior. Division of these muscles allows the surgeon to widen the space between the scapula and the spine, and it is essential that the transverse width of the wound should be as great as possible. Deep to the muscles of the shoulder girdle, the splenius spreads upwards from the dorsal spines; and lateral to the splenius are the cervical extensions of the sacrospinalis (Fig. 82).

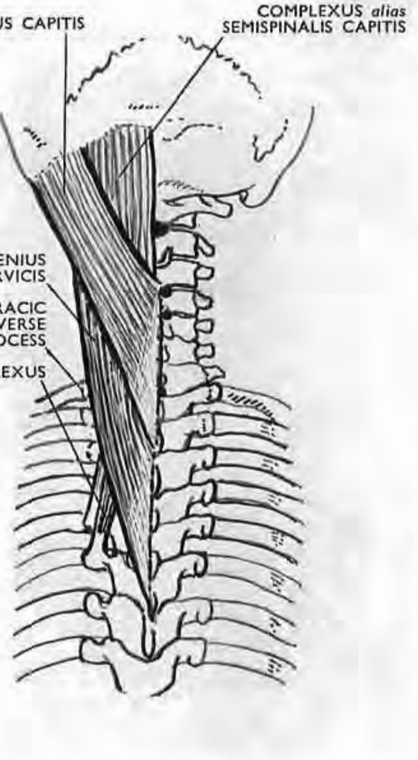


Fig. 83

The first thoracic transverse process is the first which projects beyond the edge of splenius. It forms a deep landmark for identifying the second rib.

The second rib.—The second rib must be accurately identified. It is not difficult to mistake it for the first, and thus in error to remove the third rib. The second rib and transverse process viewed from behind lie dorsal to the first, and the body of the first rib runs steeply down and forwards from the costotransverse articulation; it is difficult to palpate. When, however, the trapezius and the other muscles passing to the scapula have been divided and retracted, the first rib can be felt from behind by hooking the finger deeply down along the neck.

The *first* dorsal transverse process is a good landmark (Fig. 83): it lies at the level of the seventh cervical spine, three fingerbreadths from the middle line. It is the first transverse process to project beyond the edge of the splenius. *Here its tip is felt but is not seen,* being covered by two cervical extensions of sacrospinalis (iliocostalis cervicis and longissimus cervicis). Reckoning from this landmark, the surgeon finds the second transverse process and the second rib.[1]

[1] For additional security, the second rib should be localised by radiography before operation, and the radiologist should be asked to examine the thoracic inlet for accessory cervical or rudimentary thoracic ribs which might confuse the surgeon approaching them from behind.

The left subclavian artery.—The anterior relations of this artery in its first stage make an impressive list. Deep to the muscular planes consisting of the sternomastoid, sternohyoid, and sternothyroid, lie the left innominate, internal jugular, and vertebral veins, together with the vagus and phrenic nerves, the carotid artery, and branches of the cervical sympathetic. In the posterior

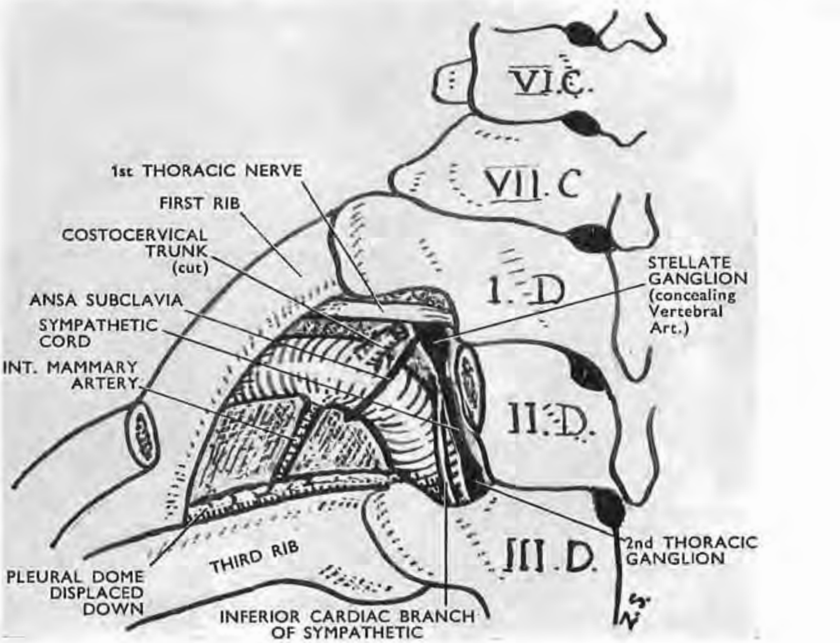


Fig. 84

The relations of the first stage of the left subclavian artery seen from behind after removal of the second thoracic process and part of the second rib. The œsophagus, and the thoracic duct which stripes its left side, are not shown in the figure : they are nearer the middle line. To see the origin of the subclavian artery from the aortic arch and to tie the *proximal* part of the artery stand behind the head of the table.

approach, however, when the pleural dome has been depressed, only one small structure intervenes between the surgeon and the artery—the ansa subclavia of Vieussens. This tough but slender loop crosses the back of the subclavian as the vessel arches after giving off its vertebral branch (Fig. 84). The depth of the proximal part of the artery from the dorsal surface is about 3 in.; that is to say, if the index finger could be thrust through the skin it would just touch the artery. By making a large flap as described below, the thickness of the skin and subcutaneous tissue is eliminated from the field, and suitable division of the muscles to the shoulder girdle allows the surgeon to work *from the plane of the thoracic* *wall.* The ' working depth ' of the artery is thus reduced to 2 in., which is the actual depth of the artery from the upper border of the manubrium in front. The ' working depth,' therefore, is the same whether the approach is from the front or back.

The left vagus.—The presence of the left vagus need not be feared. The relations of the nerve depicted in most text-books of anatomy are those which it assumes after it has been freed by dissection. It then falls away from the common carotid, and lies close in front of the first stage of the subclavian. If this were its true position, it would be in danger when the artery was tied from behind. Actually the nerve is, as Charpy [1] states, a satellite of the common carotid, and passes downwards and inwards close along this artery, coming gradually forwards as it descends : it thus lies beside, rather than behind, the left carotid at the root of the neck, and is on a plane anterior to the left subclavian (Fig. 85). About a fingerbreadth above the aortic arch the direction of the vagus changes ; the nerve passes out, down, and back, to cross the root of the left subclavian artery, so that this part of the vagus lies between the vertical carotid and subclavian origins of the left side like the oblique stroke of the letter N.

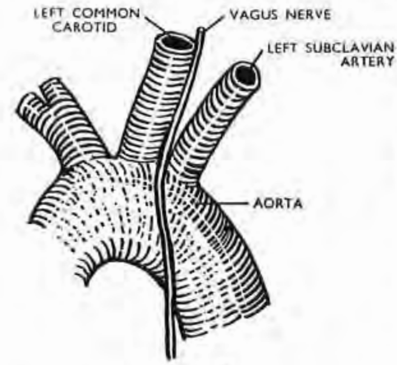


Fig. 85

The aortic arch viewed from the left side, showing left vagus related to the left common carotid and left subclavian arteries like the oblique stroke of the letter N. The vagus is safe from inclusion when the left subclavian artery is tied from behind.

Further, there is a barrier between the vagus and the subclavian which protects the nerve from inclusion when the artery is tied by the posterior route. This barrier consists of a layer of areolar tissue which contains : (1) The middle and sometimes the superior cardiac branch of the cervical sympathetic ; (2) descending œsophageal and tracheal branches of the inferior thyroid artery ; (3) an occasional thymic tributary of the vertebral vein. These structures not only make it difficult to expose the subclavian from in front, but obscure the origin of the vertebral artery, which tends to lie at a relatively low level on the left side.

The left vertebral artery.—This vessel during development is often absorbed into the aortic arch, and seen from in front may be mistaken for the subclavian, since it then arises from the arch

[1] Poirier and Charpy, *Traité d'Anatomie*, 2nd edn., vol. ii, pt. 1, p. 426.

to the left of the left common carotid. This error will not be made in ligation from behind.

The thoracic duct and the inferior cardiac nerve.—The thoracic duct will not be injured from the back; it stripes the left side of the œsophagus in the superior mediastinum, and only leaves it to pass in front of the root of the vertebral artery. In an anterior attack the duct, though not in contact with the first stage of the subclavian, may be injured as it arches outwards over the vertebral origin.

The inferior cardiac branch of the sympathetic also lies medial to the artery. With the most ordinary care it is easily avoided (Fig. 84).

THE OPERATION

A good headlight should be used, but in the cadaver I have repeatedly tied the artery without artificial illumination. The

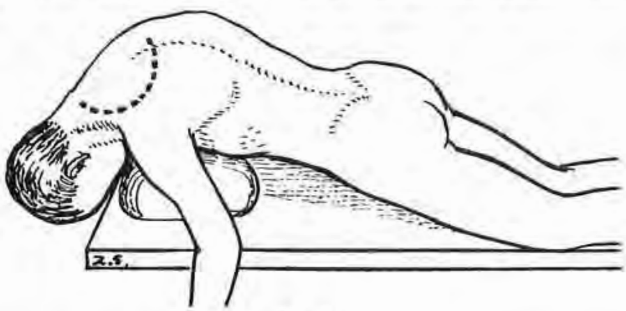


Fig. 86

Showing the position securing a maximum abduction of the scapula. The original incision is shown. (It might, of course, be replaced by White's transverse muscle-split of trapezius, which should be stopped a thumbwidth medial to the scapula to avoid the accessory and cervical innervation.)

patient lies prone, with the left shoulder clear of the table and the left upper limb hanging vertical (Fig. 86). Make the upper dorsal region as kyphotic as possible. This gives the space between the scapula and the vertebral column its maximal width.

1. Find the seventh cervical spine. Mark: (*a*) A point four fingerbreadths above it and one fingerbreadth to the *right* of the middle line; (*b*) a similar point six fingerbreadths below the seventh spine; (*c*) a point over the middle of the spine of the left scapula. Join these three points by the incision shown in Fig. 86, which is carried down to the sheath of the trapezius muscle. Raise the flap of skin and subcutaneous tissue thus outlined and turn it over to the *right* of the middle line.

2. With a vertical cut one fingerbreadth to the left of the vertebral spines, divide the origins of (*a*) the trapezius, (*b*) the rhomboids, and (*c*) the serratus posterior superior. Do this first at the middle of the wound where the silvery tendon of the serratus indicates the depth reached. Extend this incision throughout the entire length of the wound. Retract the divided muscles outwards. The pointed caudal end of the fleshy splenius is now exposed.

3. At the level of the seventh cervical spine, and three fingerbreadths from the middle line, find the tip of the first left dorsal transverse process, remembering that it is the first which projects beyond the edge of the splenius. Find the second left rib.

4. Clear the transverse process of the second dorsal vertebra as far as the lamina. Clear at least 3 in. of the second rib. Divide the transverse process at its root and remove it. Divide the rib as far as the wound will permit from the costotransverse articulation.

5. Raise the proximal cut end of the rib. With a finger push the pleura away from its head and neck. Rotate the rib segment and divide its attachments. The sympathetic cord is now seen close to the vertebral body, lying on the pleura like a tape.

6. Very gently push the pleural dome downwards and outwards from the vertebræ. A small strand will now be found holding the pleura to the neck of the first rib. This strand is a branch of the superior intercostal artery. Divide and tie it. The pleural dome can then be freely depressed, and the left subclavian is felt by the finger passed vertically and at a tangent to the vertebral body. *The removal of the transverse process, together with the costal neck, permits of this direct approach.* A broad malleable retractor keeps the lung and pleura out of the field. It should be polished so as to reflect light into the cavity. The artery is isolated under direct vision by blunt dissection, and its sheath is opened in the usual manner, using a long dissecting forceps. The ansa subclavia should be avoided.

7. The surgeon stands facing the head of the table. An aneurysm needle with a slot eye (or, better, the cup-and-ball needle described on p. 133) is passed with the *left* hand from within outwards: introduction of the right forefinger into the wound facilitates this manœuvre. The eye is threaded with a ligature, or with a guiding thread to which a broad definitive ligature can be attached. Ample space is afforded for securing the knot.

The internal mammary and costocervical trunks can be tied at their origins. The vertebral artery is obscured by the cervico-dorsal ganglion of the sympathetic, but can be safely ligatured by opening the subclavian sheath close to the vertebral origin and passing an aneurysm needle round the parent trunk so that its point appears in the angle between the subclavian and the vertebral artery. The thoracic duct may thus be avoided. The thyrocervical trunk is difficult to secure by the posterior route.

A CUP-AND-BALL ANEURYSM NEEDLE FOR DEEP LIGATIONS [1]

While investigating the posterior approach to the first part of the left subclavian artery, which is described in the preceding pages, I asked the students in the dissecting-room of the Royal College of Surgeons, Ireland, to test the description and simplicity of the method. Using ordinary aneurysm needles, they tied the vessel correctly, but it was plain that a better tool would have made the task yet more simple. When the needle was threaded and then passed, the ligature lay back along the shaft, and was difficult to catch in the deep wound, while if the needle were passed unthreaded, it was not easy to expose and thread the terminal eye.

On experiment I found that an ordinary dental stopping instrument (Fig. 87, A) passed easily under the artery, and it occurred to me that if the smooth ball-tip of the instrument were detached and pierced like a bead, and if the stem were hollow, with a mouth wide enough to seat the ball, the ball could then be strung on a thread going through the stem. The thread, pulled taut, fixed the ball firmly to the cupped end of the stem, and the implement passed like an ordinary aneurysm needle under the vessel. It then remained merely to pick up the ball beyond the artery and thus retrieve the thread, which was done very simply under the guidance of vision, or of *touch*, by means of a fine hairpin bent into the shape shown in Fig. 88.

Keeping the thread taut, the ball was first made to enter the wide part of the loop, and was then caught at the constricted end; the thread was relaxed and the ball withdrawn.

I had another and smaller model of this needle made for ligating the middle meningeal artery as a preliminary to operation

[1] Shown at the Section of Surgery, Royal Academy of Medicine in Ireland, April 27, 1923. Reprinted from the *Irish Journal of Medical Science*, October 1924.

on the gasserian ganglion (Fig. 87, c). With ordinary technique the aperture in the temporal fossa has a diameter of about 3 cm., while the distance of the artery from the surface of the zygoma is some 5 cm. Thus here, too, a deep vessel is tied through a small unyielding gap. Mr (now Regius Professor) A. A. McConnell found that with my instrument ligation of the artery at the foramen spinosum became extremely simple—but that, of course, was before plugging the foramen had replaced ligation.

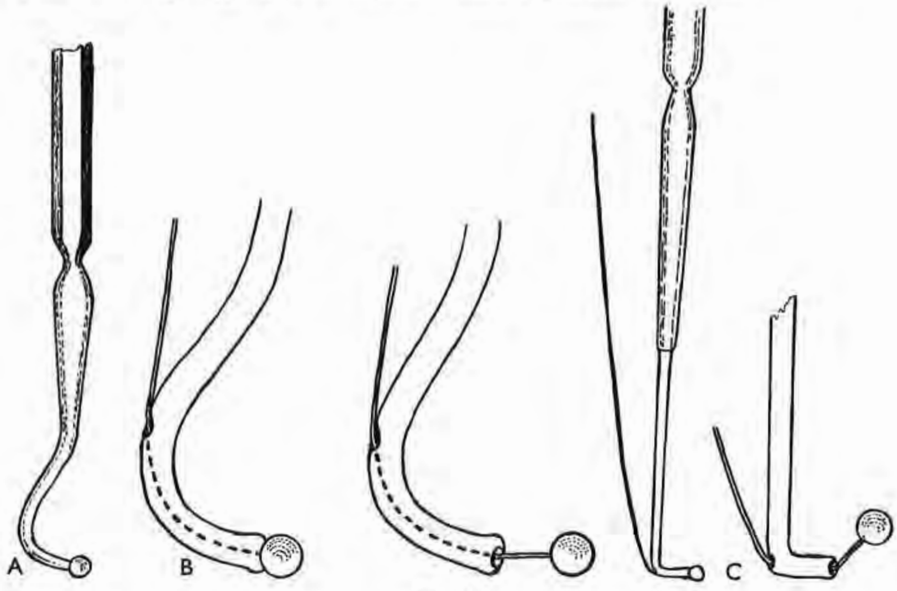


Fig. 87

When the ball is being strung on the thread, instead of knotting one end to secure the ball and passing the other through the hollow needle, it is better to slide the ball half-way along the thread and then to pass the *two* ends through the tubular stem.

The first of these cup-and-ball needles were made for me in 1921 by the late Edwin Haines of Dublin, a most skilled artificer who had long worked on astronomical instruments and, in World War I, on submarine equipment. It is to him that my needles owe the distinction of being perhaps the first surgical tools that were modelled in duralumin. They were afterwards made by Messrs Down Bros., London, in stainless steel.

There is nothing new. Long after describing the cup-and-ball needle I read, in a selection from the works of Abraham Colles published by the New Sydenham Society in 1881 (p. 342), that during the first ligation of the subclavian artery it became impracticable to retrieve the ligature although the aneurysm needle had been successfully passed round the vessel. An assistant suggested that Colles should make a knot on one *end* of the ligature, sufficiently large to prevent it from slipping through the needle's eye, so that when needle and knot had passed together under the vessel, the knot might be picked up on the far side. Unfortunately the eye of the needle was so long that it allowed the knot to slip back when the needle was pushed forward. Yet,

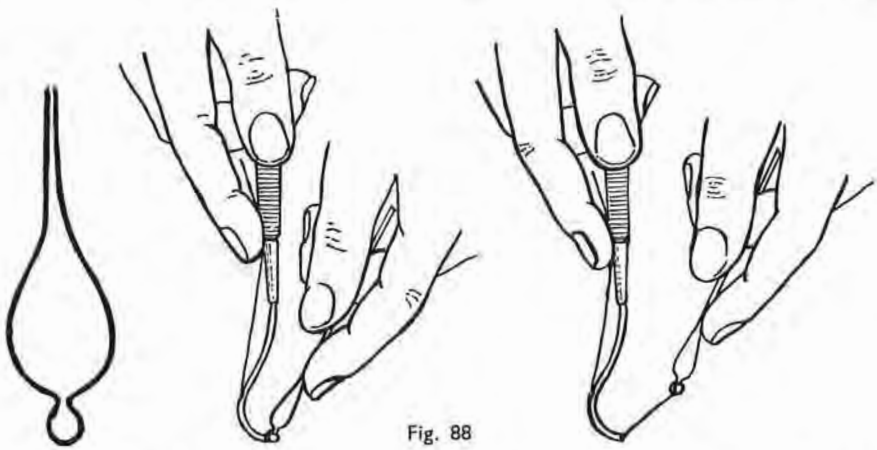


Fig. 88

despite the fact that the cup-and-ball principle was already foreshadowed in 1811, I feel privileged in following (though unawares and over a century later) a suggestion born at the crisis of an operation by Colles.[1]

A TECHNIQUE FOR REMOVING PULMONARY EMBOLI

Excepting for an obsolete paragraph on restoring the heart beat, this article is reprinted by kind permission of the *Lancet*

[1] A memoir by the editor of this New Sydenham Society volume records two unfamiliar tales regarding him. One of them, with perhaps a grain of truth in a halo of myth, tells how a flood of the River Nore, near his Kilkenny School, swept away the side of a house and took with it a treatise of anatomy which Colles found later in a field, "and soon preferred to his Horace or Lucian." The other, from a letter in his own hand, adds an unlooked-for gleam to the quiet portrait in the Dublin College. In April 1796 he writes from Scotland: "I must begin by telling you that I am much improved in point of personal appearance and accomplishments; for having this day cast aside my winter clothes and put on my summer dress, my landlady could not be restrained even by the dictates of female modesty, from telling me to wear hair-powder. I need scarcely tell you that, strong as my pride is, it could not persuade me to go to the expense of six guineas a year."

much as it stood (*Lancet*, 1940, **1**, 349). I have three reasons for including it here :—

First, the method (which discards classic instruments) was welcomed as simple and bloodless by René Leriche, who for many years has occupied a place in surgery one thinks of as the growing point (*Les Embolies Pulmonaires*, 1947, pp. 52, 53, Paris : Masson et Cie).

Secondly, the exposure is extensile in that its early stage affords an extrapleural access to upper thoracic ganglia, both sympathetic and sensory (p. 147).

Thirdly, pre-operative practice of its technique can provide surgical teams with the finest test I know of smooth unhurried speed.[1]

It has, of course, long been obvious that many lives might be saved by the organisation of hospitals in respect of emboli ; O'Shaughnessy found that those unorganised were lucky if they could claim a single success. But in these islands how many have ever installed the warning bells that twenty years ago were rung in Sweden ? If bells rang here, how many competently practised ' residents ' would they alert ? How often would these find their patients or their instruments prepared ? Success, at best, will be infrequent ; yet now, when hearts are trumps in surgery, " live and let *die* " is a poor motto for ' residents ' with decent sporting instincts. But instinct without guidance would be disastrous, and guidance in this matter is lamentably overdue.

In eight months (1939-40) I performed pulmonary embolectomy on three patients, and, though none was saved, a procedure has taken shape from these attempts which serves at least to meet some of my own difficulties.

FIRST OPERATION

The first operation, except for one detail, followed tradition. Four inches of second left rib and cartilage were resected through a T-shaped incision ; and, after the medial edge of the pleural sac had been displaced outwards by gauze dissection, an opening was made in the pericardium. The special hooked sound then looped a rubber tube through the tunnel of the transverse sinus behind the aorta and pulmonary artery. With both vessels thus controlled, I opened the blue and bulging pulmonary trunk and

[1] In 1939-40 I was exceptionally privileged in housemen : Barber, from Toronto Billimoria, from India (via Barts) ; Dunlop of Melbourne ; Harty, from Dublin *en route* for Cambridge ; Yeates, from Sydney.

drew out a long clot like a tapeworm folded lengthwise, using the bulky forceps supplied for this purpose. The lips of the opening in the artery were held with small hæmostats. Cardiac movement ceased as the patient reached the theatre, only returning after fifteen minutes—a tardy response to the combination of two restorative measures, injection of the left auricle with adrenaline and compression of the heart at systolic intervals between a hand inside the chest and one passed under the diaphragm by laparotomy. Meanwhile artificial respiration with carbon dioxide and oxygen was maintained by the anæsthetist. A pulse presently beat at the wrist and was felt for an hour; for this hour, too, the dulled eyes became living and bright; then the patient died—apparently a second time.

It is worth note that, once the clot was out, crossing the hæmostats on the lips of the pulmonary opening checked bleeding from this source and gave leisure to close the vessel. No use, therefore, was made of the special clamp designed in the original technique to seal the opening between removals of clot and during final suture.

Slight delays in passing the hooked sound through the transverse sinus and fastening on its rubber tube led me to relinquish their use.

There are two sources of delay: (1) Even with practice it is not always easy to deliver the end of the retrieving sound and make fast the rubber tube; the end will sometimes hide behind the sternal edge or engage pericardium. (2) In haste one may screw the bayonet catch of the tube into the sound while—wrongly—holding the rubber tube itself; the catch snaps out when the tube untwists. This has happened to at least three other surgeons (Nyström, 1930). The vessels, too, have been wounded by the sound or injured by the tube; even the right auricle has been opened. Lake (1927) used his finger for hooking up the vessels when no sound was available.

It was just as easy to pass a finger through the sinus in cadavers and then hook up and handle aorta and pulmonary artery. Thus I came to question the need of occluding both these main trunks, for I could hold at pleasure the pulmonary with finger and thumb and free the aorta. But tradition blinds; and forceful use of the transverse sinus—with fingers now instead of tube—still seemed the way to gain control of the pulmonary trunk.

It is well, however, to know how to *find* the transverse sinus, in order to tell pulmonary trunk from aorta, and, especially to steady the trunk. More than once the wrong vessel has been opened, for the aorta may be pulled in front of the pulmonary by the tube or, because of sclerosis, be mistaken for pulmonary filled with clot; the aorta can even be hooked up separately by anyone really determined. But books still fail to guide the tyro. I have found each of the following methods useful in locating the sinus: (1) The right index finger, slid vertically inside the pericardium opposite the second rib and kept in contact with the lining of the left wall of the sac, crosses over the left auricular appendix and goes straight into the sinus; (2) outward retraction of the left wall of the pericardium brings to view the blunt, free tip of the appendix; a finger enters the sinus a little behind and medial to this landmark. The pulmonary artery is the trunk next the left end of the sinus.

SECOND OPERATION

My second operation was performed shortly after the first. This time the patient's heart was beating when the chest was opened, but it stopped at once when I passed a finger into the sinus and hooked up the two great vessels. I immediately let slip the aorta and kept hold of the pulmonary trunk. Emboli had already reached its smaller branches; and, though most were removed in the way described presently, the outlook for the patient—even from the standpoint of pulmonary embolectomy—could only be desperate. This time I discarded the special clot-forceps that seemed so large in the previous case and used an aspirator instead. Attached to it was a cannula curved to the shape of a favourite dissecting scissors, which happened, when introduced from the main trunk in cadavers, to enter, like sword into sheath, branches arising from the right and left pulmonary arteries.

I had found, through the courtesy of the late T. H. Belt, that with this cannula the aspirator, in dead lungs, removed emboli from small branches and in my second case was able to extract, as I have said, most of the peripheral clot. But the real virtue of the aspirator—at least as yet—is not in these peripheral extractions; at present it seems impossible to save a patient who has been gradually overcome by clots that reach remoter branches. Advantage lies in the cannula entering a small and easily controlled incision in the main trunk and then cleaving at once by suction to adjacent clot, which may either stick in its mouth and thus be drawn out or else pass on through the lumen. Nyström (1930) has long used aspiration for removing pulmonary emboli and cites Trendelenburg as using it many years before him in animal experiments.

An unexpected source of delay in this case was the peculiar depth and density of the propericardial tissue—rich, perhaps, in thymic remains—which appeared on retracting the pleura. After dividing this tissue I lost time through mistaking the smooth face of pericardium for the exposed wall of a great vessel. I had till then not learnt to rely on the likeness of pericardial wall to thin dural membrane as sure guidance for opening the sac.

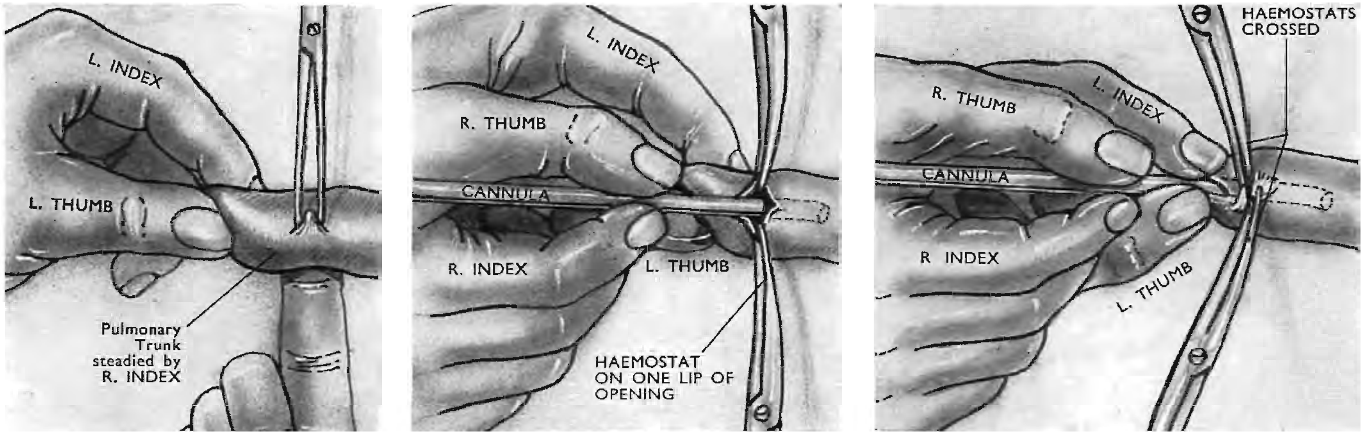
THIRD OPERATION

The third patient—like the second—was alive in the early part of the operation, though obviously dying. The heart stopped immediately after the pericardium was incised.

Professor B. O. Pribram (a refugee in 1940, but formerly Professor of Surgery in Berlin) told me that he too, on opening the pericardium, had seen the heart stop and require massage to restore its beat. Others have stopped it, as I did in my second case, by hooking up aorta and pulmonary artery. It would be well to know how these stimuli act, and meanwhile, perhaps, to atropinise the patient thoroughly before operation.

This time I did not hook up or disturb the aorta ; it was, however, easy to grasp and control the pulmonary artery separately between finger and thumb while I made a short opening in its wall. The lips of this opening were caught with delicate hæmostats, and the cannula after a moment's check found the way in (Fig. 89, A, B, and C). There were no clots in the main trunk, but several were sucked from right and left branches and quickly reached the flask of the aspirator. I thought afterwards how useful a manual control would have been with which I could interrupt aspiration myself and then redirect the cannula while circulation continued round it.

It is by no means difficult to stop hæmorrhage from the pulmonary artery where pressure averages a fifth of that of systemic trunks and through sympathetic influence may rise during systole to perhaps 50 to 60 mm. Hg. Mr R. Shackman and I have found by experiment on fresh post-mortem material that the crossing of two hæmostats placed on the lips of the small opening by which the cannula enters prevents leakage (Fig. 89, B and C), even if pressure within the vessel is equal to the



A B C

Fig. 89

A. The pulmonary trunk controlled immediately before opening the vessel. The right index in the transverse sinus locates and steadies the trunk, while the first assistant picks up a fold of its front wall with a fine-toothed forceps. The surgeon withdraws his right index from the sinus and uses his right hand to open the artery. Then, and not till then, he occludes the lumen between left thumb and index. If the artery wall is friable the finger of a *second* assistant should replace the surgeon's in the sinus to relieve strain by supporting the vessel. The aorta is not disturbed nor is the pulmonary trunk hooked up.

B. The pulmonary trunk is opened and the cannula passed. The lumen of the trunk is still momentarily occluded by the surgeon's left thumb and index. He has opened the vessel by cutting through the fold (A). The first assistant has caught each lip of the opening with a Dunhill hæmostat.

C. Prevention of leakage. The momentary occlusion of the trunk's lumen has ceased. The first assistant has crossed the hæmostats to prevent leakage. The surgeon, after releasing the lumen, is now using his *left* thumb and index to fix and further seal the opening by pressing its lips against the cannula.

maximum found in normal life. At the low pressures, therefore, that go with pulmonary embolus risk of hæmorrhage is small indeed. None the less, however, in operating on our patient we took care to reinforce closure by pressing the lips of the opening with finger and thumb against the wall of the cannula (Fig. 89, c).

A DRAFT OF TECHNIQUE

The following provisional scheme, based on my three operations, will serve for epitome.

1. **Skin preparation.**—As soon as operation is even considered,

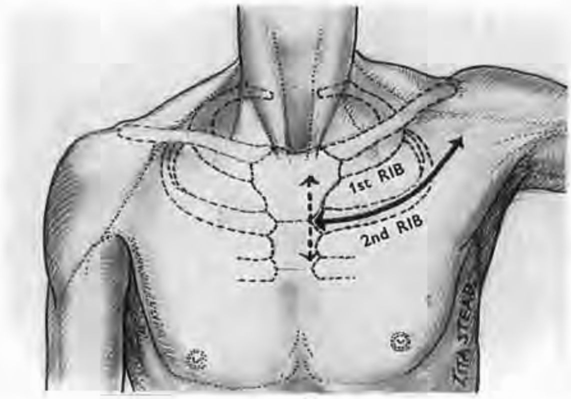


Fig. 90
The incision
Its sternal limb allows the wide exposure of thoracic skeleton from which alone the 'working-depth' is reckoned.

prepare the whole front of the chest and upper part of the abdomen.

2. **Local anæsthesia.**—If likelihood of operation increases, infiltrate a triangle whose base on the left edge of the sternum measures a liberal span from the sternoclavicular joint, and whose apex lies a span out along the second left rib. The epigastrium, too, should be injected in view of cardiac massage. (My second and third operations were performed under local anæsthesia.)

3. **Incision** is T-shaped (Fig. 90); it cuts down on 7 in. of sternal border and on 7 in. of second rib and cartilage. (Beginners—for fear of opening pleura—should by no means follow the expert who cuts between ribs.) The flaps of skin and pectoral muscle are then turned back from the costal plane widely enough to let the operator proceed unhampered from this new surface and so

reduce the working depth of the wound. It is prudent to open the epigastrium at this stage.

4. **Resecting the second left rib and cartilage.**—After superficial

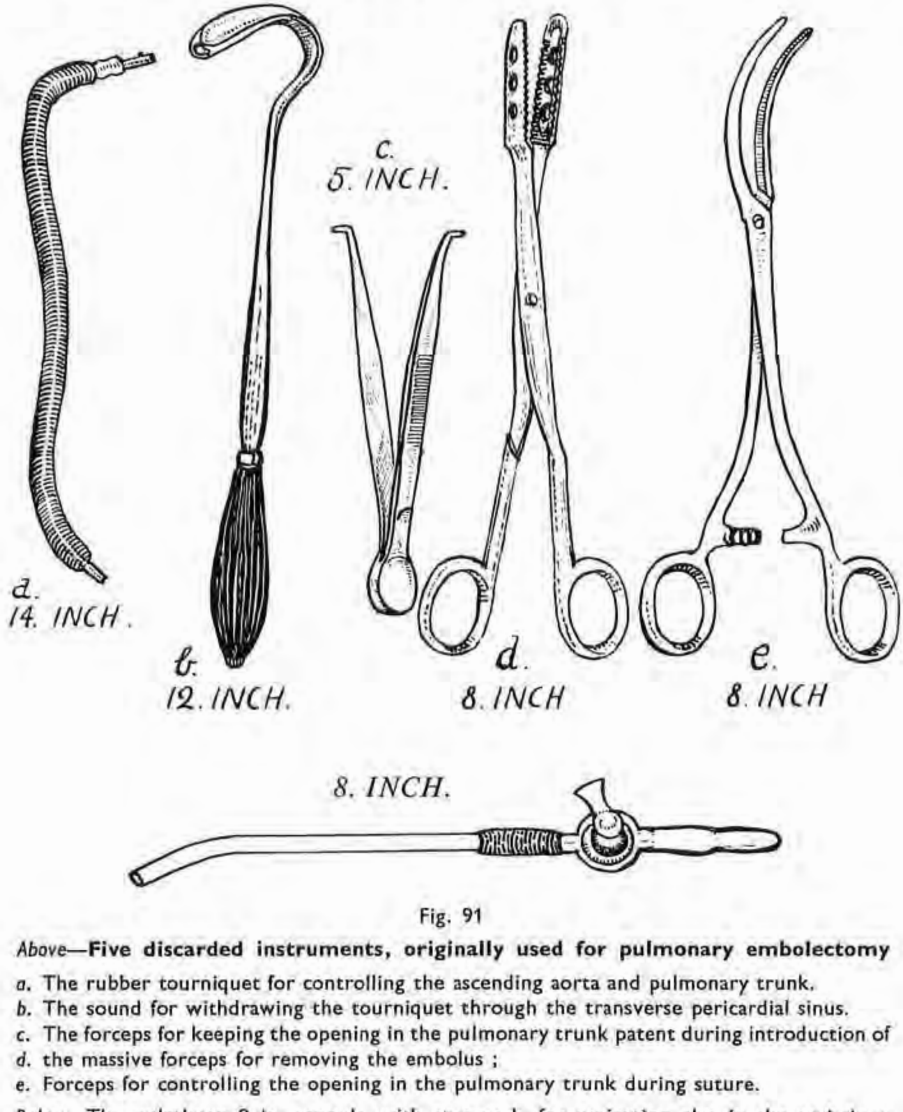


Fig. 91

Above—**Five discarded instruments, originally used for pulmonary embolectomy**

a. The rubber tourniquet for controlling the ascending aorta and pulmonary trunk.
b. The sound for withdrawing the tourniquet through the transverse pericardial sinus.
c. The forceps for keeping the opening in the pulmonary trunk patent during introduction of
d. the massive forceps for removing the embolus ;
e. Forceps for controlling the opening in the pulmonary trunk during suture.

Below—The polythene 8 in. cannula, with stop-cock, for aspirating clot in the technique described here.

division, above and below, of intercostal muscles, begin with the cartilage, near the sternum. In this place a streak of fat clothes the internal mammary vessels, which lie deep to the cartilage, and with them keeps the pleura far enough off to give a safe plane of cleavage to any common raspatory that is slightly curved on the flat near its edge. Divide the sternal end of the cartilage and use it for drawing the rib gently away from the pleura while the curved raspatory helps a finger to finish the extraperiosteal separation. Resect at least 6 in. of rib-plus-cartilage—a wide removal which gives the great advantage of *oblique* access.

5. **Exposure of the pericardium.**—With the pulp of the finger draw the edge of the left pleural sac outwards. To do this without

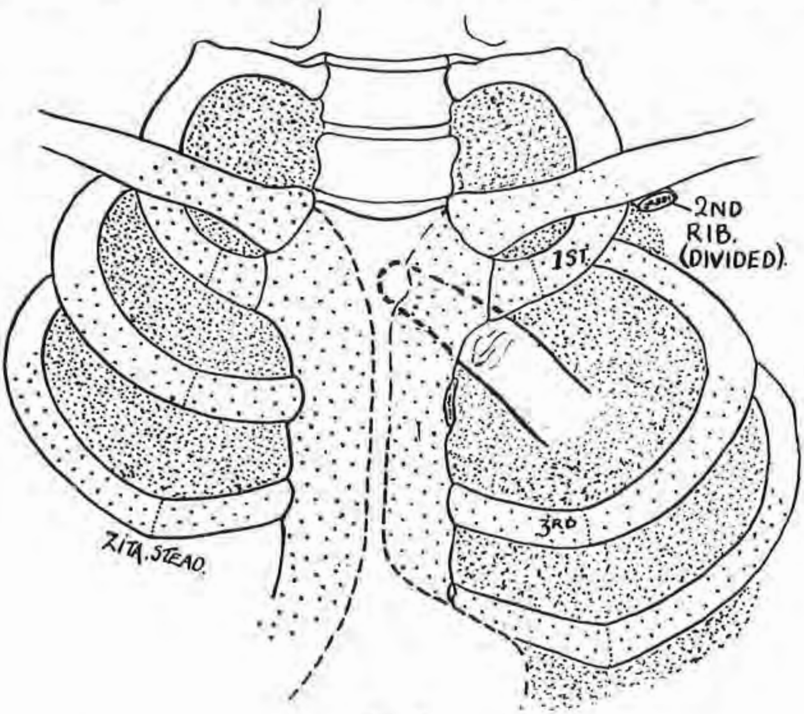


Fig. 92

opening the pleura choose a spot at the lower border of the first costal cartilage and work a finger in gently under the mammary vessels, then under the manubrium. Aim the finger so as to reach the middle point of the manubrium, and, when that point is reached, but not till then, flex the finger and begin to mobilise and retract the pleural edge; for there the left sac leaves its fellow and goes to its own apex (Fig. 92). This is only another use of the old trick of tracing planes of cleavage from the place where structures part, and after learning to apply it here I never opened the pleura once in all the material put so generously at my disposal by Professor J. H. Dible; nor was it opened in any of my three patients.[1] A very little care leaves the internal mammary vessels unharmed and close to the sternum. The gap left by the wide resection of rib allows the apex of the lung to be mobilised and then flattened in a posterior direction within the sac of the pleura, a flattening which liberates the side of the pericardial cone and so gives better access to the pulmonary trunk, which slopes backwards. Withdrawing the pleura reveals a variable thickness of propericardial fat, which is sometimes pink and feebly vascular; pick this up in forceps and divulse it boldly with blunt-nosed scissors down to the smooth, unmistakable face of pericardium.

6. **Opening the pericardium.**—Catch this membrane near the sternal edge with a fine-toothed forceps; open it longitudinally for at least 3 in. with the same scissors and expose the conus arteriosus of the right ventricle in company with the pulmonary trunk and ascending aorta.

7. **Catching and opening the pulmonary trunk.**—Slide the tip of the right index into the transverse sinus (see the description of the first operation) and locate and steady, but *do not hook up*, the pulmonary trunk (Fig. 89, A). The assistant, standing on the right of the patient, then catches the middle part of the trunk with a fine-toothed forceps held in his left hand, making a small transverse fold in its anterior wall (Fig. 89, A). The surgeon withdraws his right finger from the sinus and occludes the stem of the pulmonary trunk between left thumb and index close to the heart. To prevent the forceps from tearing a friable trunk the surgeon's finger must be replaced in the sinus by that of a *second* assistant, who thus relieves strain by supporting the vessel. Scissors in the surgeon's right hand now cut longitudinally into the artery through the small transverse fold held by the first assistant. The opening in the vessel should be just large enough for the cannula. The scissors are then put down and the cannula is picked up. The first assistant, using his right hand, meanwhile grasps in turn each lip of the opening with a delicate hæmostat, taking care to keep his original hold of the vessel with the toothed forceps till the second hæmostat is on (Fig. 89, A and B). (I used Dunhill's goitre hæmostats for this purpose and found them excellent.) It is worth noting that some pericardia contain oily fluid, which makes the pulmonary trunk slippery; it might thus be well for the surgeon to wear cotton gloves over rubber ones.

[1] Behind the sternal *body*, on the other hand, the two pleural sacs are sometimes in wide apposition; separation there is done at great disadvantage.

8. **Passage of the cannula, hæmostasis, and removal of clot.**—The surgeon, still occluding the lumen, passes the cannula through the opening. The first assistant then forestalls hæmorrhage by gently crossing the hæmostats over the cannula (Fig. 89, c). This control of the opening is the cue for the surgeon to release his grasp of the lumen ; he now uses his *left* thumb and index and presses instead the wall of the vessel against the cannula to fix the opening and keep it shut when the cannula moves from branch to branch (Fig. 89, c). A tap controls suction (Fig. 91). Small clots go clean through the cannula ; the large stick in the nozzle and can then be drawn out. By this method, therefore—with fingers and aspirator in place of tourniquet and clot-forceps—the lumen of the pulmonary trunk is only closed during the very few seconds required for opening the wall and passing the cannula in. Aspiration is stopped while the cannula moves from branch to branch, so that blood may circulate past it. (The directions of the main branches of the artery—the left almost perpendicular to the table, the right nearly horizontal—must be remembered.) *There is at no time interference with the aorta ;* indeed, the hooking up of this trunk seems in retrospect an unnecessary act of violence.

9. **Closing the incised trunk.**—After removing the cannula, keep the hæmostats crossed at the lips of the opening and close the trunk with mattress sutures. Then close the pericardium and chest wall.

I would stress here the need of training oneself and others for embolectomy on fresh unhardened cadavers ; formalin stiffens and withdraws parts otherwise supple and easily reached, while stale material tends to exaggerate difficulties due to friability. I have had recently to demonstrate the operation on preserved cadavers ; in all but one of them the heart and great vessels had withdrawn to the right and backwards. Even in that awkward abnormal situation it was easy to gain separate control of the pulmonary trunk—not indeed as usual with left thumb and index but between the two index fingers of an assistant standing on the right side of the subject. Approach in a difficult case of this sort, or in any case, is greatly helped by tilting the chest with a pillow under the left scapula. The surgeon will then appreciate in full the value of oblique access given by a really wide resection of the second costal arch.

Summary

Attention is called to certain points in the operation for removing pulmonary clot.

Flaps are reflected widely enough to reduce 'working' depth by making a new surface at the level of the ribs. The epigastrium is opened early for possible cardiac massage. Wide resection of the second left rib gives oblique access to the pulmonary trunk, for through the large gap the lung apex can be mobilised and flattened backwards within its pleural sac. These parts are seen best when a pillow is put under the left scapula of the patient. The likeness to thin dura of pericardial wall helps the surgeon to find it through any thickness of propericardial fat.

Two methods of finding the transverse sinus are described. No sound or tourniquet is passed through it; *the sinus is used merely in locating and steadying the pulmonary trunk.* The aorta is left undisturbed. The pulmonary trunk is separately controlled with the fingers; it is *not* hooked up. An aspirating cannula, properly curved, is used instead of forceps for removing clot. The cannula requires only a short opening in the pulmonary trunk, and, when it enters the lumen, hæmostasis can be secured at once. The time during which fingers occlude the lumen of the trunk is thus reduced to the few seconds spent in making the opening and passing in the cannula. Bleeding from the pulmonary trunk after the introduction of the cannula is prevented by crossing the two hæmostats which have caught the lips of the opening in its wall; this opening is further sealed by pressing it against the cannula. A tap stops aspiration so that circulation may proceed while the cannula is redirected from branch to branch.

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ANTERIOR EXTRAPLEURAL ACCESS TO UPPER THORACIC GANGLIA, SYMPATHETIC AND SPINAL [1]

Years ago, during a former appointment at the Royal College of Surgeons in Ireland, one of us came upon a dorsal route—procured by costotransversectomy—for dealing with the upper part of the thoracic sympathetic chain (1922). Before that date, in Continental surgery, and later here (though not in the United States, where Adson gave the Dublin method currency in 1928), emphasis lay most on a cervical path for entering the chest by way of the thoracic inlet. From 1934, however, the dorsal route—adapted then for sectioning preganglionic fibres—acquired new prestige.

A choice of means uncramps the mould of surgical procedure, and so we venture to describe a third approach.

In 1942 a Service class held at the British Postgraduate Medical School was shown how a cannula could aspirate a pulmonary embolus without the added use of clamp, or tourniquet, or anything but fingers, scissors, and mosquito forceps. And, afterwards an officer, who hurried out and left no name, drew our attention to a windfall we had missed—the reach of sympathetic chain accessible on drawing down the pleural dome through the large gap produced by wide removal of a second rib and cartilage.

Division of this second cartilage beside the sternum is easily performed without incising pleura: the sac is buffered off the cartilage by internal mammary vessels which run within a streak of fat, and often by a portion of the sternocostal muscle. So, when the knife has freed both borders of the cartilage, a little-finger tip and then a curved director find room to pass beneath it and protect the pleural sac.

The lifted cartilage provides a handle for gently raising up the rib from the undamaged, close-adherent pleura, and safely clearing it far into the axilla; there the rib is either cut away or, better, cracked across for subsequent replacement.

The way of entry next the sternum thus obtained will let us separate the pleural sacs; for these are parted best—like other structures—from levels where they naturally trend apart. The

[1] T. P. Garry and A. K. Henry, *Irish Journal of Medical Science*, October 1949, p. 757.

index finger, therefore, sliding in until its *nail* lies close behind the midpoint of manubrium (Fig. 93) will, when the finger tip is flexed, engage the separation of the pleural domes (Henry, 1940). A little movement sideways soon makes room for entry of the middle finger; and presently the whole hand slipping in can peel the dome intact from the thoracic inlet. The dome, with the included apex of the lung, is drawn easily towards the diaphragm, and so leaves bare (excepting for a lining of translucent fascia)

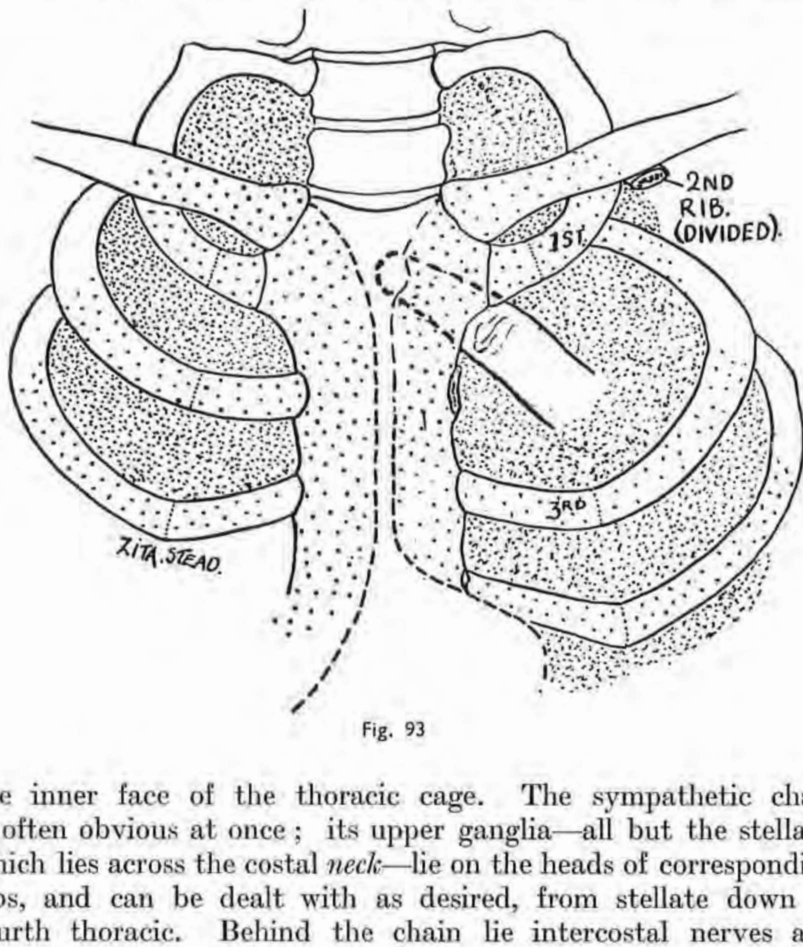

Fig. 93

the inner face of the thoracic cage. The sympathetic chain is often obvious at once; its upper ganglia—all but the stellate, which lies across the costal *neck*—lie on the heads of corresponding ribs, and can be dealt with as desired, from stellate down to fourth thoracic. Behind the chain lie intercostal nerves and vessels.

The present-day objective.—Resection of some inches of the third and second of these nerves with rami grey and white, including, too, the hinder primary divisions, and, finally, a sub-arachnoid section of their *roots*, both sensory and motor—these steps to-day afford a favoured means for burking the regrowth

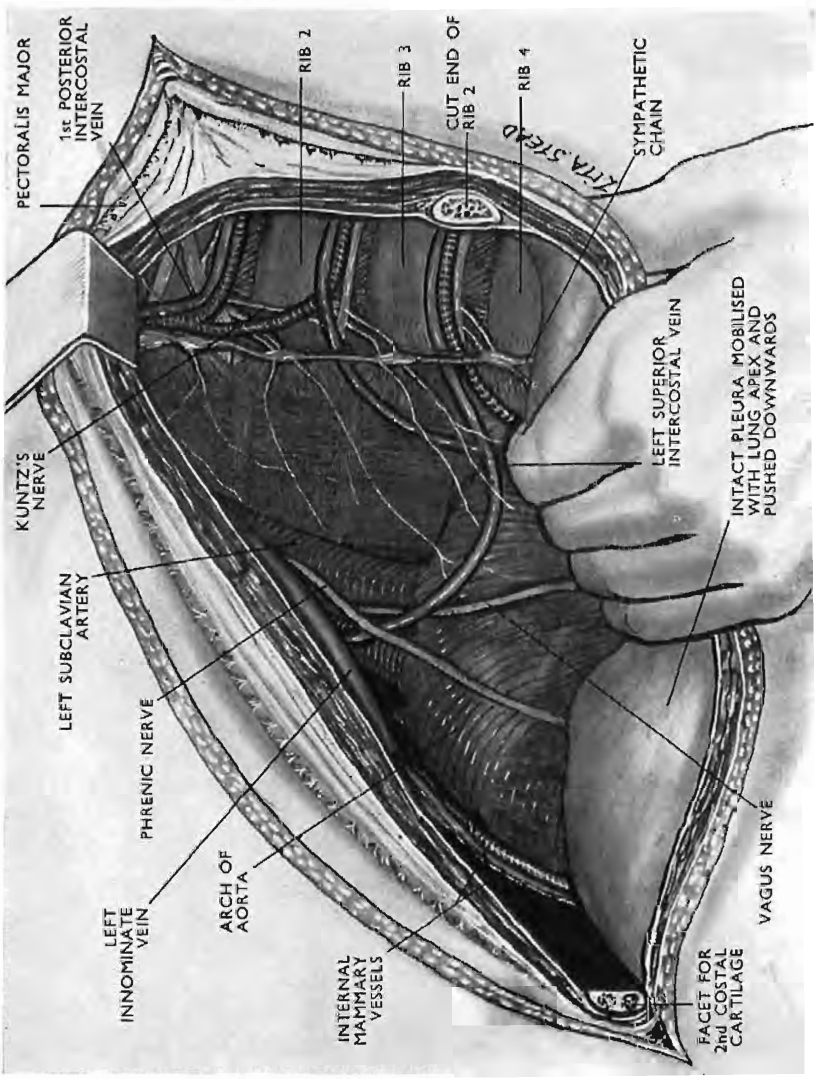

Fig. 94
The Exposure.

of upper-limb *pre*ganglionic fibres that govern sweating and constrict the vessels (White and Smithwick, 1942).[1]

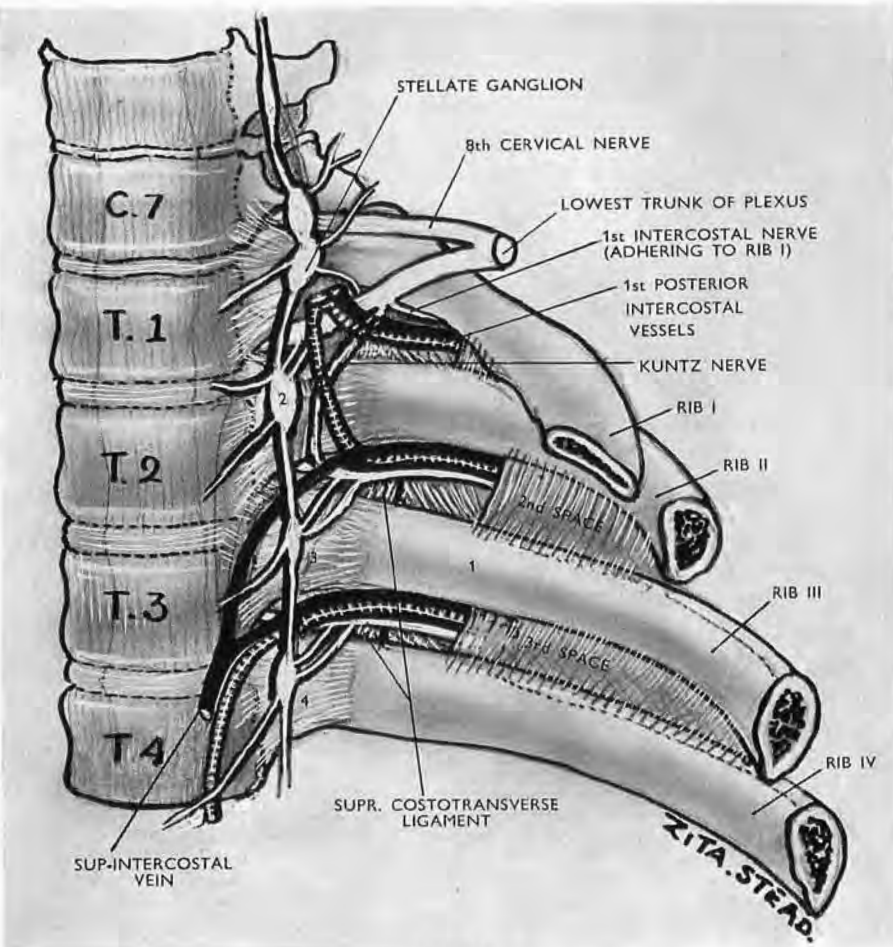

Fig. 95

Diagram of parts seen in the transthoracic extrapleural approach to upper thoracic ganglia. Kuntz's nerve has its common relation to the anterior primary ramus of Th. 1, joining the ramus close to where the first intercostal nerve separates. (M. Stranc.)

We find it easier to trace and clear and resect nerves Th. 2 and Th. 3 (together with the chain) through the anterior route than through the dorsal path obtained by costotransversectomy: the prospect from in front is very wide indeed. The intervertebral foramina are readily accessible between the heads of ribs, though

[1] These authors' own account of their technique with costotransversectomy suggests they would be glad if it were possible to drop the part concerned with root resection. This, from behind, can sometimes be most difficult, though easy from in front.

each is covered and concealed. Except in the obese, the trunks of intercostal veins and arteries (which pass behind the chain) are plainly visible (Figs. 94 and 95).

ANATOMICAL CONSIDERATIONS

Finding the second rib in the chest.—It is, unfortunately, easy, as was stressed in the former Dublin method, to miscount ribs when working from the back ; the natural kyphosis of the upper dorsal vertebræ brings first and second ribs confusingly together. The same is true when working from within the chest—a fact which matters in determining the number of a sympathetic ganglion or of an intercostal space beside the spine. We find it can be curiously baffling to try to follow back the second rib from where it has been cut in the axilla : the finger slips unwittingly along the third.

Within the chest the sharp front edge of the first rib (though out of sight) is clearly felt two fingerbreadths lateral to the vertebral bodies, and is, of course, the spot from which to find the second. Pass in the hand, therefore, palm up, left on left side, right on right, with the index touching the vertebral bodies. The middle finger goes through the thoracic inlet, and is made to bulge the tissues of the neck above the clavicle, a sign that it certainly lies above the first rib. Then travelling down and back into the chest the middle finger nail slides over the sharp edge of the first rib, and—after moving only through the thickness of the finger tip—strikes the second rib, below and behind the first. It is easy to pass an instrument along the palm and mark the second rib for recognition by means of dye or a clip.

Foraminal coverings.—A handbreadth from the bodies of the vertebræ each intercostal nerve is screened by tense translucent fascia, and, followed centrally, is lost to view (together with the vessels) ; for fat accumulates between the costal heads behind the fascia, and there occludes and hides each intervertebral foramen.

Considered from the surgeon's point of view, this cellophane or onion-skin-like membrane forms a single barrier, but one of us (T. P. G.) has found the 'skin' is really double, consisting of two demonstrable coats : (1) An inner fascia called till lately *endothoracic*, which, though the name has dropped from books, continues still to line the chest after we strip the wall of pleura.

This layer where it lies on the ribs is loosely joined, but normally not fused, with periosteum. (2) The second 'skin,' which partly coats the outer surface of the first, invests the flattened *endocostal* bellies (sternocostalis alias trangularis sterni, subcostales, intercostales intimi); and fusing where it touches periosteum, spreads in and out *between* each pair of ribs, across the intervals that part these scattered groups of muscle. This outer patchy 'skin' might well be called the *intracostal* fascia.

Ligaments.—Two sets of these are relevant. The first, the superior costotransverse, is formed of thumbwide bands that lie a thumbwidth lateral to vertebral bodies: one in each intercostal space unites the nuchal crest belonging to the lower rib with the preceding transverse process next above (Fig. 95). Each slopes just lateral to and partly screens the stout posterior primary ramus; it also lies *behind* the anterior ramus, which is, of course, the intercostal nerve. The ligament affords a useful base for scissors to divide the hinder ramus (p. 158).

The second ligament, remarked by one of us (T. P. G.), is small, inconstant, and, so far as we can find, unnamed. It matters, for, when present, it lies in front of, and blocks our access to, the very short thoracic trunk formed by the union of motor and sensory nerve roots (p. 158). We shall therefore liberate the obvious trunk and use it plus its anterior ramus as a handle for getting control of the far less obvious roots.

The second and third thoracic nerve roots.—The roots of Th. 2 and Th. 3, if measured from their highest levels of attachment to the cord, begin about two fingerbreadths or, more exactly, 33 and 38 mm. above the points where they escape from intervertebral foramina (Soulié). These segments of the cord leave no more room in the canal they occupy than that which lies around a little fingertip encircled by a dorsal vertebra, and in that tiny space the roots are almost vertical to any transverse section of the cord. Then, suddenly, on leaving the canal at a foramen, the roots turn through a full right angle (Fig. 96). Both facts are useful to the surgeon. For, firstly, since these roots converge downward, towards the point of exit, their sensory and motor parts—which on the cord are separated only by about 5 mm.—come close enough together to be cut 'in one' as they emerge from each foramen. And, secondly, the sudden bend as they emerge protects the cord from minor operative pulls whose brunt will fall instead on the foramen's mouth.

A recent windfall (1956), photographed as Fig. 97, bears out our draft of 1949 (Fig. 96). This draft was put forward in lieu of ocular proof of the supposed true lie of upper dorsal roots. We had inferred this layout from tables of nerve-root length (due separately to Soulié and to Hovelacque), considered with our measurements of cord and dural-sheath diameters.

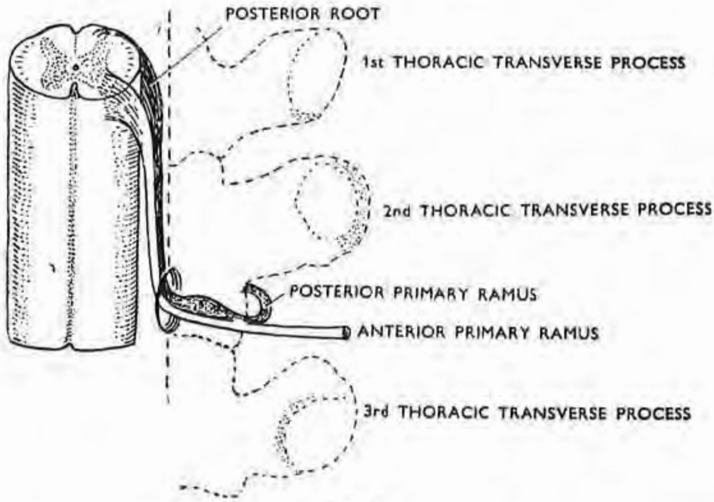

Fig. 96

The second thoracic segment

This draft of the lie of roots of Th. 2 was inferred (1949) : (*a*) from their average intradural length at this level—33 mm. or two fingerbreadths ; (*b*) from estimates of cord and dural-sheath diameters. (Compare the actual specimen in the next figure.)

Note how the spinal ganglion at upper thoracic levels is *not* framed by the foramen but lies outside on a sill formed by articular processes where T. P. Garry's 'jolt' test detects it in the dead *and* in the living subject (Professor P. Fitzgerald).

Comparing that draft (Fig. 96) with the actual specimen, one sees in both the surprising—almost vertical—drop of an upper dorsal root, so very like the more familiar lumbosacral declivities.

In the draft figure (Fig. 96) the intradural root length was made to equal Soulié's mean of 33 mm.—an average length of two fingerbreadths. In the actual specimen photographed in Fig. 97, the root length of Th. 2 was considerably longer (44 mm. on the right side ; 46·5 mm. on the left side), which proves our inference to be an understatement.

Two months later, however, another specimen was found with Th. 2 root lengths of 35 mm. (right) and 37 mm. (left), which gave a close agreement of inference and fact.

Thus it would seem that the splayed-out courses of upper

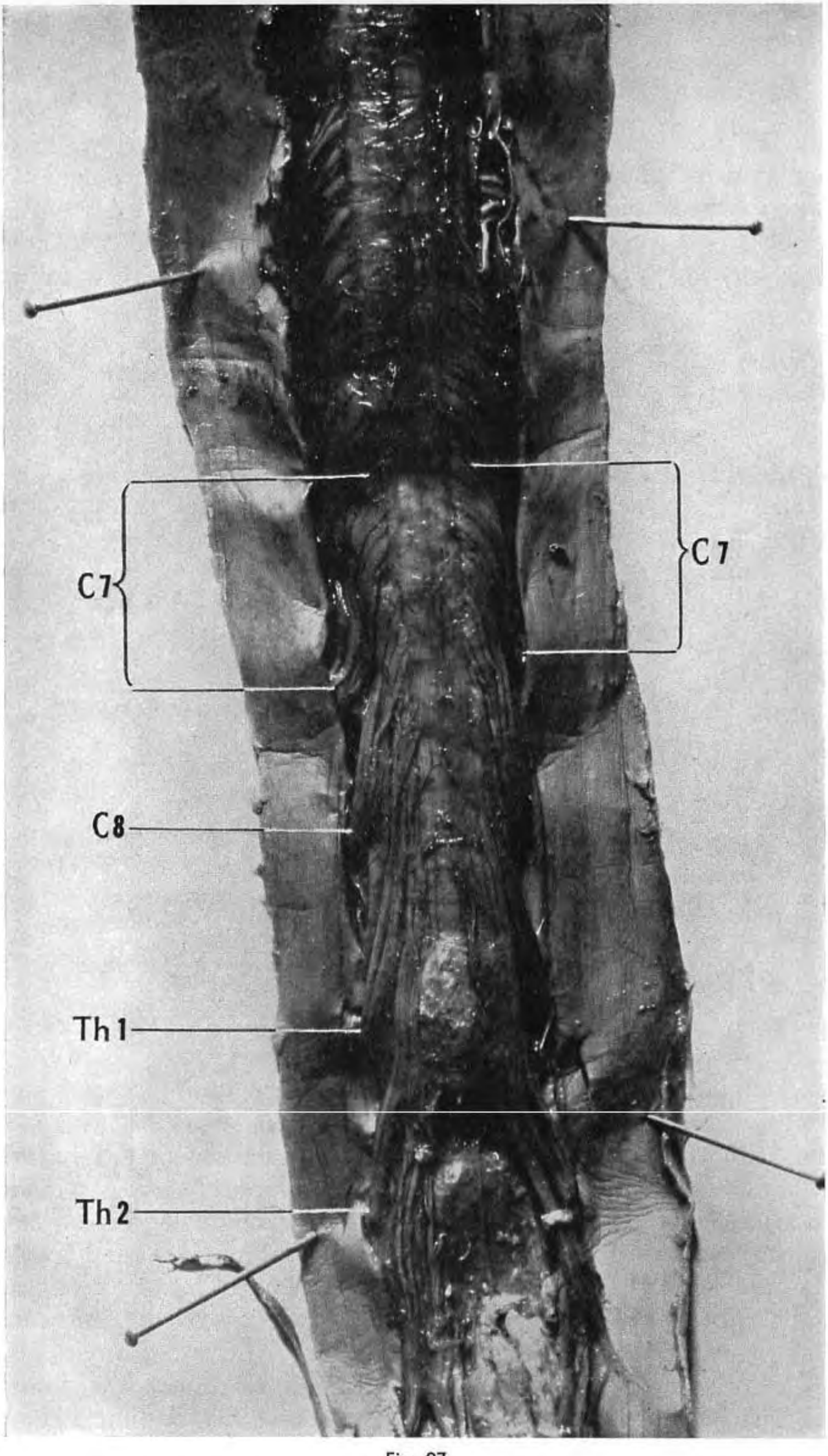

Fig. 97

Photograph of a hardened spinal cord with opened membranes (slightly enlarged)

Despite the widely gaping dura a rare chance has let thoracic roots stay put. They thus go steeply and unsplayed to reach their dural openings, just as though they still were crowded in the narrows between cord and close-encircling sheath.

dorsal roots shown in the text-books are nothing more than artefacts—"errors of retraction," essential for presenting nerve-root pictures (Fig. 98).

Our draft, however, failed in one respect: it did not demonstrate that individual rootlets cling to the cord through half their length as they stream down and mould themselves to its circumference.

This *moulding* is clearest in the photograph at the seventh cervical segment where (unlike their thin thoracic fellows, from Th. 2 to Th. 12) rootlets suggest the back of a child's head with hanks of hair smeared down to right and left and parted widely (Fig. 97).

The position of thoracic spinal ganglia.—The text-books (Buchanan, Cunningham, Gray, Piersol) state that these ganglia lie *in* the intervertebral foramina. From this agreement one would think that if the intervertebral foramen were, as the Latin word implies, a hole, or like, perhaps, an open window, it then should frame the ganglion. In point of fact the ganglion appears to lie *outside* the window—on the sill. Each sill is formed by joined articular processes, protruding right and left so that they show beyond the bodies of each pair of vertebræ; and looking from above directly down on a recumbent spine one does not see the intervertebral foramina; one sees the sills that bear the ganglia (Fig. 96).

A barrister, however, might contend that 'intervertebral foramen' may apply not only to the obvious and rounded hole between two vertebræ but also to an orifice, elliptical in shape, whose longer axis and whose plane slope back and outward from the bodies. The inner pole of this ellipse would then be figured by the front edge of the hole; the outer, by the outer edge of the combined articular facets. And so, by thus imagining a funnel sliced obliquely, he could contrive to bring the sill within the bounds of the foramen. The barrister might, therefore, argue that a ganglion—like an evasive member of the Commonwealth—can be both 'in' and at the same time 'out.' Anatomists, we hope, will leave that kind of shift to older callings, and either rule that these upper intervertebral foramina are simply holes (resembling their congeners elsewhere), or that they constitute a special order of foramen—the silled or liminate.

Meanwhile what matters to a surgeon is the fact that ganglia of the thoracic nerves do *not* lie in a hole, but clean outside it on a dorsal sill—so far outside, indeed, that we shall show they can

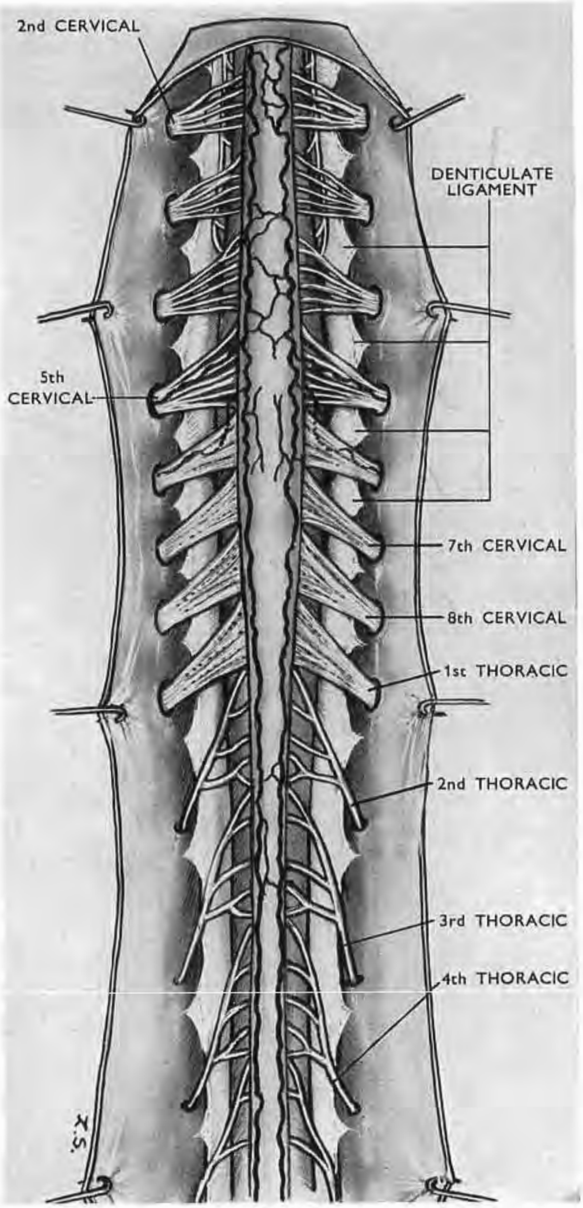

Fig. 98

The upper spinal nerve roots (after Hovelacque)

The wide abduction of the roots in this figure is required to demonstrate three of the different types of rootlet distinguished by Hovelacque—upper cervical, lower cervical, thoracic.

Current illustrations in other hands are misleading and often fail in four respects : (1) they do not distinguish variety in upper spinal roots ; (2) they greatly shorten their intradural length ; (3) they change an almost vertical trend below C7 to a frank outward slope ; (4) they fail to mould the rootlets to the cord.

be lifted forward (with their roots intact) and *felt* by pressing them against a rib head.

In case experience should clinch the usefulness of spinal-root division, there follows a technique for its performance from the *front*.

SECTION FROM IN FRONT OF SENSORY AND MOTOR ROOTS

A special instrument.—Apart from means of lighting up the field, the only special tool that helps in the performance of the operation is a very long-handled pair of Bozeman's gynæcological scissors, which one of us (T. P. G.) discovered rusting in a junk shop on the Dublin quays. These scissors (Fig. 99) have two

Fig. 99
Bozeman's 10-in. scissors, invaluable for dividing anterior and posterior nerve roots.

useful curves: their 10 in. shaft is (like a rifle) cranked near the grip; the nose is oppositely bent (and slightly twisted) on the flat. So, when the user sights along the shaft, he has unbroken view of what he wants to cut.

The sympathetic chain.—The chain where we divide it lies in front of intercostal nerves and vessels; therefore divide it first. Cut it below the third thoracic ganglion, counting the first as portion of the stellate. Displace the upper segment of the chain towards the patient's head, dividing rami communicantes and medial branches. This gives access to the site of intervertebral foramina. (The surgeon deals with the divided chain as he prefers —resecting it below the stellate, encasing it in silk, displacing it to dorsal muscle, or blocking it with alcohol injected neat or laced with phenol.)

Rami, roots, and ganglia of Th. 2 and Th. 3.—Divide each anterior ramus alias intercostal nerve 2 in. lateral to bodies of the vertebræ, and take it as a guide. Lift the cut central end and trace it medially. (Use clips and then divide the vessels where they screen the lifted nerve.) A thumbwidth from the vertebræ the nerve is tethered by its dorsal ramus which lies beside the inner edge of the superior costotransverse ligament, and travels with a dorsal vein and artery. The ramus and the vessels should be therefore ' clipped ' *en masse* before we cut them.

Dividing the dorsal tether.—Its section is accomplished by passing the tip of the Bozeman scissors in along the intercostal space, letting its convex aspect slide on the front of the superior costotransverse ligament. (When cutting through this tether take special care the scissors' tip does not rise forward off the ligament and cut by accident the nerve *trunk* with the ramus.) Clip the tether as far back as possible. There will seldom be room enough for two clips between which to cut, so do not hesitate to cut the bundle in *front* of a single clip: bleeding from *central* ends of the divided vessels—if not already checked by clips put on the screen of major intercostal veins and arteries—at once becomes accessible by severing the dorsal tether. Should the clip fail to close the dorsal vessels, division of the costotransverse ligament gives access to the bleeding point, which will retract towards the dorsal muscles. The *second* ligament, in front of the thoracic trunk—if present—must be cut (p. 152). The trunk thus liberated leads us to the spinal nerve roots.

Finding the spinal ganglion and dividing the nerve roots.—The closed tip of the scissors can now locate this ganglion, which is both firm and inconspicuous: the metal sliding out across the ganglion jolts on to bone, as if it had crossed a knot (T. P. G.). The bone may be the foramen's sill or the rib head, depending on the direction given to the handle formed by the liberated trunk and the divided intercostal nerve. And once it has been felt its shape will be descried.

Next, with the ganglion located on the dorsal root, divide the root just central to the ganglion, turning the scissors' tip conveniently to cut through motor roots as well. The presence of recurrent vessels at each intervertebral foramen makes it advisable to catch the roots with clips before dividing them.

Division of the roots necessitates, of course, an opening of the subarachnoid space, so spinal fluid leaks; but Smithwick finds that this gives no occasion for concern.

The method we describe already claims the signal privilege of having been used in Dublin by Mr (now Professor) P. Fitzgerald, at St Vincent's Hospital, in June 1948.

Two anatomical points are worth emphasis :—

1. The accessibility of the upper thoracic spinal ganglia which are more laterally placed than text-books suggest and can thus be felt by Garry's ' jolt ' test.
2. The intradural lie and length of upper spinal roots are quite unlike their current portraits.

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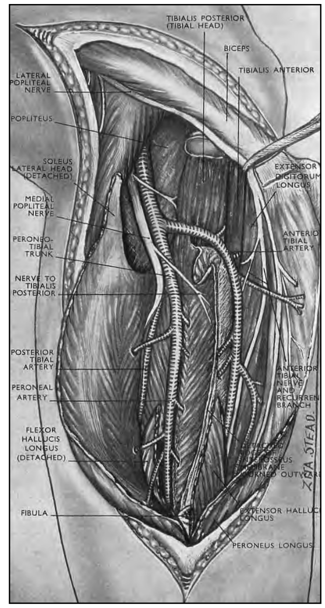
This book is a surgical classic -- it is famous for what a reviewer described as its “use of the English language and its literature to present cold fact with such warmth and life”. It has been unavailable for some time, but is now available as a facsimile of the second edition with the addition of a short bibliographical note by Arnold K. Henry himself.

An exposure is the route by which the surgeon gains access to the structures on which he or she wishes to operate, and the exposures can be extended if necessary (hence the term “extensile exposures”). Many of the exposures described in this book are still in use, but it will mainly be obtained for the literary pleasure of reading.

As it has been out of print for some time, many surgeons will be pleased to have the opportunity of adding this famous work to their libraries. The Lancet: “There is no pleasanter way of revising anatomy”. British Medical Journal: “The distinguished author is to be congratulated on this further development of a masterpiece”.



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